Connected Vehicle Pilot Deployment Program Phase 2

Interface Control Document (ICD) – WYDOT CV Pilot

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Notice

Version History

#	Date	Author	Comment
1	06/01/2017	WYDOT	First draft of the ICD
2	06/17/2017	WYDOT	Updated based on vendor updates
3	07/27/2017	WYDOT	Updated based on SDD and vendor updates
4	09/04/2017	WYDOT	RDE & CVPEP interfaces added.
5	12/21/2017	WYDOT	Final version based on USDOT comments
6	02/16/2018	WYDOT	Traceability cleanups. Integrated Commercial Vehicle CAN interface added to Architecture Diagram.
7	03/16/2018	WYDOT	Updated requirement references.
8	06/01/2018	WYDOT	Updated Architecture diagram. Renamed CVPEP to SDC. Removed SCMS<->ODE. Removed CAN from Retrofit Commercial Vehicles. Added HSM.
9	07/27/2020	WYDOT	Updated to reflect the “as built” version of the system.

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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 is being 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 Interface Control Document (ICD) for the physical object connections and data flows identified in the System Architecture Document. The intent is to describe the interfaces and message flows for each data flow in the WYDOT CV Pilot. This As Built version of the ICD presents the latest information regarding these connections and flows, based on the final and deployed version of the system.

17. Key Words Connected Vehicle Technology, I-80 Corridor, Road Weather, Truck Safety, System Architecture	**18. Distribution Statement** This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161		
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1 Introduction

The Interface Control Document describes all interfaces and data flows shown in the System Architecture Document (SAD). All data flows and triples[1] that appear in the SAD appear in Covered Information Flows Section 5, sub-sections 5.X.X.2. Interface Functions that involve interoperable data flows (Category 1 or 2 Triples) are close to identical between the CV Pilot sites so these sections have been developed collaboratively between CV Pilots. Legacy Interfaces (those shown by a solid line within the SAD physical architecture view) that are not being modified for the WYDOT CV Pilot deployment, are not defined with extensive details in this ICD and rely primarily on external document references.

1.1 Purpose of the Interface Control Document

This Interface Control Document (ICD) captures the necessary information required to define the WYDOT interfaces. The purpose of this ICD is to clearly communicate all inputs and outputs for each action whether they are internal to the system or transparent to system users. The audience for this document is intended to be developers.

1.2 Document Overview

The document describes the purpose of each interface between system entities within the system of interest or between the system of interest and an external interface, message structure and protocol, size and frequency of transmission of data, security, timing and sequencing.

1.3 Assumptions

Key assumptions pertaining to external components for the implementation of the WYDOT Connected Vehicle (CV) Pilot include:

1. The Situation Data Exchange (SDX) will be continuously available during the pilot.
2. The Security Credential Management System will be continuously available during the pilot
3. The Dedicated Short-Range Communications frequencies will be continuously available during the pilot (the WYDOT Pilot is currently licensed for all 75 road side unit locations by the FCC for DSRC)
4. The WYDOT backhaul, used to connect the RSUs to the TMC, will have IPv6 natively running with IPv4.
5. The WYDOT TMC will have IPv6 access to the Internet.

[1] A triple is a three part list: "source", "destination", "function". The System Architecture Document formally defines all major operations of the CV system in terms of a source sub-system, a destination sub-system and a discrete operation performed.

1.4 Constraints

The WYDOT CV Pilot is designed with the following constraints:

1. The system is built to rely upon existing TMC and WYDOT ITS staff capabilities to operate. No authorization has been made for additional staffing.
2. The WYDOT backhaul data communications need to support this deployment exist along I-80. This is a mix of fiber, microwave and wireless. Upgrades have been authorized for IPv6 between the TMC and the RSUs.
3. All vehicle-to-infrastructure (V2I) and infrastructure-to-vehicle (I2V) communications will use DSRC (5.9 GHz); one or more service channels will be used to upload all data collected on the vehicles and download applications and operating parameters.
4. The backhaul bandwidth is limited and shared use with other WYDOT functions.

1.5 Risks

Key risks associated with the interfaces described here include:

1. The RSU and OBU vendors can not deliver devices compliant with the pilots SyRS.
2. The environmental sensor vendor can not deliver devices compliant with the pilots SyRS.
3. The WYDOT political climate changes and our pilot losses its current strong support.
4. The Distress Notification application is a new and untested application; this is inherently an added risk.
5. The CAN bus interface is complex and there are vehicle specific differences in CAN bus implementations. It is likely that our OBU and associated software will not be able to obtain the desired vehicle data over the CAN bus for many of the vehicles in the pilot.

   Mitigation: Most critical functions of the Pilot are not dependent on CAN bus integration. Additionally, *Can bus integration is no longer part of this Pilot.*
6. If the SDX is not available for delivering TIMs to Satellite Service Providers (SSPs) then the TIM notifications may not reach connected vehicles as quickly as expected, which will impact effectiveness of driver notifications.
7. FCC makes ruling dis-allowing DSRC frequencies.

2 Definition of Terms and Acronyms

Table 2-1. Glossary of Terms.

Term	Definition
Basic Safety Message	Connected V2V safety applications are built around the capability to transmit BSMs, following the Society of Automotive Engineers (SAE) J2735 standard. For additional details see Section: **7.1**.
Broadcast	Sharing data with no specific destination. All broadcast data is sent unencrypted but is signed with a certificate (based on the Institute of Electrical and Electronics Engineers (IEEE) standard 1609.2).
Commercial Vehicle Operator Portal	A free service provided by WYDOT to commercial vehicle operators traveling the state of Wyoming. The purpose of the portal is to provide commercial vehicle operators with road and travel information tailored to commercial vehicles.
Distressed Vehicle	A vehicle which is broadcasting the DNM to indicate it is in distress. Distress situation is ~~triggered automatically, e.g., air bag deployed, vehicle disabled, or~~ initiated by the vehicle operator.
DN, DNM	DN stands for Distress Notification. DNM stands for a TIM representing a Distress Notification. For details on this message see Section: **7.5**.
FEUmsg	Full Event Update Message (from TMDD Standard)
HMI	The Human Machine Interface used in the CV pilot will be an Android device. The Android device is used purely as the screen, speaker and input device for the OBU so no distinction is made between the HMI and the Android device itself. Throughout this document the Android device is referred to simply as the HMI.
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 an RSU.
Independent Evaluator	USDOT sponsored evaluators that will focus on measures not covered by the WYDOT team's evaluation, impacts of larger scale CV deployments, and national programmatic aspects of this CV Pilot project, combined with other similar projects being conducted. The IE works to understand how the project outcomes can contribute to the future of the CV Program nationally.
Maintenance Vehicle	WYDOT Maintenance Vehicles as used in this document primarily refers to large snow plows.
On-Board Unit	This represents the package of DSRC radios, computing, sensors and HMI that will be installed on a vehicle. This is like the Retrofit Safety Device used in the Safety Pilot Program.
Relay Vehicle	A vehicle which has received a DNM broadcast by a Distressed Vehicle and which has begun to broadcast the DNM for the benefit of other vehicles. Relay vehicle behavior is defined in Section: **5.1.2.3.2**.
Remote Vehicle	A connected vehicle that periodically and dynamically broadcasts a message about its general situation to a host vehicle.
Roadside Units	This represents the package of DSRC radios, computing, communications that will be installed on the roadside on I-80
Traveler Information Message	Connected vehicle applications are built around the capability to transmit advisory and road sign information to vehicles, following the Society of Automotive Engineers (SAE) J2735 standard. For additional details see Section: **7.2**.

Term	Definition
Triples	A triple is a thee part list: "source", "destination", "function." The CV system architecture document formally defines all major operations of the CV system in terms of a source sub-system, a destination sub-system and a discrete operation performed.
WYDOT Road Segment	A road segment is defined as a link in Traffic Management Data Dictionary (TMDD) v3.03c: a roadway or transit right-of-way between two nodes. WYDOT has implemented road segments to fully cover I-80 in both directions.
Transportation Management Center	Center that collects information and informs the public about changing travel conditions.

Table 2-2. Acronyms.

Acronym / Abbreviation	Definition
511App	WYDOT 511App (phone app)
ASN.1	Abstract Syntax Notation One
BCVI	Broadcast Vehicle Information
BSM	Basic Safety Message
CAN bus	Controller Area Network Bus
CAS	Central Authentication Service for single sign-on
CMS	ISS/GHS Certificate Management System
CMV	Commercial Vehicle
CRL	Certificate Revocation List
CVRIA	Connected Vehicle Reference Implementation Architecture
CVOP	Commercial Vehicle Operator Portal
SDC	Secure Data Commons
DN	Distress Notification (application focused term)
DNM	Distress Notification Message (TIM)
DSRC	Dedicated Short Range Communications
EWD	External Weather Data
GNSS	Global Navigation Satellite System
FCW	Forward Collision Warning
FLTS	Field Location and Time Source
HMI	Human Machine Interface, to include the Android device, speaker and display
HSM	Hardware Security Module
I2V	Infrastructure-to-Vehicle
IE	Independent Evaluator
IRB	Institutional Review Board
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
JSON	JavaScript Object Notation
LTS	Location and Time Service
MV	WYDOT Maintenance Vehicle

Acronym / Abbreviation	Definition
netCDF	Network Common Data Form
NTP	Network Time Protocol
O&M	Operation and Maintenance
OBU	On-Board Unit
ODE	Operational Data Environment
OTA	Over-the-Air
PDM	Probe Data Management
PID	Personal Information Device
PII	Personally Identifiable Information
Protobuf2	Protocol Buffers Standard Version 2
RDE	Research Data Exchange
RSE	Roadside Equipment
RSU	Roadside Unit
RSYNC	Remote Sync (Linux command)
RWIS	Road Weather Information Service
SAD	Systems Architecture Document
SDD	Systems Design Document
SDX	Situation Data Exchange
SCMS	Security Credential Management System
SNMP	Simple Network Management Protocol
SyRS	System Requirements Specification
TTI	Texas Transportation Institute
TIM	Traveler Information Message
TMC	Traffic Management Center
TMDD	Traffic Management Data Dictionary
TPI	Third Party Interface
TRAC	Transportation Reports and Action Console
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
VSL	Variable Speed Limit (aka. Posted Speed)
WSMP	Wave Short Message Protocol
WTI	WYDOT Traveler Information System
WYDOT	Wyoming Department of Transportation
WYDOT CA	WYDOT Construction Administration
WYDOT DB[2]	WYDOT Data Broker
WYDOT DW	WYDOT Data Warehouse
WYDOT IC	WYDOT Incident Console
WYDOT ITS	WYDOT ITS Maintenance

[2] The CVOP REST Service is a sub entity within the WYDOT Data Broker.

Acronym / Abbreviation	Definition
WYDOT ODE	WYDOT Operational Data Environment
WYDOT TRAC	WYDOT Transportation Reports and Action Console

3 References

3.1 Standards Bodies

The following table lists the major standards bodies referenced in this document.

Table 3-1. Standards Bodies

Abbreviation	Organization Name
AASHTO	American Association of State Highway and Transportation Officials
Bluetooth SIG	Bluetooth Special Interest Group
FHWA	Federal Highway Administration
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
ITU	International Telecommunication Union
NTCIP	National Transportation Communications for Intelligent Transportation System Protocol
OGC	Open Geospatial Consortium
SAE	SAE International
USDOT	United States Department of Transportation

3.2 Reference Sources

The following table lists the standards documents and other resources used and referenced to develop the concepts in this document.

Table 3-2. References.

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5.	*IEEE 1609.3-2016 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services* https://standards.ieee.org/findstds/standard/1609.3-2016.html
6.	*IEEE 1609.4-2016 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE) -- Multi-Channel Operation* https://standards.ieee.org/findstds/standard/1609.4-2016.html
7.	*IEEE 1609.12-2016 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Identifier Allocations* https://standards.ieee.org/findstds/standard/1609.12-2016.html
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#	Document (Title, source, version, date, location)
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19.	*IETF RFC 5905 - Network Time Protocol Version 4: Protocol and Algorithms Specification*, Internet Engineering Task Force, June, 2010 https://tools.ietf.org/html/rfc5905
20.	*IETF RFC 6455 - The WebSocket Protocol*, Internet Engineering Task Force, December, 2011 https://tools.ietf.org/html/rfc6455
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4 System Description

Wyoming is one of the first wave of CV Pilot sites selected to showcase the value of and spur the adoption of CV technology in the United States. CV technology is a broad term to describe the applications and the systems that leverage dedicated short-range communications (DSRC) for vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) and infrastructure-to-vehicle (I2V) communication to improve safety, mobility and productivity of the users of the nation's transportation system.

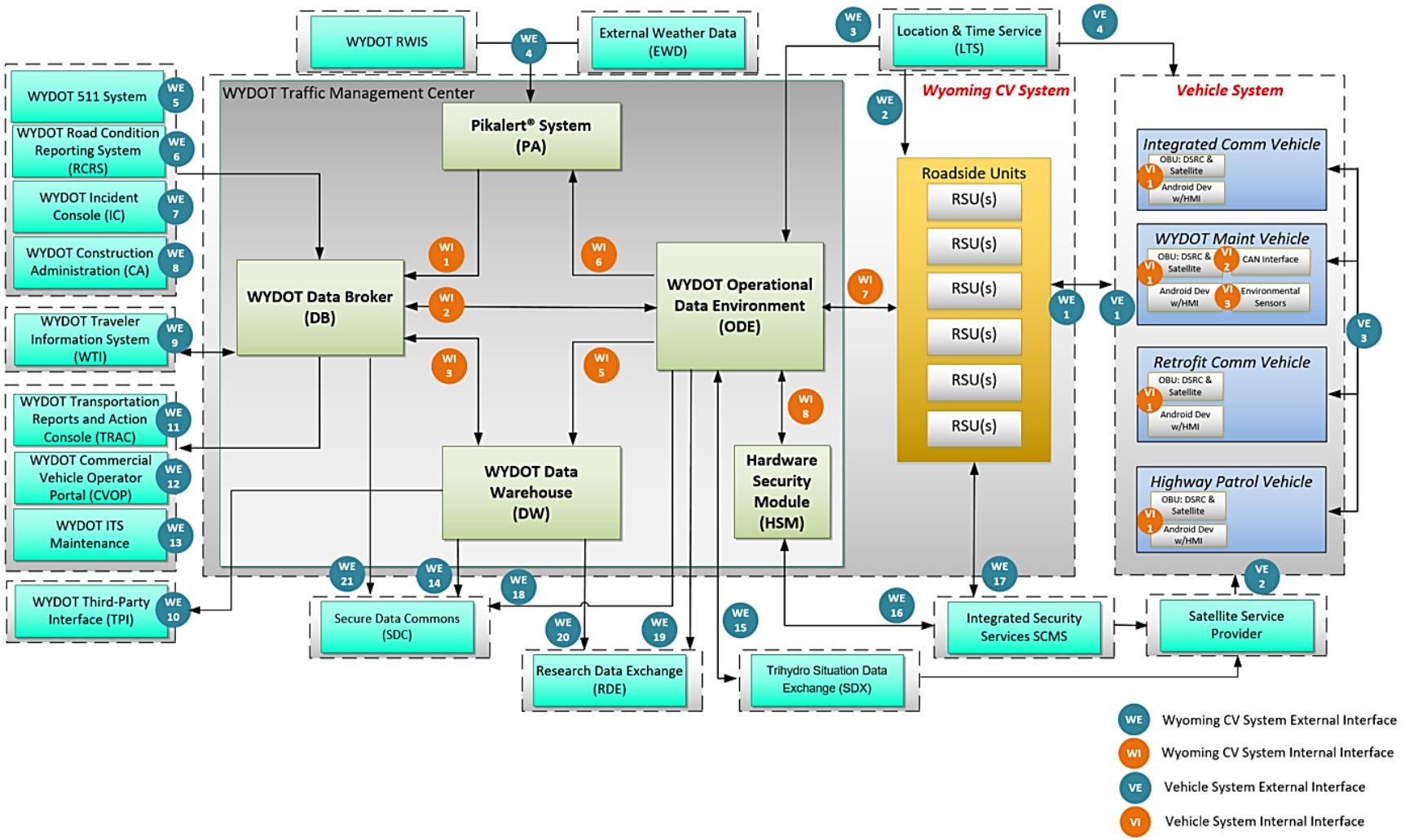
As one of the three selected pilots, WYDOT is focusing on improving safety and mobility by creating new ways to communicate road and travel information to commercial truck drivers and fleet managers along the 402 miles of Interstate 80 (I-80 henceforth) in the State. For the pilot project, WYDOT concluded Phase 1 (planning) in September 2016 and then initiated Phase 2 (deployment), which is scheduled to conclude in August 2020. This will be followed by a 12-month demonstration period in the third phase.

Systems and applications developed in the pilot will enable drivers of connected vehicles to have improved awareness of potential hazards and of situations they cannot see. At a very high level, the pilot scope includes the following implementation elements:

- **Deploy about 75 roadside units (RSU)** that can receive and broadcast messages using DSRC along various sections on I-80.
- **Equip around 400 vehicles, a combination of fleet vehicles and commercial trucks, with on-board units (OBU).** Of the 400 vehicles, at least 75 are planned to be heavy trucks. All vehicles are expected to be regular users of I-80. Several types of OBUs 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) Part I and will include a human-machine interface (HMI) to share alerts and advisories to drivers of these vehicles.
- **Develop several V2V, V2I, I2V applications** that will enable communication to drivers of 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 ingesting more location specific mobile road weather information system (RWIS) data, using Pikalert® to provide for more accurate and road segment specific conditions to define better variable speed limits (VSLs), and improving road condition dissemination via 511, Dynamic Message Signs (DMS) and other WYDOT sources.

4.1 Physical System Overview

The physical view in Figure 4-1 represents the block diagram of the systems and interfaces, numbered for reference and discussion here and in following sections. This provides a detailed graphical view of the physical architecture of the WYDOT CV Pilot and interactions that occurs within and between the different entities. Refer to the System Architecture Document (FHWA-JPO-17-451) for a detailed review and full explanation of the WYDOT CV System, Vehicle System, and WYDOT Traffic Management Center.



NOTE: The Wyoming CV System Interfaces WI4 (PA→DW) and VI2 (OBU-CAN Bus) were not implemented in the final system design.

Figure 4-1. Physical View of WYDOT CV Pilot System Architecture with Numbered Interfaces. (Source: WYDOT).

4.2 List of Interfaces

This section lists the interfaces that are being defined in Section **5**, considering all the interfaces within the SAD, along with the Unique Identifiers from the Triples.

Heading Descriptions for Table 4-1:

1. WYDOT Interface Number: The interface number from Physical View, Figure 4-1
2. Source Element: The device which provides data for the flow
3. Destination Element: The device which consumes the data for the flow
4. Communication Profile: Communication protocol(s) used [Figure # from SAD Communications Profiles]
5. Application Information Standard: Key standard(s) governing this information exchange

Table 4-1. List of Data, Information Exchanges and SET-IT Communication Profile Template for each Interface in WYDOT CV Pilot.

WYDOT Interface Number	Source Element	Destination Element	Communication Profile [SAD Figure Number]	Application Information Standard
WE1/VE1	WYDOT RSUs	Vehicle System	DSRC-WSMP RSU Gateway SCMS	J2735/1 Secure Copy (SCP)
WE1/VE1	Vehicle System	WYDOT RSUs		J2735/1 Secure Copy (SCP)
WE2	Field Location and Time Data Source	WYDOT RSUs	Time Position-Location-Interface	NA
WE2	Network Time Source	WYDOT RSUs	Time Position-Location-Interface	Network Time Protocol
WE3	Network Time Source	WYDOT ODE		
WE4	WYDOT RWIS System	WYDOT Pikalert System (PA)	WAW-WWWBrowser-JSON WAW-XML XML	RWIS Interface Control Document (ICD)
WE4	External Weather Data	WYDOT Pikalert System (PA)		EWD ICD
WE5	WYDOT 511 System	WYDOT Data Broker		Custom JSON
WE6	WYDOT Road Condition Report System (RCRS)	WYDOT Data Broker		TMDD
WE7	WYDOT Incident Console (IC)	WYDOT Data Broker		TMDD
WE8	WYDOT Construction Administration (CA)	WYDOT Data Broker		TMDD

WYDOT Interface Number	Source Element	Destination Element	Communication Profile [SAD Figure Number]	Application Information Standard
WE9	WYDOT Traveler Information System (WTI)	WYDOT Data Broker		TMDD
WE9	WYDOT Data Broker	WYDOT Traveler Information System (WTI)		TMDD
WE10	WYDOT Data Warehouse	WYDOT Third Party Interface (TPI)		TMDD
WE11	WYDOT Data Broker	WYDOT Transportation Reports and Action Console (TRAC)		TMDD
WE12	WYDOT Data Broker	CVOP		TMDD
WE13	WYDOT Data Broker	WYDOT ITS Maintenance		TMDD
WE15	WYDOT ODE	Situation Data Exchange		J2735/1 SSP ICD
WE14	WYDOT Data Warehouse	Secure Data Commons	AWS S3 Bucket	Vehicle speed
WE18	WYDOT ODE	Secure Data Commons	AWS S3 Bucket	BSM, DNM, Custom JSON
WE21	WYDOT Data Broker	Secure Data Commons	AWS S3 Bucket	n/a
WE20	WYDOT Data Warehouse	Research Data Exchange	AWS S3 Bucket	BSM, DNM, Custom JSON
WE19	WYDOT ODE	Research Data Exchange	AWS S3 Bucket	BSM, TIM
WE22	WYDOT Data Broker	Research Data Exchange	AWS S3 Bucket	TIM, DN, Alerts and advisories within TIMs
WE16	HSM	SCMS	SCMS	SCMS
WE16	SCMS	HSM		SCMS
WE17	WYDOT RSUs	SCMS	SCMS	SCMS
WE17	SCMS	WYDOT RSUs		SCMS
WI1	WYDOT Pikalert System (PA)	WYDOT Data Broker	Internal	TMDD
WI2	WYDOT ODE	WYDOT Data Broker	Internal	DN, TIM Content
WI2	WYDOT Data Broker	WYDOT ODE		TIM Content
WI3	WYDOT Data Warehouse	WYDOT Data Broker	Internal	TMDD DN, TIM Content
WI3	WYDOT Data Broker	WYDOT Data Warehouse		TMDD DN, TIM Content
WI5	WYDOT ODE	WYDOT Data Warehouse	Internal	TMDD

WYDOT Interface Number	Source Element	Destination Element	Communication Profile [SAD Figure Number]	Application Information Standard
WI5	WYDOT Data Warehouse	WYDOT ODE	Internal	TMDD
WI6	WYDOT ODE	WYDOT Pikalert System (PA)	Internal	TMDD BSM, CAN, ES Content
WI7	WYDOT ODE	WYDOT RSUs	RSU-C2F-SNMP RSU-C2F	J2735/1 Secure Copy (SCP)
WI7	WYDOT RSUs	WYDOT ODE		J2735/1 Secure Copy (SCP)
WI8	HSM	WYDOT ODE	Internal	IEEE 1609.2, IETF 7230, IETF 4648
WI8	WYDOT ODE	HSM	Internal	IEEE 1609.2, IETF 7230, IETF 4648
VE2	Satellite Service Provider	Vehicle System	SSP ICD (proprietary)	SSP ICD
VE3	Highway Patrol Vehicle Integrated Comm Vehicle Retrofit Comm Vehicle WYDOT Maintenance Vehicle	Highway Patrol Vehicle Integrated Comm Vehicle Retrofit Comm Vehicle WYDOT Maintenance Vehicle	DSRC-WSMP	SAE J3067, J2945/1 and J2735
VE4	Vehicle Location and Time Data Source	Vehicle System	Time Position-Location-Interface	NA
~~VI2~~	~~Vehicle CAN bus~~	~~OBU~~	Vehicle-On-Board	Vehicle OEM ICD
VI1	OBU	HMI		Custom JSON
VI3	MV Environmental Sensors	HMI		Custom JSON

Heading Descriptions for Table 4-2:

- Interop Cat Num: indicates if the interface is used by different pilot sites.
- Shared / Custom: indicates of the interface is shared across pilots or is unique to WYDOT.
- Instance ID: a unique identifier for the flow.
- Flow Name: a name for the operation or interaction between source and destination.
- Fig. Num: figure number from the Physical Architectural Diagrams in the System Architecture Document (SAD).
- Source Element: the device which provides data for the flow.
- Destination Element: the device which consumes the data for the flow.
- WYDOT Interface Num: interface number from Physical View: Figure 4-1

Table 4-2. WYDOT CV Flows.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
1	**Shared**	**30001**	**device enrollment information**	4-31	Highway Patrol Vehicle	SCMS	WE17-WE1/VE1
					Integrated Comm Vehicle	SCMS	WE17-WE1/VE1
					Retrofit Comm Vehicle	SCMS	WE17-WE1/VE1
					WYDOT Maintenance Vehicle	SCMS	WE17-WE1/VE1
					WYDOT RSUs	SCMS	WE17
1	**Shared**	**30002**	**security policy and networking information**	4-31	SCMS	Highway Patrol Vehicle	WE17-WE1/VE1
					SCMS	Integrated Comm Vehicle	WE17-WE1/VE1
					SCMS	Retrofit Comm Vehicle	WE17-WE1/VE1
					SCMS	WYDOT Maintenance Vehicle	WE17-WE1/VE1
					SCMS	WYDOT RSUs	WE17
1	**Shared**	**30003**	**security credentials**	4-31	SCMS	Highway Patrol Vehicle	WE17-WE1/VE1
					SCMS	Integrated Comm Vehicle	WE17-WE1/VE1
					SCMS	Retrofit Comm Vehicle	WE17-WE1/VE1
					SCMS	WYDOT Maintenance Vehicle	WE17-WE1/VE1
					SCMS	WYDOT RSUs	WE17
					WYDOT RSUs	Highway Patrol Vehicle	WE1/VE1
					WYDOT RSUs	Integrated Comm Vehicle	WE1/VE1
					WYDOT RSUs	Retrofit Comm Vehicle	WE1/VE1
					WYDOT RSUs	WYDOT Maintenance Vehicle	WE1/VE1
1	**Shared**	**30004**	**vehicle location and motion**	4-8, 4-19	Highway Patrol Vehicle	Remote Vehicle OBEs (all types)	VE3
					Integrated Comm Vehicle	Remote Vehicle OBEs (all types)	VE3
					Retrofit Comm Vehicle	Remote Vehicle OBEs (all types)	VE3
					WYDOT Maintenance Vehicle	Remote Vehicle OBEs (all types)	VE3
					Remote Vehicle OBEs (all types)	Highway Patrol Vehicle	VE3
					Remote Vehicle OBEs (all types)	Integrated Comm Vehicle	VE3
					Remote Vehicle OBEs (all types)	Retrofit Comm Vehicle	VE3
					Remote Vehicle OBEs (all types)	WYDOT Maintenance Vehicle	VE3

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
1	**Shared**	**30006**	**vehicle location and motion for surveillance**	4-12	Highway Patrol Vehicle	ODE	WI7-WE1/VE1
					Integrated Comm Vehicle	ODE	WI7-WE1/VE1
					Retrofit Comm Vehicle	ODE	WI7-WE1/VE1
					WYDOT Maintenance Vehicle	ODE	WI7-WE1/VE1
1	**Shared**	**30007**	**emergency notification**	4-10	Vehicle (distressed)	Vehicle (receive and relay)	VE3
					Vehicle (distressed)	Vehicle (receive)	VE3
					Vehicle (distressed)	ODE	WI7-WE1/VE1
					Vehicle (receive and relay)	ODE	WI7-WE1/VE1
					WYDOT Data Broker (DB)	WYDOT Transportation Reports and Action Console (TRAC)	WE11
					WYDOT ODE	WYDOT Data Broker (DB)	WI2
					Vehicle (receive and relay)	Vehicle (receive)	VE3
2	**Shared**	**30023**	**I2V Situational Awareness TIM (C2C and C2I)**	4-13	Situation Data Exchange	Satellite Service Provider	USDOT Owned Interface
					WYDOT Data Broker (DB)	WYDOT Data Warehouse (DW)	WI3
					WYDOT Data Broker (DB)	WYDOT ODE	WI2
					WYDOT ODE	Situation Data Exchange	WE15
					WYDOT ODE	WYDOT RSUs	WI7
2	**Shared**	**30024**	**I2V Situational Awareness TIM (I2V)**	4-13	WYDOT RSUs	Highway Patrol Vehicle	WE1/VE1
					WYDOT RSUs	Integrated Comm Vehicle	WE1/VE1
					WYDOT RSUs	Retrofit Comm Vehicle	WE1/VE1
					WYDOT RSUs	WYDOT Maintenance Vehicle	WE1/VE1
2	**Shared**	**30025**	**I2V Situational Awareness TIM (S2V)**	4-13	Satellite Service Provider	Highway Patrol Vehicle	VE2
					Satellite Service Provider	Integrated Comm Vehicle	VE2
					Satellite Service Provider	Retrofit Comm Vehicle	VE2
					Satellite Service Provider	WYDOT Maintenance Vehicle	VE2
~~**5**~~ *No longer part of pilot*	~~**Custom**~~	~~**N/A**~~	~~**security credential revocations**~~	~~4-31~~	~~Satellite Service Provider~~	~~Highway Patrol Vehicle~~	~~VE2~~
					~~Satellite Service Provider~~	~~Integrated Comm Vehicle~~	~~VE2~~
					~~Satellite Service Provider~~	~~Retrofit Comm Vehicle~~	~~VE2~~
					~~Satellite Service Provider~~	~~WYDOT Maintenance Vehicle~~	~~VE2~~

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
2	**Shared**	**30028**	**location and time**	4-19	Field Location and Time Data Source	WYDOT RSUs	WE2
					Vehicle Location and Time Data Source	Highway Patrol Vehicle	VE4
					Vehicle Location and Time Data Source	Integrated Comm Vehicle	VE4
					Vehicle Location and Time Data Source	Retrofit Comm Vehicle	VE4
					Vehicle Location and Time Data Source	WYDOT Maintenance Vehicle	VE4
2	**Shared**	**30029**	**misbehavior report**	4-31	Highway Patrol Vehicle	SCMS	WE17-WE1/VE1
					Integrated Comm Vehicle	SCMS	WE17-WE1/VE1
					Retrofit Comm Vehicle	SCMS	WE17-WE1/VE1
					WYDOT Maintenance Vehicle	SCMS	WE17-WE1/VE1
					WYDOT RSUs	SCMS	WE17
2	**Shared**	**30031**	**[time]**	4-19	Field Location and Time Data Source	WYDOT RSUs	WE2
					Network Time Source	WYDOT ODE	WE3
					Network Time Source	WYDOT RSUs	WE2
2	**Shared**	**30034**	**traffic conditions**	4-14	WYDOT Data Warehouse (DW)	WYDOT Third Party Interface (TPI)	WE10
2	**Shared**	**30035**	**traffic situation data**	4-12	WYDOT ODE	WYDOT Data Warehouse (DW)	WI5
					WYDOT ODE	WYDOT Pikalert System (PA)	WI6
					WYDOT RSUs	WYDOT ODE	WI7
2	**Shared**	**30037**	**vehicle environmental data**	4-12	Highway Patrol Vehicle	WYDOT RSUs	WE1/VE1
					Integrated Comm Vehicle	WYDOT RSUs	WE1/VE1
					WYDOT Maintenance Vehicle	WYDOT RSUs	WE1/VE1
2	**Shared**	**30003**	**sign TIMs**	4-31	WYDOT ODE	HSM	WI8
4	**Custom**	**33001**	**driver updates**	4-13	Highway Patrol Vehicle	Vehicle Driver	VI1
					Integrated Comm Vehicle	Vehicle Driver	VI1
					Retrofit Comm Vehicle	Vehicle Driver	VI1
					Vehicle (distressed)	Vehicle Driver	VI1
					Vehicle (receive)	Vehicle Driver	VI1
					WYDOT Maintenance Vehicle	Vehicle Driver	VI1

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	**Custom**	**33002**	**CMV Parking Status Information**	4-18	CMV Driver PID	WYDOT 511 System	External WYDOT Managed Interface
					Vehicle Driver	CMV Driver PID	External WYDOT Managed Interface
					WYDOT 511 System	WYDOT Data Broker (DB)	WE5
5	**Custom**	**33003**	**advisories & alerts**	4-14	WYDOT Data Broker (DB)	WYDOT Traveler Information System (WTI)	WE9
5	**Custom**	**33004**	**segment alerts**	4-14	WYDOT Data Broker (DB)	WYDOT Transportation Reports and Action Console (TRAC)	WE11
5	**Custom**	**33005**	**driver input**	4-10	Vehicle Driver	Highway Patrol Vehicle	VI1
					Vehicle Driver	Integrated Comm Vehicle	VI1
					Vehicle Driver	Retrofit Comm Vehicle	VI1
					Vehicle Driver	Vehicle (distressed)	VI1
					Vehicle Driver	WYDOT Maintenance Vehicle	VI1
5	**Custom**	**33006**	**environmental sensor data**	4-12	MV Environmental Sensors	WYDOT Maintenance Vehicle	VI3
					WYDOT Maintenance Vehicle	WYDOT ODE	WI7-WE1/VE1
~~**5**~~	~~**Custom**~~	~~**33007**~~	~~**host vehicle status**~~	~~4-12~~	~~Vehicle CAN bus~~	~~WYDOT Maintenance Vehicle~~	~~VI2~~
					~~Vehicle CAN bus~~	~~Vehicle (distressed)~~	~~VI2~~
5	**Custom**	**33009**	**plow-operator-sourced updates**	4-14	WYDOT Road Condition Report System (RCRS)	WYDOT Data Broker (DB)	WE6
5	**Custom**	**33010**	**posted speed, restrictions, closures**	4-14	WYDOT Traveler Information System (WTI)	WYDOT Data Broker (DB)	WE9
5	**Custom**	**33011**	**segment advisories & alerts**	4-14	WYDOT Data Broker (DB)	WYDOT Commercial Vehicle Operator Portal (CVOP)	WE12
5	**Custom**	**33012**	**system oper status**	4-14	WYDOT Data Broker (DB)	WYDOT ITS Maint	WE13
5	**Custom**	**33014**	**weather information**	4-12	Weather Sources	WYDOT Pikalert System (PA)	WE4

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	**Custom**	**33015**	**Work Zone Field Information**	4-17	WYDOT Construction Administration (CA)	WYDOT Data Broker (DB)	WE8
5	**Custom**	**33019**	**incident information**	4-14	WYDOT Incident Console (IC)	WYDOT Data Broker (DB)	WE7
5	**Custom**	**33020**	**security credential revocations**	4-31	SCMS	Highway Patrol Vehicle	WE17-WE1/VE1
					SCMS	Integrated Comm Vehicle	WE17-WE1/VE1
					SCMS	Retrofit Comm Vehicle	WE17-WE1/VE1
					SCMS	WYDOT Maintenance Vehicle	WE17-WE1/VE1
					SCMS	WYDOT RSUs	WE17
5	**Custom**	**33021**	**environmental situation data**	4-12	WYDOT ODE	WYDOT Data Warehouse (DW)	WI5
					WYDOT ODE	WYDOT Pikalert System (PA)	WI6
5	**Custom**	**33022**	**road weather advisories & alerts**	4-12	WYDOT Pikalert System (PA)	WYDOT Data Broker (DB)	WI1
5	**Custom**	**30023, 33011**	**road weather forecasts**	4-4	WYDOT Pikalert System (PA)	WYDOT Data Broker (DB)	WI1
					WYDOT Data Broker (DB)	Commercial Vehicle Operator Portal (CVOP)	WE12
					WYDOT Data Broker (DB)	WYDOT Data Warehouse (DW)	WI3
					WYDOT Data Warehouse (DW)	WYDOT Data Broker (DB)	WI3
5	**Custom**	**custom**	**OTA Updates**	4-4	Integrated Comm Vehicle	ODE	WE1/VE1
					WYDOT Maintenance Vehicle	ODE	WE1/VE1
5	**Custom**	**33013**	**Automated upload data containing PII**	4-14	WYDOT ODE	SDC	WE18
					WYDOT Data Warehouse (DW)	SDC	WE14
5	**Custom**	**33013**	**Manual upload data containing PII**	4-14	WYDOT Data Broker (DB)	SDC	WE21
5	**Custom**	**33013**	**Automated upload data without PII**	4-14	WYDOT ODE	RDE	WE19
					WYDOT Data Warehouse (DW)	RDE	WE20

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	**Custom**	**33013**	**Manual upload data without PII**	4-14	WYDOT Data Broker (DB)	RDE	WE22
5	**Custom**	**custom**	**camera images**	4-14	TMC FTP Server	WYDOT Pikalert System (PA)	WE4

5 Interfaces

This part of the ICD includes all the separate Physical Object to Physical Object flows shown in the SAD, with each Physical Object to Physical Object pair mapping to its own Device to Device Section. For example, the dialogs between physical devices RSU and OBU are defined in Section: **5.9**.

Existing standards and protocols are referenced within the document and additional context is provided if there is any room for interpretation of the referenced standard or protocol. Based on this ICD a developer or other stakeholder can successfully develop an interface or develop interoperable interfaces based on its content that fully meet WYDOT's requirements. Any deviation from a published standard or protocol, or use of optional fields, or known deficiencies in clarity within the publish standard or protocol, are documented here and have been carried into the Standard Plan document for feedback to SDOs as appropriate.

5.1 OBU <-> OBU

This section describes the Vehicle-to-Vehicle (OBU-to-OBU) interface which operates over DSRC. All communications are signed but not encrypted according to requirements in IEEE 1609.2.

Connected Vehicles participating in the Pilot will broadcast Basic Safety Messages (BSMs) and they will listen for and interpret BSMs from nearby vehicles. Section **5.1.1** describes how connected vehicles broadcast and receive BSMs.

Connected Vehicles can also broadcast and receive Distress Notification TIMs (DNMs). DNMs are broadcast both by Distressed Vehicles and Relay Vehicles. Section **5.1.2** describes how connected vehicles broadcast and receive DNMs.

5.1.1 Connected Vehicles broadcast and receive BSMs

Vehicle/OBU Applicability: [WYDOT Highway Patrol Vehicles, Integrated Commercial Vehicles, WYDOT Maintenance Vehicles, Retrofit Vehicles]

OBUs collect their location, heading and speed information along with additional parameters input by the vehicle driver [optionally including data from the WYDOT Maintenance vehicle's CAN interface]. A GPS module in the OBU provides the location, speed, acceleration etc. OBUs package this data into a Basic Safety Message using Part I and Part II. BSMs are then digitally signed. **OBUs broadcast BSMs at 10 Hz. OBUs broadcast BSMs using DSRC channel 172 with PSID 0x20.**

Remote vehicles listen for, receive and decode BSMs from other connected vehicles. The Forward Collision Warning Application runs on the OBU and evaluates received BSM data in the context of the host vehicle data. The application calculates the distance between the vehicles, determines whether the vehicles are on a collision course by predicting their future paths and computes a likelihood probability of any collision. Then, based on the likelihood, alerts the vehicle driver.

5.1.1.1 External References

- Basic Safety Message: SAE J2735 MAR2016
- ASN.1:2015: Abstract Syntax Notation
- BSM signatures: IEEE 1609.2
- Dedicated Short Range Communications (DSRC): ISO 15628, SAE J2735, SAE J2945/1, SAE J3067, IEEE 802.11p
- ~~CAN bus: ISO 11898-1~~

5.1.1.2 Covered Information Flows

Table 5-1. Flows: OBUs broadcasting BSMs to remote OBUs

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
1	**Shared**	**30004**	**vehicle location and motion**	4-8, 4-19	Retrofit Comm Vehicle	Remote Vehicle OBEs (all types)	VE3
					Highway Patrol Vehicle	Remote Vehicle OBEs (all types)	VE3
					Integrated Comm Vehicle	Remote Vehicle OBEs (all types)	VE3
					WYDOT Maintenance Vehicle	Remote Vehicle OBEs (all types)	VE3
					Remote Vehicle OBEs (all types)	Highway Patrol Vehicle	VE3
					Remote Vehicle OBEs (all types)	Integrated Comm Vehicle	VE3
					Remote Vehicle OBEs (all types)	WYDOT Maintenance Vehicle	VE3
					Remote Vehicle OBEs (all types)	Retrofit Comm Vehicle	VE3

5.1.1.3 Dialogs

5.1.1.3.1 Dialog: OBU continuously broadcasts signed BSMs at 10Hz

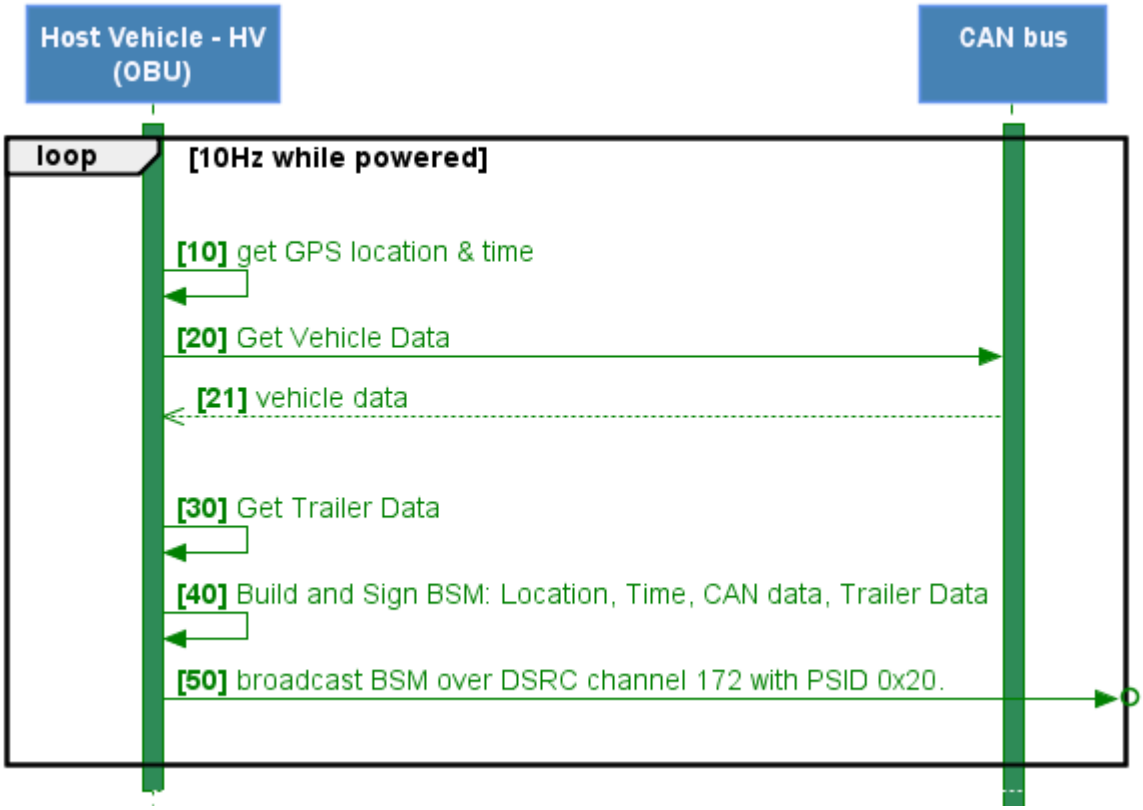


Figure 5-1. Sequence Diagram: OBU continuously broadcasts signed BSMs at 10Hz. Source: WYDOT

[10] Get GPS Location & Time for BSM

For details on LTS see Section: **5.3.1**.

~~**[20] Get CAN bus data for BSM**~~

~~For details on CAN bus data collected see Section: **5.4.2**.~~

[30] Get other vehicle data for BSM

Additional fixed vehicle parameters such as vehicle size are also incorporated into BSMs. For details on additional data entered by vehicle driver see Section: **5.2.1**.

[40] Sign BSM

BSMs are signed to assure the recipient of the message of: Authenticity, Authorization, Integrity, Non-repudiation (of origin). For details on security management see Section: **5.13**.

[50] Broadcast BSM over DSRC

OBUs broadcast BSMs at 10 Hz. OBUs broadcast BSMs using DSRC channel 172 with PSID 0x20.

5.1.1.3.2 Dialog: OBUs continuously broadcast and receive BSMs

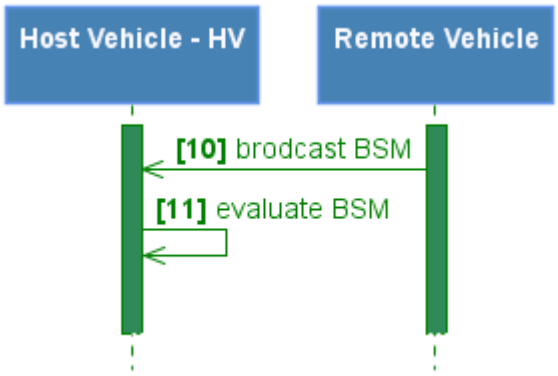


Figure 5-2. Sequence Diagram: OBUs continuously broadcast and receive BSMs.
Source: WYDOT

[30-31] OBU B broadcasts BSM B.1 and OBU A receives it

OBU-A receives BSM from OBU-B. OBU A evaluates the BSM. Before taking any action based on the BSM the digital signature must be validated. If OBU-A determines that the vehicle for BSM A does not pose any danger, then it is not necessary for OBU-A to validate the signature of the BSM.

5.1.1.3.3 Dialog: FCW detects and alerts an imminent danger.

This dialog depicts FCW user case scenarios from J2945/1 in which one vehicle is approaching another vehicle in the same direction of travel. From J2745/1:

- 4.2.4.2 (a) stopped remote vehicle in same lane.
- 4.2.4.2 (b) stopped remote vehicle in adjacent lane.
- 4.2.4.2 (c) slow-moving remote vehicle in same lane.

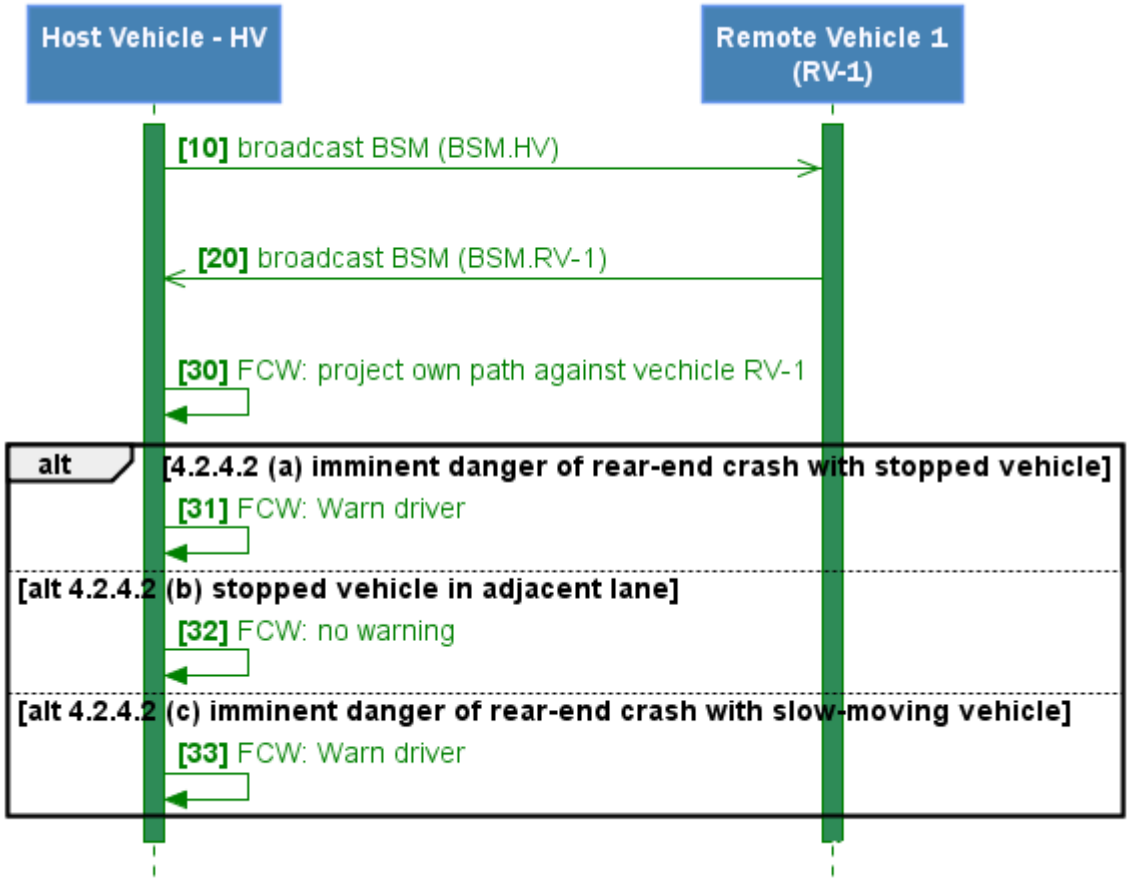


Figure 5-3. Sequence Diagram: FCW detects and alerts an imminent danger.
Source: WYDOT

[10-20] Host Vehicle and Remote Vehicle broadcast and receive each other's BSMs

As Connected Vehicles get within range of each other's DSRC broadcasts the vehicles begin to receive each other's BSM broadcasts.

[30] Host Vehicle evaluates BSM from Remote Vehicle 1

Host Vehicle (HV) receives BSM from Remote Vehicle 1 (RV-1). The FCW application running on HV evaluates predicts both its path and that of RV-1. If vehicles are in the same lane and distance between vehicles is decreasing, the FCW application must alert driver based on danger level.

Note: before issuing a FCW to the vehicle driver the BSM signature must be validated.

[31] 4.2.4.2 (a) stopped remote vehicle in same lane.

The FCW application determines a stopped remote vehicle is ahead in the same lane and alerts the vehicle driver of imminent danger.

[32] 4.2.4.2 (b) stopped remote vehicle in adjacent lane.

The FCW application determines a stopped remote vehicle is ahead in adjacent lane. There is no alert.

[33] 4.2.4.2 (c) slow-moving remote vehicle in same lane.

The FCW application determines a slow-moving remote vehicle is ahead in the same lane and alerts the vehicle driver of imminent danger.

5.1.1.4 Messages

- Signed, Basic Safety Message as described in Section: **7.1**.

5.1.1.5 Data Elements

- The fields used in the BSM are defined in: **Table 7-1: BSM Message Fields**

5.1.1.6 Requirement Traceability

- VS-REQ-1 Receive BSM
- 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 FCW Rear-End Crash in Straight Road
- VS-REQ-9.2 FCW Rear-End Crash in Curved Road
- VS-REQ-10 FCW No Warnings
- VS-REQ-10.1 Safely Following a Vehicle
- VS-REQ-10.2 Passing a Stopped Vehicle
- VS-REQ-33 BCVI Messages
- 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-44 VSM SCMS Sign
- VS-REQ-50 Safety Communication
- VS-REQ-51 VS Equipment
- SCMS-REQ-2 Vehicle System SCMS Use
- SCMS-REQ-2.1 SCMS Vehicle System Certificates
- SCMS-REQ-2.3 SCMS Vehicle System Certificates Revocation List (CRL)
- SCMS-REQ-2.4 SCMS Vehicle System Rejection
- MV-REQ-10 OBU Equipment
- HP-REQ-5 OBU Equipment
- IT-REQ-7 OBU Equipment
- RFV-REQ-6 OBU Equipment
- MV-REQ-9 General
- IT-REQ-6 General
- RFV-REQ-5 General
- HP-REQ-1 General

5.1.2 OBUs broadcast and receive Distress Notifications

Vehicle/OBU Applicability: [Integrated Commercial Vehicles, WYDOT Maintenance]

This sub-section describes the following interactions between vehicles in the context of Distress Notifications

- A Distressed Vehicle broadcasts the Distress Notification TIM (DNM) over DSRC. (Dialog shown in Section **5.1.2.3.1**. The content and format of a DNM can be found in Section: **7.2**)
- A vehicle which receives the broadcast DNM will perform relay functions to help ensure the distress situation reaches approaching vehicles as well as the WYDOT TMC. (Dialog shown in Section: **5.1.2.3.2**)
- A vehicle which receives a DNM and which travels toward the Distressed Vehicle will alert its driver that a Distressed Vehicle is ahead. (Dialog shown in Section: **5.1.2.3.2**)

The distressed situation can be ~~initiated automatically due to a CAN bus message [WYDOT Maintenance vehicle] for: (1) an air bag deploy, (2) a vehicle disable, (3) or it can be~~ manually initiated by the driver through the HMI. The cause of the DN is included in the DNM. The DNM includes the time & location that the distress condition was initiated, distress message explanation (e.g., air bag deployed, vehicle disabled, operator initiated), vehicle heading and vehicle type.

A Distressed Vehicle stops broadcasting when the driver turns off the distress notification via the HMI or the power is removed from the OBU. **Vehicles broadcast DNMs using DSRC channel 172, at 1Hz 5Hz or 10 Hz depending on speed, and use PSID 0x40-82**.

In addition to OBU-OBU interactions described in this section, OBUs also report DN situations to the ODE as follows: RSU advertises the IPv6 address of the ODE RSYNC server, the OBU sends a log file for the DNM to the ODE. For details on OBU-ODE interaction, see Section: **5.16.1**.

5.1.2.1 External References

- BSM, TIM, DNM signatures: IEEE 1609.2
- Dedicated Short Range Communications (DSRC): ISO 15628, SAE J2735, SAE J2945/1, SAE J3067, IEEE 802.11p
- Distress Notifications: SAE J3067, SAE J2735, SAE J2540-2
- ~~CAN bus: ISO 11898-1~~

5.1.2.2 Covered Information Flows

The CV System Architecture Document formally defines all major operations of the CV system in terms of a source sub-system, a destination sub-system and a discrete operation performed. The following table is a subset of **Table 4-2**. The Dialogs following this table describe the flows shown in the following table. For a description of the table headings see master: **Table 4-2**.

Table 5-2. Flow: Distressed Vehicle Broadcasting DNM to opposing traffic.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
1	**Shared**	**30007**	**emergency notification**	4-10	Vehicle (distressed)	Vehicle (receive and relay)	VE3
					Vehicle (distressed)	Vehicle (receive)	VE3
					Vehicle (receive and relay)	Vehicle (receive)	VE3

5.1.2.3 Dialogs

The OBU will create a DNM based on ~~a CAN Bus message for *air bag deployed* or *vehicle disabled*, as well as for~~ a driver initiated distressed situation. Advisory information (text ~~Air Bag/Vehicle Disabled~~/Driver Initiated; and text for BasicVehicleClass identified in the BSM part II) along with the respective ITIS codes (ITIS code 531 for incident) are sent in this DNM. Remote Vehicles receiving the broadcast DNM immediately start rebroadcasting the DNM for the benefit of other Connected Vehicles, and continue to broadcast it for a configurable distance and configurable time. Initially this distance would be set to 5 miles. After this distance or a max time of 10 minutes, a Relay Vehicle will stop broadcasting the DNM and go silent until it receives an RSU WSA broadcast for the ODE server's IPv6 address. The OBU will then copy a log for the DNM to the ODE server. The flow between a Relay Vehicle and the ODE Server is covered in Section: **5.16.1**.

5.1.2.3.1 Dialog: Vehicle becomes a Distressed Vehicle

This dialog shows the initial actions taken by an OBU for a distress situation.

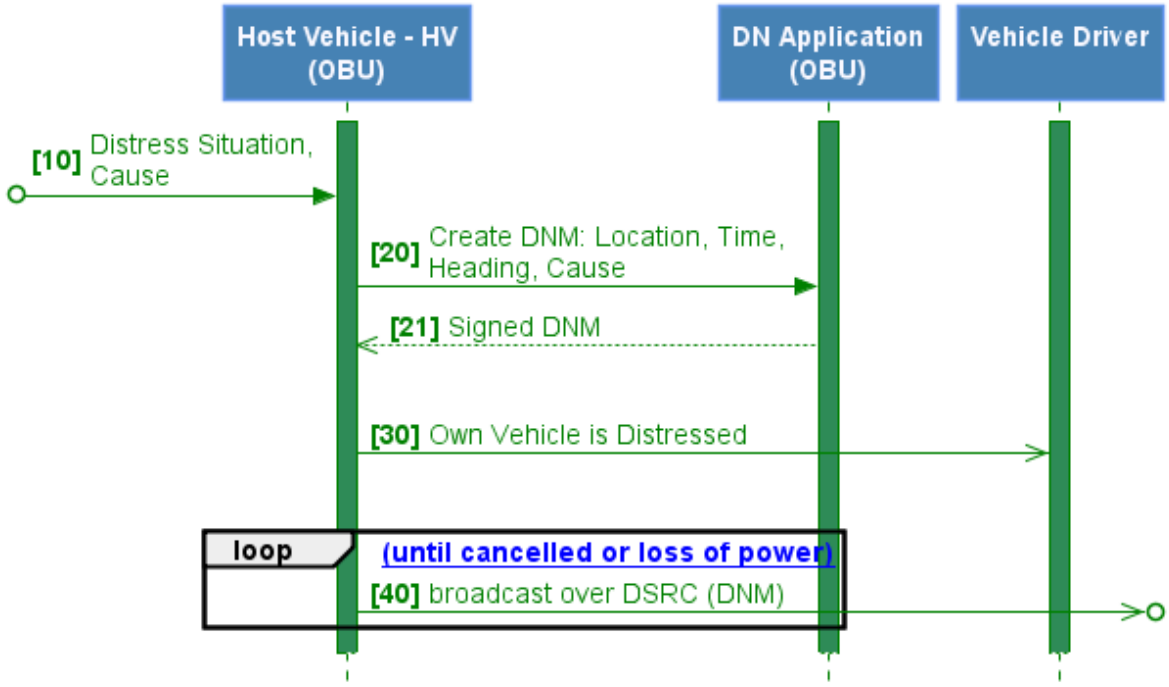


Figure 5-4. Sequence Diagram: Vehicle Becomes Distressed.
Source: WYDOT

[10] Distress Trigger

Host Vehicle triggers a Distress Situation (e.g., air bag deployed, vehicle disabled, operator initiated).

[20-21] DN application creates signed DNM

DNM must be populated with cause of distress, the location & time (from vehicle location and time system), as well as the vehicle heading when Distress Situation occurred. The DNM must also be signed.

[30] Notify Vehicle Driver

The OBU alerts the vehicle driver when its vehicle has declared a distress situation. This interaction is described in detail in Section: **5.2.2.3.2**.

[40] Broadcast DNM

A Distressed Vehicle will begin broadcasting the DNM. **Distressed Vehicles broadcast DNMs using DSRC channel 172, broadcast at 1Hz below 20 Mph, 5Hz between 20-60 Mph and 10Hz above 60 Mph and use PSID 0x40-82.** A Distressed Vehicle will continue broadcasting the DNM until either the power to the OBU is lost or the Vehicle Driver terminates the DN via the HMI.

5.1.2.3.2 Dialog: Host Vehicle broadcasts DNM, DNM received by Remote Vehicle

Remote vehicles which receive DNMs serve as Relay Vehicles and have the following responsibilities: (1) Create a log for the DNM for subsequent relay to the ODE, (2) Rebroadcast the DNM for a configurable distance or time.

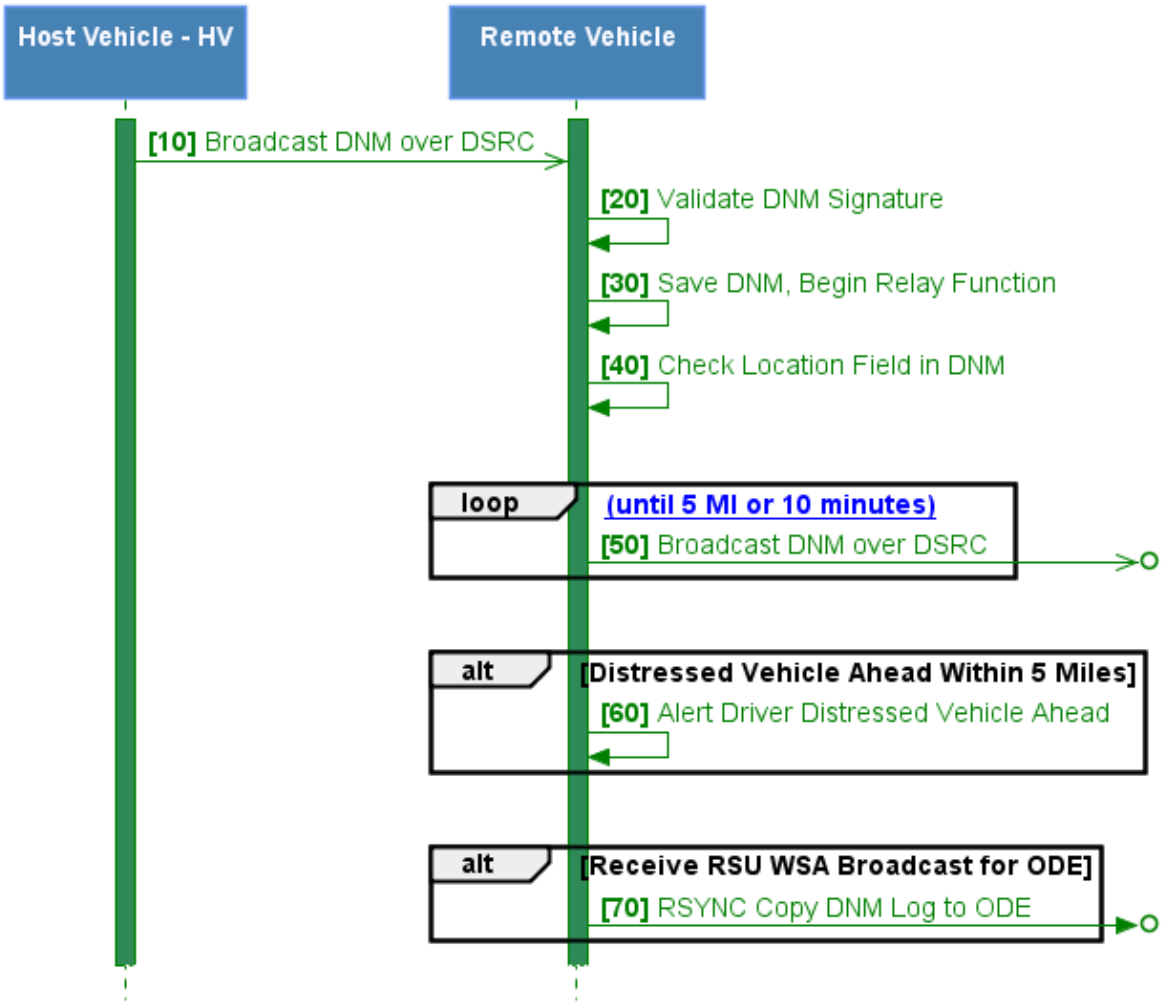


Figure 5-5. Sequence Diagram: Host Vehicle broadcasts DNM, DNM received by Remote Vehicle. Source: WYDOT

[10-20] Receive DNM over DSRC and Validate DNM

Before acting on any received message, OBUs shall validate the signature of the received message and ignore any message which cannot be validated. Note: If signature is invalid then apply logic to report misbehavior. For details see Section: **5.13.4**.

[30] Save DNM Log for ODE relay

Mentioned here only for completeness, the OBU will save a log for the DNM so that it can copy the log to the ODE when it comes within range of an RSU advertising ODE IPv6 address.

[40] Check Location Field of DNM

Check the location field of the DNM to determine the location of the Distressed Vehicle.

[50] Remote Vehicle Broadcasts DNM to Alert Other Vehicles

Remote vehicle will begin broadcasting the DNM over DSRC, for a configurable time and distance. **Remote Vehicles broadcast DNMs using DSRC channel 172, broadcast at 1Hz below 20 Mph, 5Hz between 20-60 Mph and 10Hz above 60 Mph and use PSID 0x40-82.**

[60] Alert Driver if Location of Distressed Vehicle is Ahead Within 5 Miles

If a Distressed Vehicle is within 5 MI of the Remote Vehicle's current location and in the current direction of travel, the Distress Notification Application notifies the driver there is a distressed vehicle ahead. For more details on driver notification see Section: **5.2.3.3.1**.

[70] Receive RSU WSA Broadcast for ODE

Mentioned here only for completeness, the OBU will copy a log for the DNM up to the ODE when the OBU receives a WSA broadcast from an RSU containing the ODE server's IPv6 address. The complete OBU-ODE interaction is described in Section: **5.16.1**.

5.1.2.4 Messages

- The content and format of a DNM is described in Section: **7.5**.

5.1.2.5 Data Elements

- The fields of TIM messages used when representing Distress Notifications are defined in: **Table 7-2. Traveler Information Message (TIM) Fields.**

5.1.2.6 Requirement Traceability

- VS-REQ-3 Receive Distress Information
- 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 DN TIM-Region
- VS-REQ-18 DN PSID
- 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-44 VSM SCMS Sign
- VS-REQ-50 Safety Communication
- VS-REQ-51 VS Equipment
- SCMS-REQ-2 Vehicle System SCMS Use
- SCMS-REQ-2.1 SCMS Vehicle System Certificates
- SCMS-REQ-2.3 SCMS Vehicle System Certificates Revocation List (CRL)
- SCMS-REQ-2.4 SCMS Vehicle System Rejection
- MV-REQ-9 General

- IT-REQ-6 General
- HP-REQ-1 General
- RFV-REQ-5 General
- IT-REQ-7 OBU Equipment
- RFV-REQ-6 OBU Equipment
- MV-REQ-10 OBU Equipment
- HP-REQ-5 OBU Equipment
- IT-REQ-1 Receive TIM over DSRC
- RFV-REQ-1 Receive TIM over DSRC
- HP-REQ-2 Receive TIM over DSRC
- MV-REQ-4 Receive TIM over DSRC

5.2 OBU <-> Vehicle Driver

This section describes the interface between the OBU and the Vehicle driver. All OBUs will include a human-machine interface (HMI). The HMI and OBU form a system in which the HMI works seamlessly as an extension of the OBU.

The HMI functions as an input device when a driver inputs basic vehicle information such as whether a trailer is present along with its configuration (for details see Section: **5.2.1**). The HMI will have a distress button to allow a driver to notify the Vehicle System that the driver has initiated a distress condition (for details see Section **5.2.2**).

The HMI functions as an output device when it shares alerts and advisories with drivers of connected vehicles. Driver notifications are described in Sections: **5.2.3** and **5.2.4**.

5.2.1 Vehicle Driver inputs vehicle data to HMI (non-DN)

This sub-section describes the process where a Vehicle Driver inputs data about the vehicle to the HMI. The vehicle data becomes input to the BSM messages broadcast by the vehicle.

5.2.1.1 External References

- Basic Safety Message: SAE J2735
- HMI: ISO/TC 145, SAE J2831, ISO 15006
- Protocol Buffer interface is used to send the data from HMI to OBU.

5.2.1.2 Covered Information Flows

Table 5-3. Flow: Vehicle Driver entering vehicle data to HMI (non-DN).

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33005**	**driver input**	4-10	Vehicle Driver	Highway Patrol Vehicle	VI1
					Vehicle Driver	Integrated Comm Vehicle	VI1
					Vehicle Driver	WYDOT Maintenance Vehicle	VI1
					Vehicle Driver	Retrofit Comm Vehicle	VI1

5.2.1.3 Dialogs

5.2.1.3.1 Dialog: Driver enters vehicle Data for BSM.

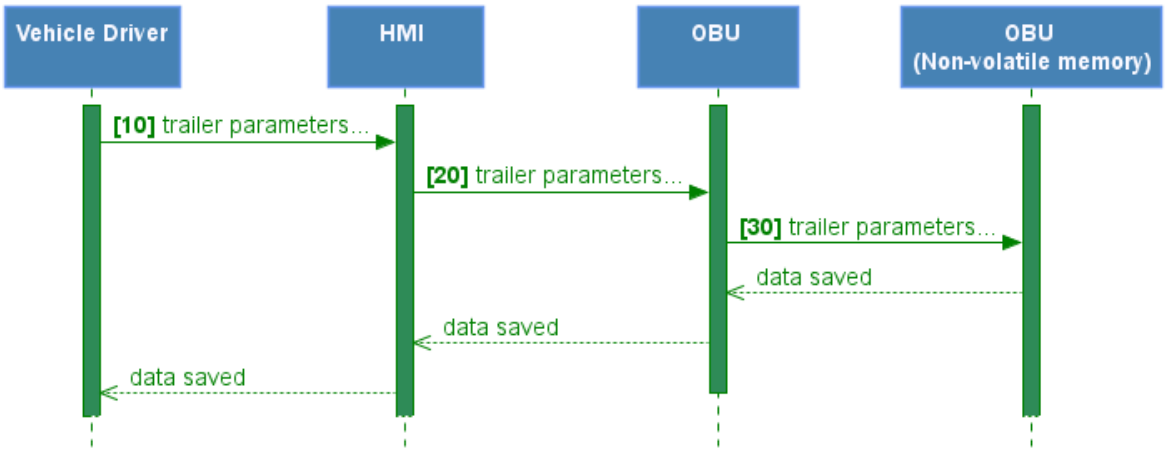


Figure 5-6. Sequence Diagram: Driver enters vehicle Data for BSM.
Source: WYDOT

5.2.1.4 Messages

- True/False indication that trailer is present
- Trailer length, width, height.
- True/False indication for *isDolly* field of BSM Part II, SpecialVehicleExtensions, TrailerData.

5.2.1.5 Data Elements

There are no optional data elements in this flow.

5.2.1.6 Requirement Traceability

- VS-REQ-4 Collect Vehicle Data
- VS-REQ-4.2 Collect Dimension Data
- VS-REQ-4.2.1 Vehicle Dimension Data
- VS-REQ-4.2.2 Vehicle Trailer Data
- VS-REQ-32 HMI Characteristics
- VS-REQ-32.8 Non-Distress Information
- IT-REQ-7 OBU Equipment
- RFV-REQ-6 OBU Equipment
- MV-REQ-10 OBU Equipment
- HP-REQ-5 OBU Equipment

5.2.2 Vehicle Driver Declares a Distress Situation using HMI

This sub-section describes how a driver explicitly initiates a distress situation. A distress notification application will be created on the HMI. The HMI will have a distress button to allow a driver to notify the Vehicle System that the driver has initiated a distress condition. The HMI will provide a list of Emergency Situation options for the user to select. The OBU will create a DNM based the driver initiated distressed

situation. Advisory information (Driver Initiated; and text for BasicVehicleClass identified in the BSM part II) along with the respective ITIS codes (ITIS code 531 for incident) are included in this DNM. The OBU signs the DNM and begins to broadcast over DSRC.

5.2.2.1 External References

- Protocol Buffer interface is used to send the data from HMI to OBU.
- Distress Notification: SAE J3067, SAE J2735, SAE J2540-2
- BSM, TIM, DNM signatures: IEEE 1609.2
- HMI: ISO/TC 145, SAE J2831, ISO 15006

5.2.2.2 Covered Information Flows

Table 5-4. Flow: Vehicle Driver Triggers DN on HMI.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33005**	**driver input**	4-10	Vehicle Driver	Vehicle (distressed)	VI1

5.2.2.3 Dialogs

5.2.2.3.1 Dialog: Vehicle Driver Triggers DN on HMI

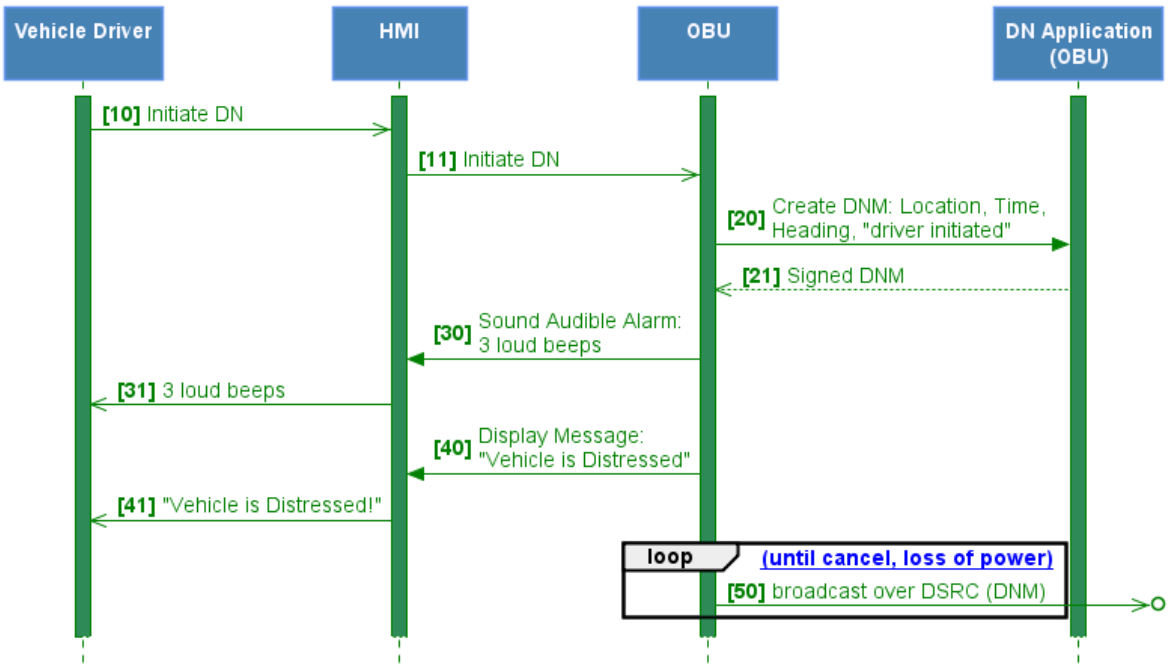


Figure 5-7. Sequence Diagram: Vehicle Driver Triggers DN on HMI.
Source: WYDOT

[10-11] Vehicle Driver presses button to trigger DN

Vehicle driver triggers DN by pressing button on HMI. Protocol Buffer interface used to communicate data between HMI and OBU.

[20-21] OBU calls DN application to generated signed DNM

DNM must be populated with cause of distress (operator triggered), the location & time (from vehicle location and time system), as well as the vehicle heading when Distress Situation occurred. The DNM must also be signed.

[30-31] HMI: audible alarm

OBU uses Protocol Buffer to send commands to HMI to signal an audible alarm.

[40-41] HMI: display message

OBU uses Protocol Buffer to send commands to HMI to display message that this vehicle has declared itself a Distressed Vehicle.

[50] Broadcast DNM

A Distressed Vehicle will begin broadcasting the DNM. **Vehicles broadcast DNMs using DSRC channel 172, broadcast at 10 Hz and use PSID 0x40-82.** A Distressed Vehicle will continue broadcasting the DNM until either the power to the OBU is lost or the Vehicle Driver terminates the DN via the HMI.

5.2.2.3.2 Dialog: Driver Notification that own vehicle is distressed.

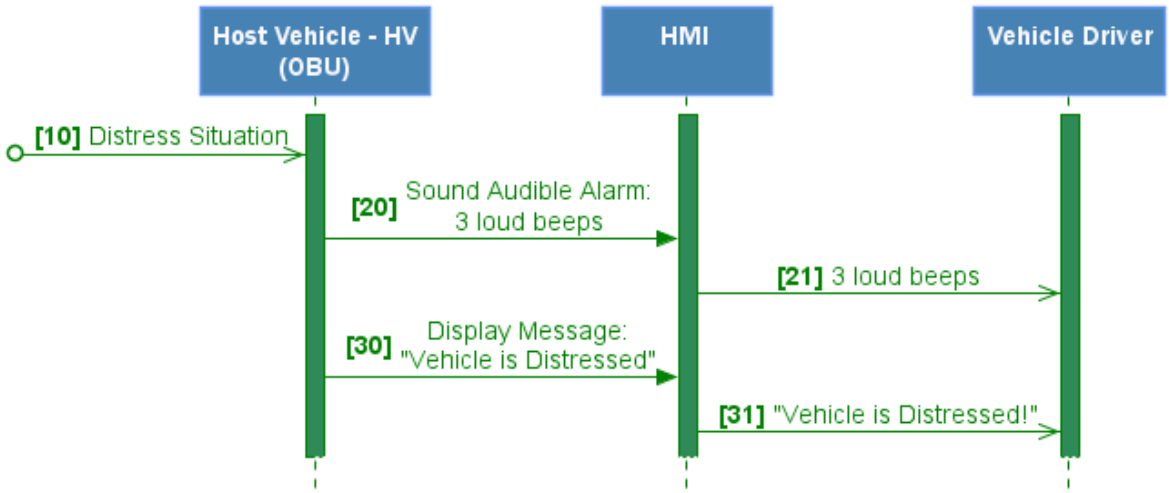


Figure 5-8. Sequence Diagram: Driver Notification that own vehicle is distressed.
Source: WYDOT

[10] Triggered Distress Notification

Local vehicle triggered a Distress Notification (e.g., operator initiated)

[20-21] HMI: audible alarm

OBU uses Protocol Buffer to send commands to HMI to signal an audible alarm.

[30-31] HMI: display message

OBU uses Protocol Buffer to send commands to HMI to display message that this vehicle has declared itself a Distressed Vehicle.

5.2.2.4 Messages

- Driver presses button on HMI to initiate Distress Situation
- HMI sounds 3 loud beeps to signal driver that distress situation has been initiated.
- HMI displays graphical image and text message that distress situation has been initiated.

5.2.2.5 Data Elements

There are no optional data elements in this flow.

5.2.2.6 Requirement Traceability

- VS-REQ-16 Create Distress Notification
- VS-REQ-16.2 Driver-Generated Distress Notification
- VS-REQ-32 Human-Machine Interface
- VS-REQ-32.7 Distress Notification
- IT-REQ-7 OBU Equipment
- MV-REQ-10 OBU Equipment
- HP-REQ-5 OBU Equipment

5.2.3 OBU Alerts Vehicle Driver of Distressed Vehicle

When a connected vehicle initiates a distress situation (as defined in Section **5.1.2**) its driver is notified with an event on the Vehicle Display. When a Host vehicle receives a distress notification from a remote vehicle which is ahead of it, and the remote vehicle was traveling in the same direction as the Host vehicle when it became distressed, the driver in the Host vehicle is notified that a Distressed Vehicle is ahead.

5.2.3.1 External References

- Distress Notification: SAE J3067, SAE J2735, SAE J2540-2
- HMI: ISO/TC 145, SAE J2831, ISO 15006
- Protocol Buffer interface is used to send the data from HMI to OBU.

5.2.3.2 Covered Information Flows

Table 5-5. Flow: OBU Alerts Driver of Alerts, Advisories and own Distress Situation

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
4	**Custom**	**33001**	**driver updates**	4-13	Vehicle (distressed)	Vehicle Driver	VI1
					Vehicle (receive)	Vehicle Driver	VI1
					Highway Patrol Vehicle	Vehicle Driver	VI1
					Integrated Comm Vehicle	Vehicle Driver	VI1
					Retrofit Comm Vehicle	Vehicle Driver	VI1
					WYDOT Maintenance Vehicle	Vehicle Driver	VI1

5.2.3.3 Dialogs

5.2.3.3.1 Dialog: Driver alerted to a Distressed Vehicle ahead.

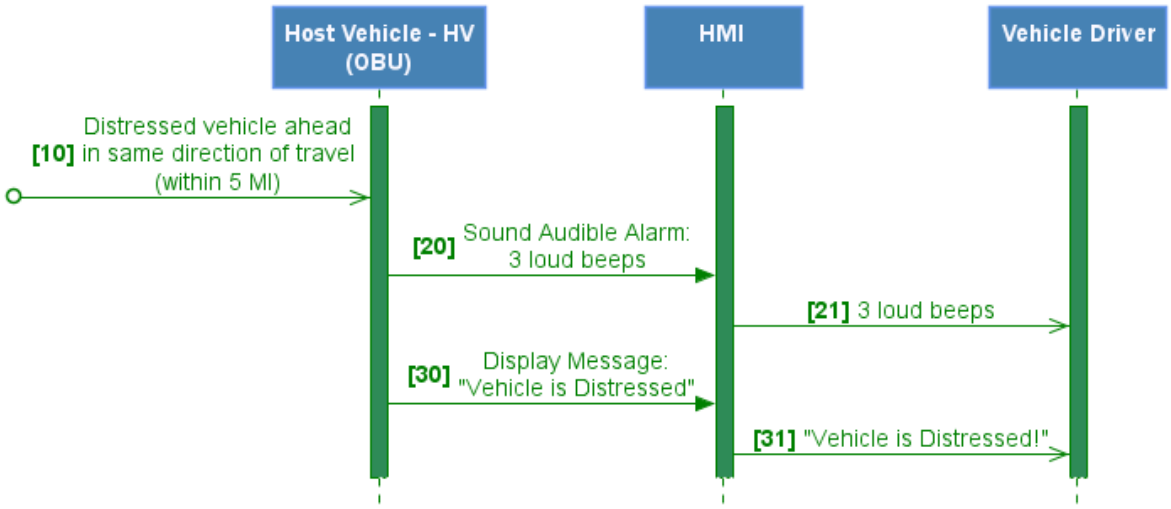


Figure 5-9. Sequence Diagram: Driver alerted to a Distressed Vehicle ahead.
Source: WYDOT

[10] A Distressed Vehicle is ahead, in same direction of travel within the next 5 miles

OBU has determined there is a valid Distress Notification for a vehicle ahead within the next 5 miles. The processing of Distress Notifications is described in Section **5.1.2**.

[20-21] HMI: audible alarm

OBU uses Protocol Buffer to send commands to HMI to signal an audible alarm.

[30-31] HMI: display message

OBU uses Protocol Buffer to send commands to HMI to display message that this vehicle has declared itself a Distressed Vehicle.

5.2.3.4 Messages

- The content and format of a DNM is described in Section: **7.5**

5.2.3.5 Data Elements

- The fields used in the DNM are defined in: **Table 7-2. Traveler Information Message (TIM) Fields**.

5.2.3.6 Requirement Traceability

- VS-REQ-23 IVAA Rank
- VS-REQ-24 IVAA Level
- VS-REQ-25 IVAA Priority Alert
- VS-REQ-27 IVAA DN
- VS-REQ-32 Human-Machine Interface
- VS-REQ-32.1 HMI-Location
- VS-REQ-32.2 HMI-Distraction
- VS-REQ-32.3 HMI-Readability
- VS-REQ-32.4 Visual and Auditory Interface
- VS-REQ-32.4.1 Visual Consistency
- VS-REQ-32.4.2 Audio Signals
- IT-REQ-6 General
- HP-REQ-1 General
- MV-REQ-9 General
- IT-REQ-7 OBU Equipment
- MV-REQ-10 OBU Equipment
- HP-REQ-5 OBU Equipment

5.2.4 OBU Interface with Vehicle Driver regarding non-DN

Connected Vehicles receive BSMs broadcast by other Connected Vehicles. They also receive Traveler Information Messages (TIMs) from RSUs and Satellite Service Providers (SSPs). Based on a vehicle's location, speed and direction of travel, Situational Awareness, Forward Collision Warning and Work Zone Warning which are running on the OBU will alert the vehicle driver. Driver alerts are sent to the HMI for audio and visual notifications. The HMI can also be configured by the Driver to set the display in Debug mode or deployment mode. Time sensitive messages will be initiated with a tone, then followed three seconds later by an HMI visual display for further explanation of the alert. This is to reduce driver distraction during critical events.

The vehicle driver can view the status of and perform basic management of the HMI interface to the OBU. The HMI will display its power status (i.e., off, powering up and online), application availability (i.e., WorkZone Warnings, Spot Weather, Exit Services, Forward Collision Warnings), and allow the user to configure display brightness, volume, font size. The vehicle driver will also be able to check application, firmware and Operating System version of the HMI.

5.2.4.1 External References

- Protocol Buffer interface is used to send the data from HMI to OBU.
- HMI: ISO/TC 145, SAE J2831, ISO 15006

5.2.4.2 Covered Information Flows

Table 5-6. Flow: OBU alerts Driver of non-Distress Notification.

Interop Cat Num	Shared/ Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
4	**Custom**	**33001**	**driver updates**	4-13	WYDOT Maintenance Vehicle	Vehicle Driver	VI1
					Highway Patrol Vehicle	Vehicle Driver	VI1
					Integrated Comm Vehicle	Vehicle Driver	VI1
					Retrofit Comm Vehicle	Vehicle Driver	VI1

5.2.4.3 Dialogs

5.2.4.3.1 Dialog: Sequence Diagram: OBU alerts driver of non-DN TIM or FCW.

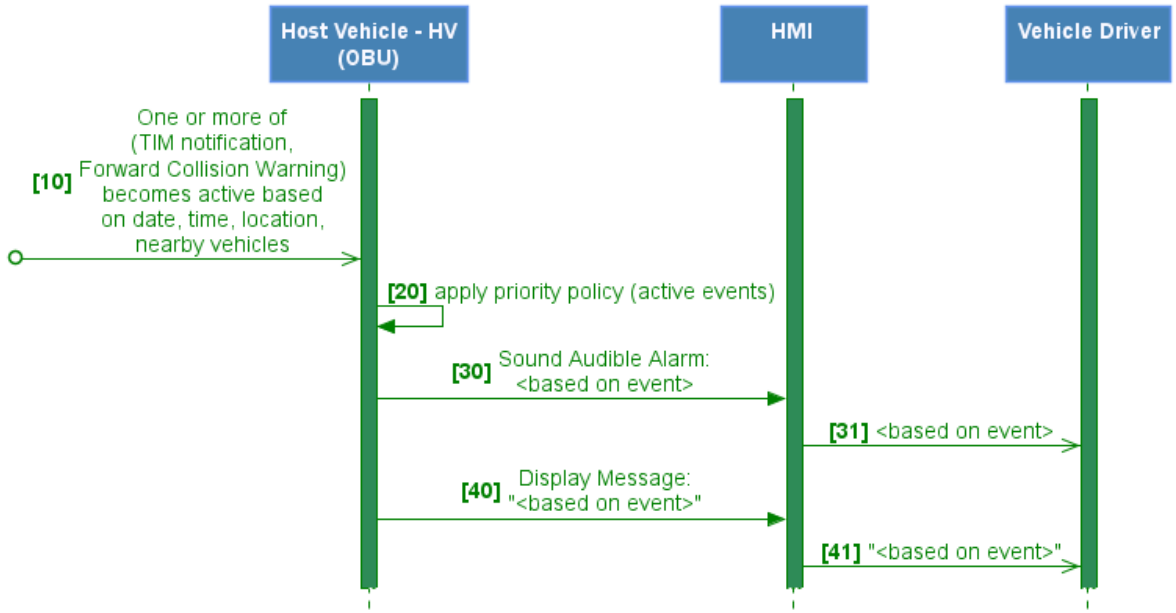


Figure 5-10 Sequence Diagram: OBU alerts driver of non-DN TIM or FCW.
Source: WYDOT

[10] One or more TIMs become active or a FCW becomes imminent

Based on location of Host Vehicle, one or more TIM notifications may become active.

- Spot Weather Impact Warning: See System Design Document, **Section 3.2.5.1**
- Work Zone Warning: See System Design Document, Section **3.2.5.2**
- I2V Situational Awareness Notification: See System Design Document, **Section 3.2.5.3** and **Table 3-84** for details on this set of notifications.

Based on location of Host Vehicle and the presence of Connected Vehicles ahead of the Host Vehicle, the Forward Collision Warning application may also trigger a driver alert.

- Forward Collision Warning: See System Design Document, **Section 3.2.5.5**

The OBU application must capture and save the BSMs generated by the Host Vehicle from 10 seconds before the event becomes active up until 10 seconds after the event became active. A log file containing the BMS must be saved along with information about what the event was. This log data must be saved until the earlier of the Host Vehicle comes in range of an RSU broadcasting an appropriate WSA or the OBU power is removed.

[20] OBU applications apply priority policy based on all active events.

Following the system requirements, the decision about what events to report will be made by the OBU applications.

[30-31] OBU application cause HMI to emit appropriate audible alarm

OBU uses Protocol Buffer to send commands to HMI to signal an audible alarm, within .5 seconds.

[40-41] OBU application cause HMI to display appropriate text and visual message

OBU uses Protocol Buffer to send commands to HMI to display the appropriate text and image, within .5 seconds.

5.2.4.3.2 Dialog: Sequence Diagram: Vehicle Driver Manages HMI.

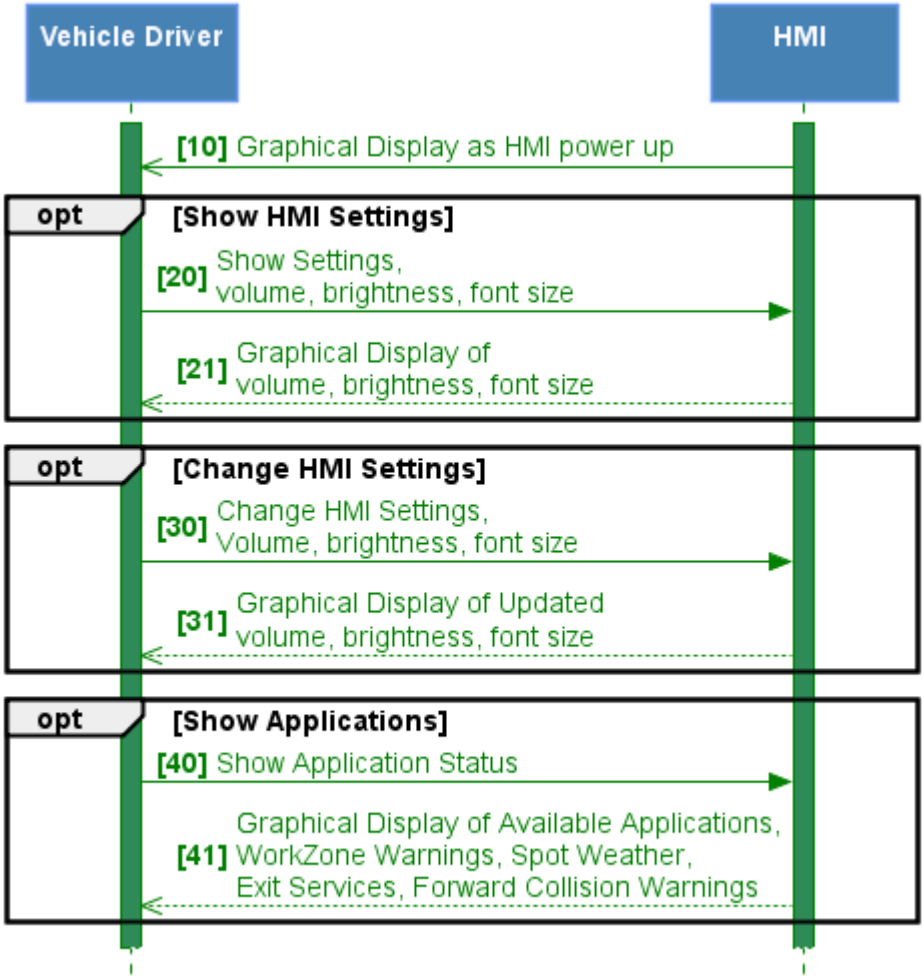


Figure 5-11 Sequence Diagram: Vehicle Driver Manages HMI.
Source: WYDOT

[10] HMI Displays status as it powers up

The HMI displays its status when powering up and then shows it's online.

[20-21] Vehicle Driver Views HMI System Settings

The vehicle driver interacts with the HMI to display the current settings for volume, brightness and font size and the HMI provides visual feedback to indicate the current settings.

[30-31] Vehicle Driver updates one or more HMI System Settings

The vehicle driver changes one or more of HMI volume, brightness or font size and the HMI provides visual feedback indicating the new settings.

[40-41] Vehicle Driver Views Application Settings

The vehicle driver interacts with the HMI to display the current applications settings. The HMI provides visual feedback to indicate application availability (i.e., failed, operating, disabled).

5.2.4.4 Messages

- HMI sounds 1 or more beeps to signal driver based on the event.
- HMI displays graphical image and text message according to the type of event being communicated. The notification types can be found in the WYDOT CV Pilot System Design Document, **Tables: 3-84, 3-87**.

5.2.4.5 Data Elements

There are no optional data elements in this flow.

5.2.4.6 Requirement Traceability

- VS-REQ-9 FCW Rear-End Crash
- VS-REQ-9.1 Rear-End Crash in Straight Road
- VS-REQ-9.2 Rear-End Crash in Curved Road
- VS-REQ-23 IVAA Rank
- VS-REQ-24 IVAA Level
- VS-REQ-25 IVAA Priority Alert
- VS-REQ-26 IVAA FCW
- VS-REQ-28 IVAA SA-Advisory
- VS-REQ-29 IVAA SA-VSL
- VS-REQ-30 IVAA SWIW
- VS-REQ-31 IVAA WZW
- VS-REQ-32 Human-Machine Interface
- VS-REQ-32.1 HMI-Location
- VS-REQ-32.2 HMI-Distraction
- VS-REQ-32.3 HMI-Readability
- VS-REQ-32.4 Visual and Auditory Interface
- VS-REQ-32.4.1 Visual Consistency
- VS-REQ-32.4.2 Audio Signals
- VS-REQ-32.5 Customizations
- VS-REQ-32.6 System Status
- VS-REQ-32.6.1 Power Status
- VS-REQ-32.6.2 System Settings
- VS-REQ-32.6.3 Application Availability
- VS-REQ-42 SLD Log Data
- MV-REQ-9 General
- IT-REQ-6 General
- RFV-REQ-5 General
- HP-REQ-1 General
- IT-REQ-7 OBU Equipment
- RFV-REQ-6 OBU Equipment
- MV-REQ-10 OBU Equipment

- HP-REQ-5 OBU Equipment

5.3 OBU <-> Vehicle Location and Time System (VLTS)

This section describes an interface within the vehicle's OBU, that between the GPS sub-system and the OBU BSM software.

5.3.1 OBU Incorporates Location and Time into BSM

This sub-section describes the interaction where the location and time service within the OBU is used to add GPS location and time information to messages sent from the OBU, including:

- Basic Safety Messages
    - BSM generation, Section: **5.1.1**
    - BSM message structure, Section: **7.1**.
- Distress Notifications
    - Driver Initiated, Section: **5.2.2**
    - ~~CAN bus triggered, Section: **5.4.1**~~
    - DNM structure, Section: **7.5**

The Basic Safety Message application will use the Vehicle Location Time Service to add location and time information to messages sent by the OBU.

5.3.1.1 External References

The interface for location and time service interaction is detailed in the SAE J2945/1 standard. Specifically, position and timing standards are specified in section 6.2 of SAE J2945/1. Additional details for LTS to RSU can be found in the **System Architecture Document (SAD) Section 4.5.7** and **SAD Figure 4-23**.

5.3.1.2 Covered Information Flows

Table 5-7. Flows: VLTS to OBUs.

Interop Cat Num	Shared/ Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30028**	**location and time**	4-19	Vehicle Location and Time Data Source	Highway Patrol Vehicle	VE4
					Vehicle Location and Time Data Source	Integrated Comm Vehicle	VE4
					Vehicle Location and Time Data Source	Retrofit Comm Vehicle	VE4
					Vehicle Location and Time Data Source	WYDOT Maintenance Vehicle	VE4

5.3.1.3 Dialogs

The following sequence diagram describes the message flow for VLTS <-> OBU for all the following vehicle types: [Basic, Highway Patrol, Integrated, WYDOT Maintenance]

5.3.1.3.1 Dialog: Vehicle request for LTS

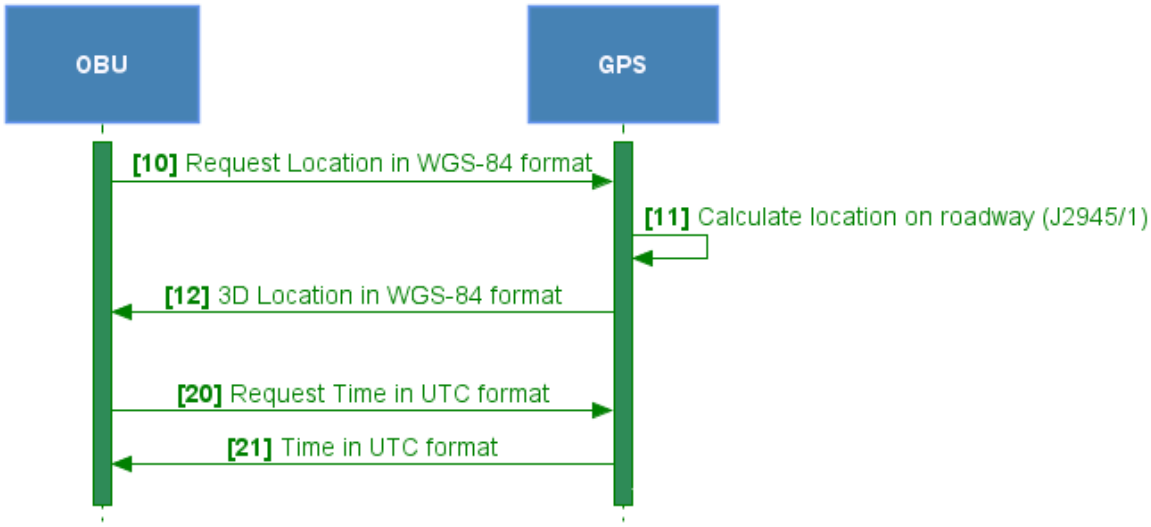


Figure 5-12. Sequence Diagram: Vehicle request for LTS.
Source: WYDOT

5.3.1.4 Messages

- Location in WGS-84 format
- Time in UTC

5.3.1.5 Data Elements

- There are no optional data elements for this message flow.

5.3.1.6 Requirement Traceability

- LTS-REQ-4 VS LTS Time
- LTS-REQ-5 VS LTS Time Standard
- LTS-REQ-6 VS LTS Location
- IT-REQ-5 Time
- RFV-REQ-3 Time
- HP-REQ-3 Time
- MV-REQ-7 Time
- IT-REQ-6 Location
- HP-REQ-4 Location
- RFV-REQ-4 Location
- MV-REQ-8 Location

~~5.4 OBU <-> Vehicle CAN bus~~

NOTE: Can bus integration is no longer part of this Pilot.

~~This section describes the interface between the OBU and the vehicle's Controller Area Network Bus (CAN bus). The vehicle's CAN bus provides data from the vehicle which is included in BSMs. The CAN bus may also alert the OBU of an Air Bag deployment or Vehicle Disabled status. Either of these would cause the OBU to trigger a Distress Notification (for details see Section: **5.1.2**).~~

~~5.4.1 CAN bus Data Triggers Distress Notification~~

~~CAN bus under a distress situation can provide alerts for an air bag deployed or vehicle disabled. The OBU will trigger the generation of a Distress Notification message using these alerts.~~

~~Vehicle/OBU Applicability: [WYDOT Maintenance]~~

~~5.4.1.1 External References~~

- ~~Basic Safety Message: SAE J2735~~
- ~~CAN bus: ISO 11898-1~~
- ~~Distress Notification: SAE J3067, SAE J2735, SAE J2540-2~~

~~5.4.1.2 Covered Information Flows~~

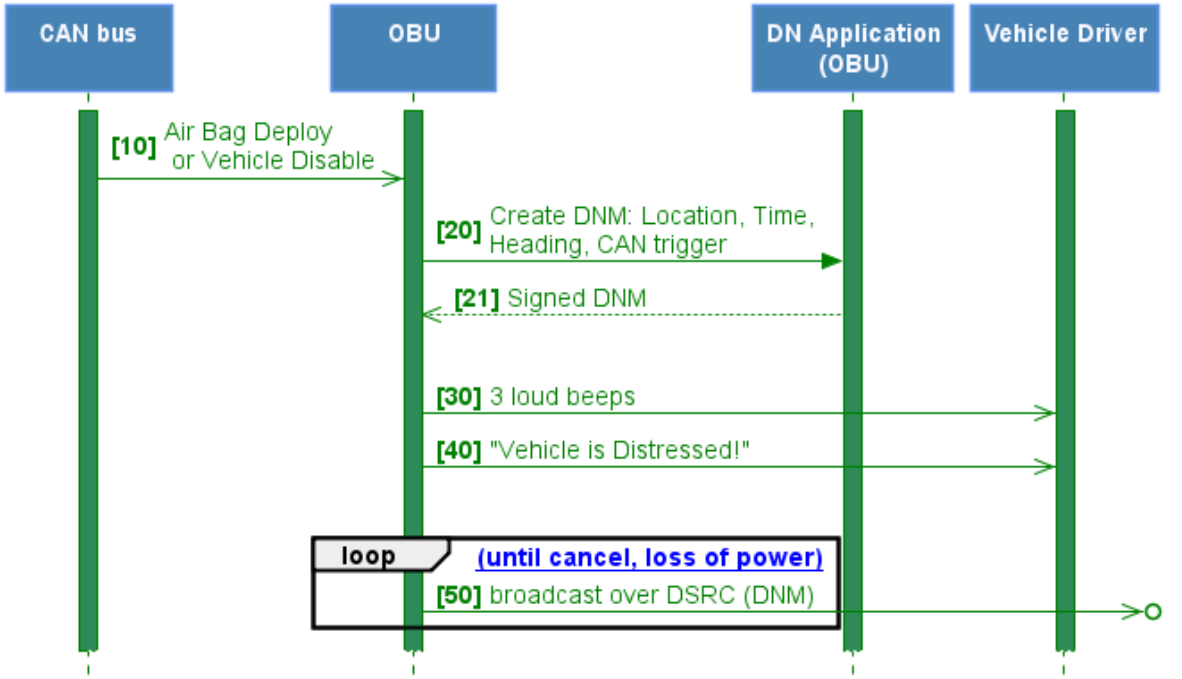
~~Table 5-8. Flow: Vehicle CAN bus of Distressed Vehicle sends data to OBU.~~

~~Interop Cat Num~~	~~Shared / Custom~~	~~Instance ID~~	~~Flow Name~~	~~Fig. Num~~	~~Source Element~~	~~Destination Element~~	~~WYDOT Interface Number~~
~~5~~	~~**Custom**~~	~~**33007**~~	~~**host vehicle status**~~	~~4-12~~	~~Vehicle CAN bus~~	~~Vehicle (distressed)~~	~~VI2~~

~~5.4.1.3 Dialogs~~

~~5.4.1.3.1 Dialog: CAN bus data triggers Distressed Notification~~

~~CAN Bus messages processed by the Vehicle will create a Distress Notification message based on the distress situation.~~



~~**Figure 5-13. Sequence Diagram: CAN bus data triggers Distressed Notification. Source: WYDOT**~~

~~[10] CAN bus message to OBU~~

~~The CAN bus sends a message to the OBU notifying either an Air Bag Deploy or a Vehicle Disable.~~

~~[20-21] OBU calls DN application to generated signed DNM~~

~~DNM must be populated with cause of distress (operator triggered), the location & time (from vehicle location and time system), as well as the vehicle heading when Distress Situation occurred. The DNM must also be signed.~~

~~[30-40] HMI: Audible Alarm and Visual Message~~

~~OBU uses Protocol Buffer to send commands to HMI to signal an audible alarm & display message that this vehicle has declared itself a Distressed Vehicle.~~

[50] Broadcast DNM

A Distressed Vehicle will begin broadcasting the DNM. **Vehicles broadcast DNMs using DSRC channel 172, broadcast at 10 Hz and use PSID 0x40-82.** A Distressed Vehicle will continue broadcasting the DNM until either the power to the OBU is lost or the Vehicle Driver terminates the DN via the HMI.

5.4.1.4 Messages

- A CAN bus message indicating either an Air Bag Deploy or a Vehicle Disable.

5.4.1.5 Data Elements

- There are no optional data elements for this message flow.

5.4.1.6 Requirement Traceability

- VS-REQ-4 Collect Vehicle Status Data
- VS-REQ-16 Create Distress Notification
- VS-REQ-16.1 System-Generated Distress Notification
- VS-REQ-18 DN PSID

5.4.2 CAN bus Periodically Delivers Host Vehicle Data to OBU

OBU is responsible to transmit BSM every 100 msec. This BSM message consists of several CAN parameters. CAN data is read periodically read from the CAN bus and the data sent to OBU over OBD-II port. This data will be read by the BSM before each packet transmission. Note: Communications with CAN bus are complex, they are very different between cars and trucks and are different between different make model and year cars. The WYDOT CV Pilot has acknowledged the risk that the desired CAN bus integration not be achieved.

Vehicle/OBU Applicability: [WYDOT Maintenance]

5.4.2.1 External References

- Basic Safety Message: SAE J2735
- CAN bus: ISO 11898-1

5.4.2.2 Covered Information Flows

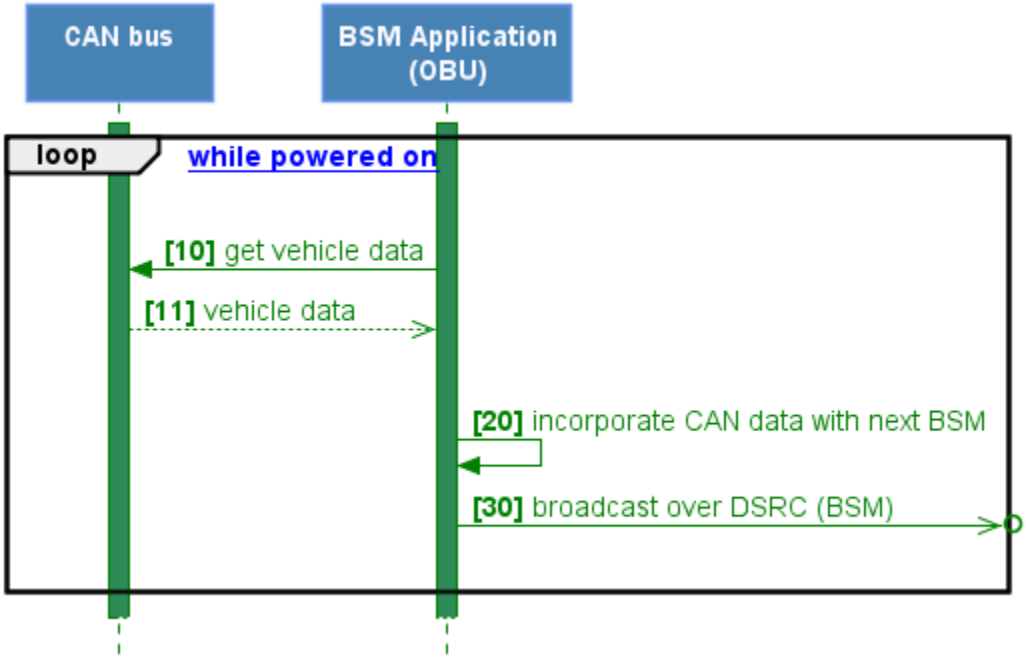
Table 5-9. Flow: CAN bus to OBU (non DN).

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	Custom	33007	host vehicle status	4-12	Vehicle CAN bus	WYDOT Maintenance Vehicle	VI2

~~5.4.2.3 Dialogs~~

~~CAN Bus messages processed by the Vehicle will create a BSM message based on the CAN and GPS data and will broadcast it.~~

~~5.4.2.3.1 Dialog: CAN bus sends non-DN data to OBU~~



~~Figure 5-14. Sequence Diagram: CAN bus sends non-DN data to OBU. Source: WYDOT~~

~~[10-11] BSM Application gets CAN bus data~~

~~The BSM application gets vehicle data from the CAN bus.~~

~~[20] Save CAN bus data to BSM~~

~~CAN bus data is incorporated into the BSM data structure.~~

~~[30] OBU Broadcasts BSM containing data received from CAN bus~~

~~OBUs broadcast BSMs at 10 Hz. OBUs broadcast BSMs using DSRC channel 172 with PSID 0x20.~~

~~5.4.2.4 Messages~~

~~The data provided by CAN bus and which is included in broadcast BSM is shown in **Table 7-1**, where column #1 contains the value "yes/CAN".~~

~~5.4.2.5 Data Elements~~

- ~~There are no optional data elements for this message flow.~~

~~*5.4.2.6 Requirement Traceability*~~

- ~~VS-REQ-4 Collect Vehicle Data~~
- ~~VS-REQ-4.1 Collect Vehicle Status Data~~

5.5 MV Environmental Sensors <-> WYDOT MV (HMI)

This section describes an interface which only exists on WYDOT Maintenance Vehicles (MV) with externally and internally mounted environmental sensors. The interface is between the Environmental Sensors and the HMI device. The HMIs in WYDOT Maintenance Vehicles will run the GroundTruth app which collects environmental sensor data. The GroundTruth app connects to the sensors using Bluetooth Low Energy (BLE).

5.5.1 GroundTruth Android Application Function

The GroundTruth app is designed to be the gateway between the sensors and the HMI device. The GroundTruth app connects to the sensors using Bluetooth Low Energy (BLE) and writes the sensor data to a local file on the HMI.

This section describes the interface between vehicle mounted weather sensors and the GroundTruth Android Application that interconnects physical sensor device's data steam to the host controller app data logger collect file.

This section describes specific functions of the software application as the host controller for modular sensor packs. The version 1.4.X of GroundTruth Android Application Connects to vehicle mounted Bluetooth 4.1 sensor packs to receive real-time weather data from the sensor's readings. The GroundTruth app logs the data in JSON format in a file called "WYC(UTC time and date stamp).TXT" in the "Downloads/WC" directory of the HMI (the WC is a configurable directory location).

Note, the following description is for illustration purposes only, the authoritative specification for the algorithm is contained in the **SDD, Section 3.2.5.1.3**: The GroundTruth app will create an entry in the file every 30 seconds when vehicle speed is over "Z" MPH, a new file will be created every "X" entries with "X" being a configurable parameter. The GroundTruth app will delete files older than "Y" days with "Y" being a configurable parameter.

Vehicle identification information can be turned on or off (configurable via text file) to include:

- Vehicle ID
- MAC bumper
- MAC sky
- RSSI bumper
- RSSI sky
- Status bumper
- Status sky
- Android software version
- Application name

Data Options:

- GroundTruth Options
- JSON
- Number of records per file
- Max age of files retained

Egress:

- Write JSON data to a file

Calibration:

- We can set up hard-coded calibration functions in the GroundTruth app

5.5.1.1 External References

The environmental sensors communicate with the HMI application over Bluetooth 4.1.

5.5.1.2 Covered Information Flows

Table 5-10. Flow: Weather Sensors to HMI.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33006**	**environmental sensor data**	4-12	MV Environmental Sensors	WYDOT Maintenance Vehicle	VI3

5.5.1.3 Dialogs

5.5.1.3.1 Dialog: HMI records environmental sensor readings

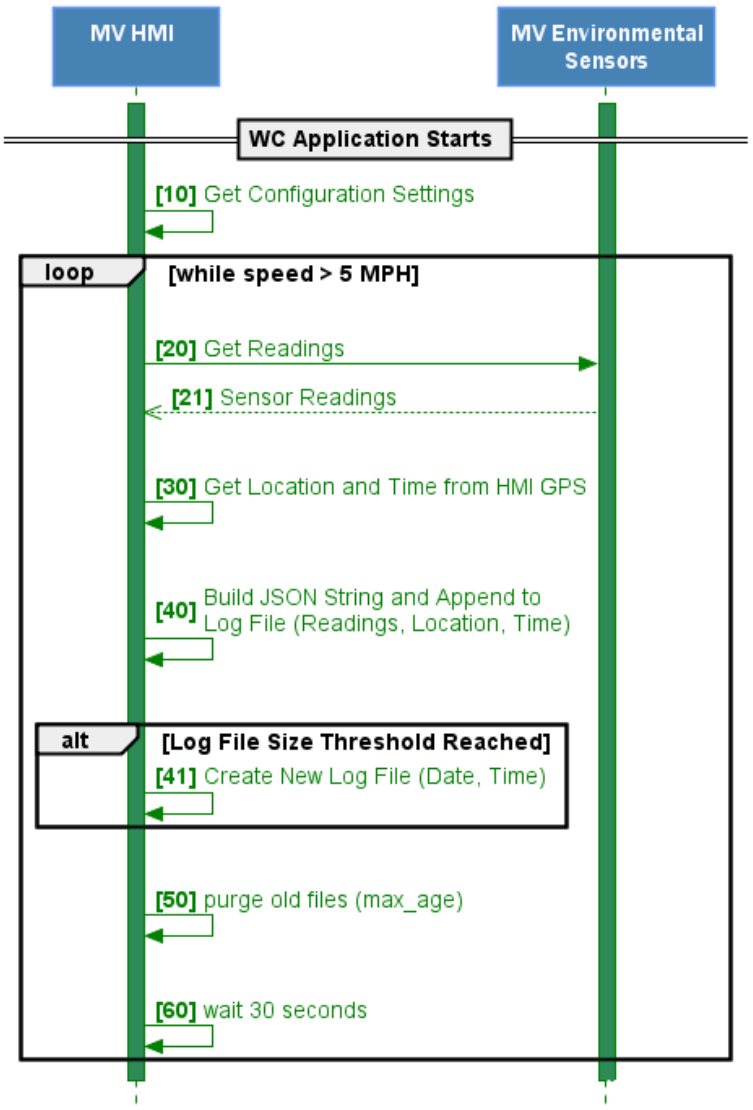


Figure 5-15. Sequence Diagram: HMI records environmental sensor readings.
Source: WYDOT

[10 - 13] Get Configuration Settings

When the Weather Cloud application starts, it reads an ASCII configuration file which tells the application:

- directory on tablet to save sensor log files
- maximum history of log files to keep, measured in days
- number of records per log file
- how often to sample (Ex. Every 5 seconds)

[20-21] Capture sensor readings

Do not collect samples if vehicle is traveling less than 5 MPH. If vehicle is traveling faster than 5 MPH then capture sensor readings from all environmental sensors.

[30] Get Location and Time from GPS on HMI

[40] Build JSON String and Append to Log File

Build a JSON string from the sensor readings. Prepend string containing UTC time, latitude, longitude and elevation. Append new reading to latest log file.

[41] Alternate: If Log File Has Maximum Number of Records

Based on the application configuration setting for the maximum number of environmental records per log file, create a new log file. The log file's name represents UTC time the file was created, down to seconds.

[50] Purge old log files

Based on configuration file setting for the amount of history to keep, purge log files older than the maximum age.

[60] Pause between sample capture

Based on configuration file setting, pause between sample captures.

5.5.1.4 Messages (GroundTruth JSON file format)

The format of the Environmental Data Log file is defined in Section: **7.7**.

5.5.1.5 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.5.1.6 Requirement Traceability

- 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 Transmit Data
- MV-REQ-1 Environmental Sensors
- MV-REQ-1.1 Environmental Sensor Equipment

5.6 CMV Driver PID <-> Vehicle Driver

This section describes the interface between a Commercial Vehicle (CMV) Driver and a Personal Information Device (PIDs) (e.g. smartphones) running the WDOT 511App. This section will describe the interactions between the vehicle drivers and the WYDOT 511 application interface running on PIDs.

The existing WYDOT 511App 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.

5.6.1 Vehicle Driver Enters Parking Data into PID

The WYDOT 511 application will share crowdsourced truck parking availability information across the state of Wyoming. Users of the 511 application will have the opportunity to enter parking availability for facilities along the corridor as part of the 511App interface, the parking availability information entered will be collated by the WYDOT CV system and per-lot, parking availability information will be made available to users of the 511 application and it will be broadcast for all vehicles participating in the WYDOT CV pilot as TIMs Exit Services (Part III content choice *exitService* defined in SAE J2735 MAR2016, Section 6.142).

5.6.1.1 External References

None

5.6.1.2 Covered Information Flows

Table 5-11. Flow: Driver enters Parking Availability Data to PID.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33002**	**CMV Parking Status Information**	4-18	Vehicle Driver	CMV Driver PID	External WYDOT Managed Interface

5.6.1.3 Dialogs

Users of the 511App enter parking availability data in their PID as shown below.

5.6.1.3.1 Dialog: User uses PID to enter parking data to 511App

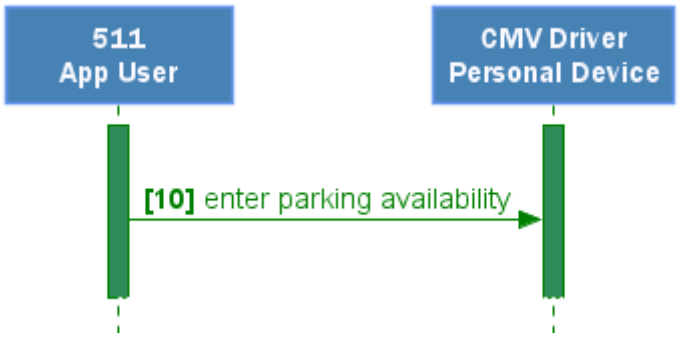


Figure 5-16. Sequence Diagram: User uses PID to enter parking data to 511App.
Source: WYDOT

[10] User enters parking availability

User enters a value of low, medium or high for the amount of available parking in the lot they are located in. The 511 Application running on the PID then adds GPS location to the parking report and sends the parking report to the 511 Application Service over mobile data network.

5.6.1.4 Messages

User enters a value of low, medium or high for the available parking in the lot where they are located.

5.6.1.5 Data Elements

There are no optional data elements in this flow.

5.6.1.6 Requirement Traceability

There are no requirements for this interface as this occurs outside of WYDOT's CV Pilot System.

5.7 CMV Driver PID <-> WYDOT 511 System

This section describes changes to the data used by the existing interface between Personal Information Devices (PIDs) (e.g. smartphones) running the WDOT 511App and the WYDOT 511 System. The interface is an existing, external WYDOT managed interface which is not being altered. Only additional data is being added to the information flow.

The existing WYDOT 511App 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.

5.7.1 CMV Driver PID Sends Parking Data to WYDOT 511 System

5.7.1.1 External References

The WYDOT 511 application will share crowdsourced truck parking availability information across the state of Wyoming. Users of the 511 application will have the opportunity to enter parking availability for facilities along the corridor as part of the 511App interface, the parking availability information entered will be collated by the WYDOT CV system and per-lot, parking availability information will be made available to users of the 511 application and it will be broadcast for all vehicles participating in the WYDOT CV pilot as TIMs Exit Services (Part III content choice *exitService* defined in SAE J2735 MAR2016, Section 6.142).

5.7.1.2 Covered Information Flows

Table 5-12. Flow: CMV PID sends Parking data to WYDOT 511 System

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33002**	**CMV Parking Status Information**	4-18	CMV Driver PID	WYDOT 511 System	External WYDOT Managed Interface

5.7.1.3 Dialogs

Once a 511App user enters parking availability data in their PID, the device will tag the reported parking availability report with the current time and current location. Then the device will push the report to the 511 Application server as shown below.

5.7.1.3.1 Dialog: CMV PID sends Parking data to WYDOT 511 System

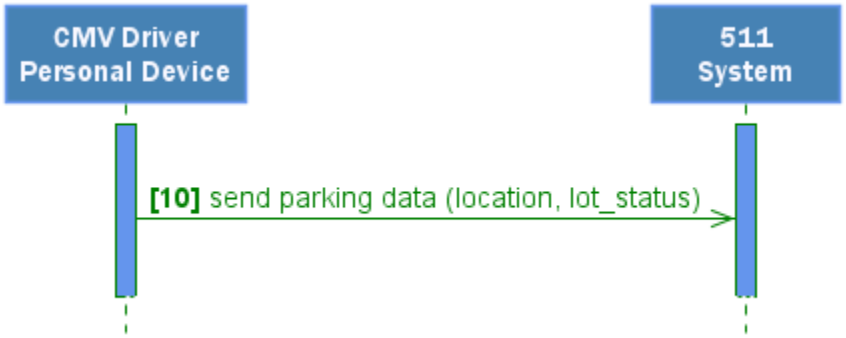


Figure 5-17. Sequence Diagram: CMV PID sends Parking data to WYDOT 511 System. Source: WYDOT

5.7.1.4 Messages

For complete details on the data transferred over this interface see Section **7.6.1**, Parking Data from 511App

5.7.1.5 Data Elements

There are no optional data elements in this flow.

5.7.1.6 Requirement Traceability

There are no requirements for this interface as this occurs outside of WYDOT's CV Pilot System.

5.8 WYDOT 511 System <-> WYDOT Data Broker

This section describes changes to the data used by the existing interface between WYDOT 511 System and the WYDOT Data Broker. The interface is an existing, external WYDOT managed interface which is not being altered. Only additional data is being added to the information flow.

The existing WYDOT 511App 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.

5.8.1 WYDOT 511 System sends Parking data WYDOT DB

The WYDOT 511 application will share crowdsourced truck parking availability information across the state of Wyoming. Users of the 511 application will have the opportunity to enter parking availability for facilities along the corridor as part of the 511App interface, the parking availability information entered will be collated by the WYDOT CV system and per-lot, parking availability information will be made available to users of the 511 application and it will be broadcast for all vehicles participating in the WYDOT CV pilot as TIMs Exit Services (Part III content choice exitService defined in SAE J2735 MAR2016, Section 6.142).

5.8.1.1 External References

Parking availability reports from the 511App will be input to the WYDOT Data Broker using a REST interface. The WYDOT Data Broker presents a REST endpoint following the standards described in Section **6.2 WEB Services Standards**.

5.8.1.2 Covered Information Flows

Table 5-13. Flow: WYDOT 511 System sends parking data to DB

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33002**	**CMV Parking Status Information**	4-18	WYDOT 511 System	WYDOT Data Broker (DB)	WE5

5.8.1.3 Dialogs

5.8.1.3.1 Dialog: WYDOT 511 System sends parking data to DB

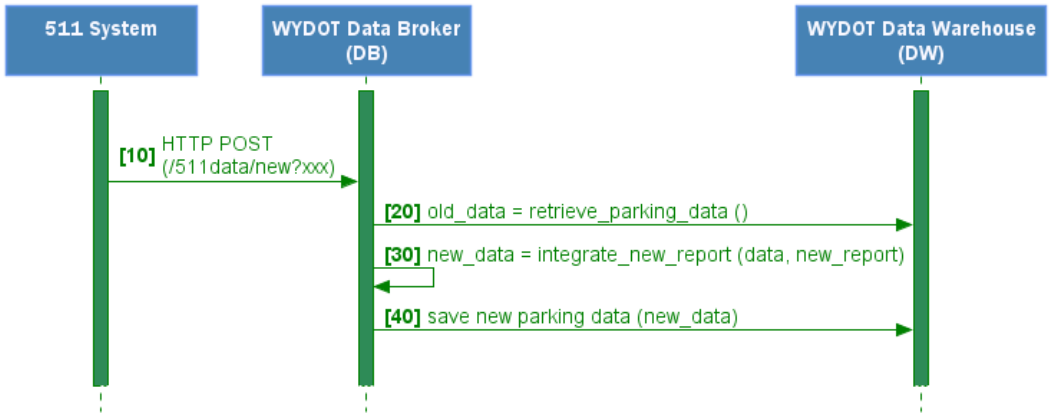


Figure 5-18. Sequence Diagram: WYDOT 511 System sends parking data to DB. Source: WYDOT

5.8.1.4 Messages

For complete details on the data transferred over this interface see Section **7.6.1 Parking Data from 511App**

5.8.1.5 Data Elements

There are no optional data elements in this flow.

5.8.1.6 Requirement Traceability

- 511-REQ-1 511App Parking Data Collection
- 511-REQ-1.1 Availability
- 511-REQ-1.2 Default
- 511-REQ-1.3 Time
- 511-REQ-1.4 Location
- 511-REQ-1.5 Protocol
- 511-REQ-1.6 Schema
- 511-REQ-2 Timeframe
- WCVS-REQ-7 External Brokerage
- WCVS-REQ-7.1 Receive from External Interfaces

5.9 OBU <-> RSU

This section describes the interface between OBUs and RSUs. This interface operates using DSRC radios to connect remote vehicles with WYDOT's Connected Vehicle infrastructure which consists of 75 RSUs along I-80 and at WYDOT Maintenance Facilities. This interface supports the following activity:

- RSUs collect BSMs Part I and Part II from passing vehicles and forward them to ODE in support of traffic situation awareness applications.
- RSUs enable several security credentials management use cases for OBUs.

5.9.1 OBU Broadcasts BSM (Part I & II) which is received by RSU

OBUs collect their location, heading and speed information along with additional parameters input by the vehicle driver as well as data from the vehicle's CAN interface. A GPS module in the OBU provides the location, speed, acceleration etc. OBUs package this data into a Basic Safety Message (BSM). BSMs are then signed and broadcast for other connected vehicles and RSUs. **OBUs broadcast BSMs at 10 Hz. OBUs broadcast BSMs using DSRC channel 172 with PSID 0x20.**

RSUs receive BSMs from passing vehicles, collect them in logs and periodically (every 5 minutes) copy these logs to the ODE.

5.9.1.1 External References

- Basic Safety Message: SAE J2735
- BSM, TIM, DNM signatures: IEEE 1609.2
- Dedicated Short Range Communications (DSRC): ISO 15628, SAE J2735, SAE J2945/1, SAE J3067, IEEE 802.11p, IEEE 1609.3

- RSU: USDOT RSU Specification 4.1
- ASN.1:2015: Abstract Syntax Notation

5.9.1.2 Covered Information Flows

Table 5-14. Flow: OBU Broadcasting BSMs to RSU.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30037**	**vehicle environmental data**	4-12	Retrofit Comm Vehicle	WYDOT RSUs	WE1/VE1
					Integrated Comm Vehicle	WYDOT RSUs	WE1/VE1
					WYDOT Maintenance Vehicle	WYDOT RSUs	WE1/VE1
					Highway Patrol Vehicle	WYDOT RSUs	WE1/VE1

5.9.1.3 Dialogs

5.9.1.3.1 Dialog: OBU Broadcasts BSMs Part I and Part II to RSU.

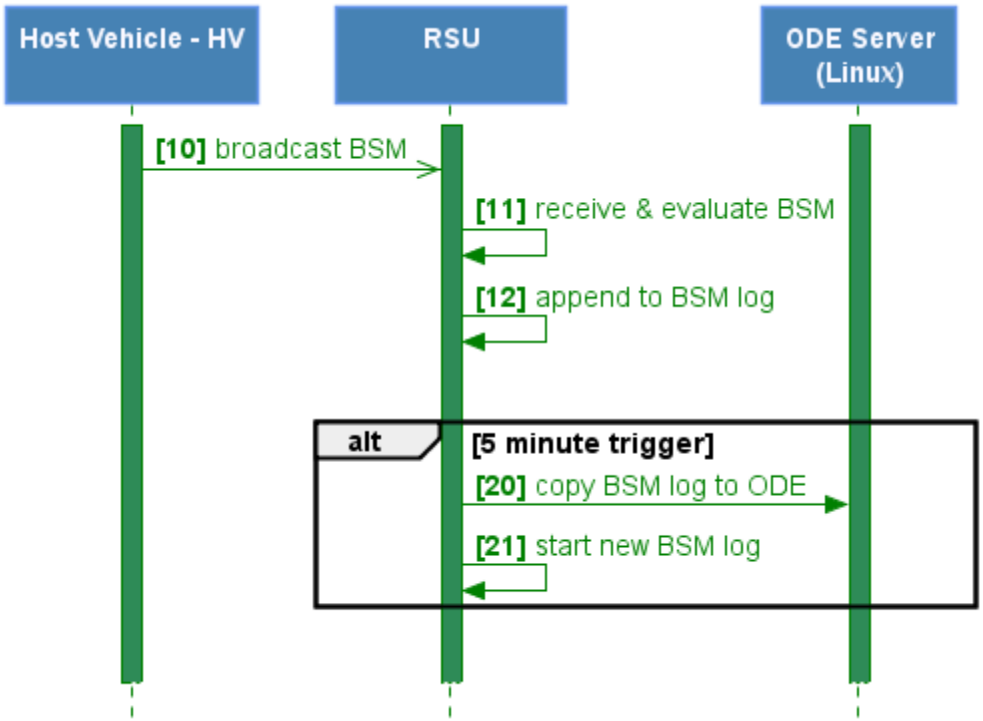


Figure 5-19. Sequence Diagram: OBU Broadcasts BSMs Part I and Part II to RSU. Source: WYDOT

[10] Host Vehicle broadcasts BSM which is received by RSU

[11-12] RSU receives BSM and

The RSU saves all BSMs and appends them to a BSM log file.

[20] Every 5 minutes, RSU Copies BSM log file to the ODE & starts a new log

For details on this operation see Section: **5.18.1**.

5.9.1.4 Messages

- BSM message structure, **Section: 7.1**.

5.9.1.5 Data Elements

- The fields used in the BSM are defined in: **Table 7-1: BSM Message Fields**.

5.9.1.6 Requirement Traceability

- WCVS-REQ-1 Collect CV Data
- WCVS-REQ-1.1 Collect BSM Data
- VS-REQ-33 BCVI Messages
- VS-REQ-35 BCVI General Broadcast Requirements
- VS-REQ-45 VSM SCMS Sign
- VS-REQ-50 Safety Communication
- RSU-REQ-6 Safety Communication
- MV-REQ-9 General
- IT-REQ-6 General
- RFV-REQ-5 General
- HP-REQ-1 General
- IT-REQ-1 Receive TIM over DSRC
- RFV-REQ-1 Receive TIM over DSRC
- HP-REQ-2 Receive TIM over DSRC
- MV-REQ-4 Receive TIM over DSRC
- MV-REQ-3 Static Identifier

5.9.2 RSU Broadcasts TIMs which are received by OBUs

RSUs broadcast digitally signed TIMs to Connected Vehicles as part of Infrastructure to Vehicle Situational Awareness. TIMs can be configured on the Roadside Units (RSU) through SNMP or from the backend WYDOT TMC configuring the messages on RSU. Store and Repeat message mechanism is used to send the messages from WYDOT TMC to RSU. These messages are broadcast by the RSU and the vehicles passing in the vicinity of the RSU receive them and process them based on the path traveled by the vehicle.

5.9.2.1 External References

- Traveler Information Message: SAE J2735, SAE J2540-2

- BSM, TIM, DNM signatures: IEEE 1609.2
- Dedicated Short Range Communications (DSRC): ISO 15628, SAE J2735, SAE J2945/1, SAE J3067, IEEE 802.11p, IEEE 1609.3
- RSU: USDOT RSU Specification 4.1
- SAE J3067 AUG2014
- ASN.1:2015: Abstract Syntax Notation

5.9.2.2 Covered Information Flows

Table 5-15. Flows: RSUs broadcasting TIMs to OBUs.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30024**	**I2V Situational Awareness TIM (I2V)**	4-13	WYDOT RSUs	Highway Patrol Vehicle	WE1/VE1
					WYDOT RSUs	Integrated Comm Vehicle	WE1/VE1
					WYDOT RSUs	Retrofit Comm Vehicle	WE1/VE1
					WYDOT RSUs	WYDOT Maintenance Vehicle	WE1/VE1

5.9.2.3 Dialogs

5.9.2.3.1 Dialog: Sequence Diagram: RSU Broadcasts TIMs which are received by OBUs

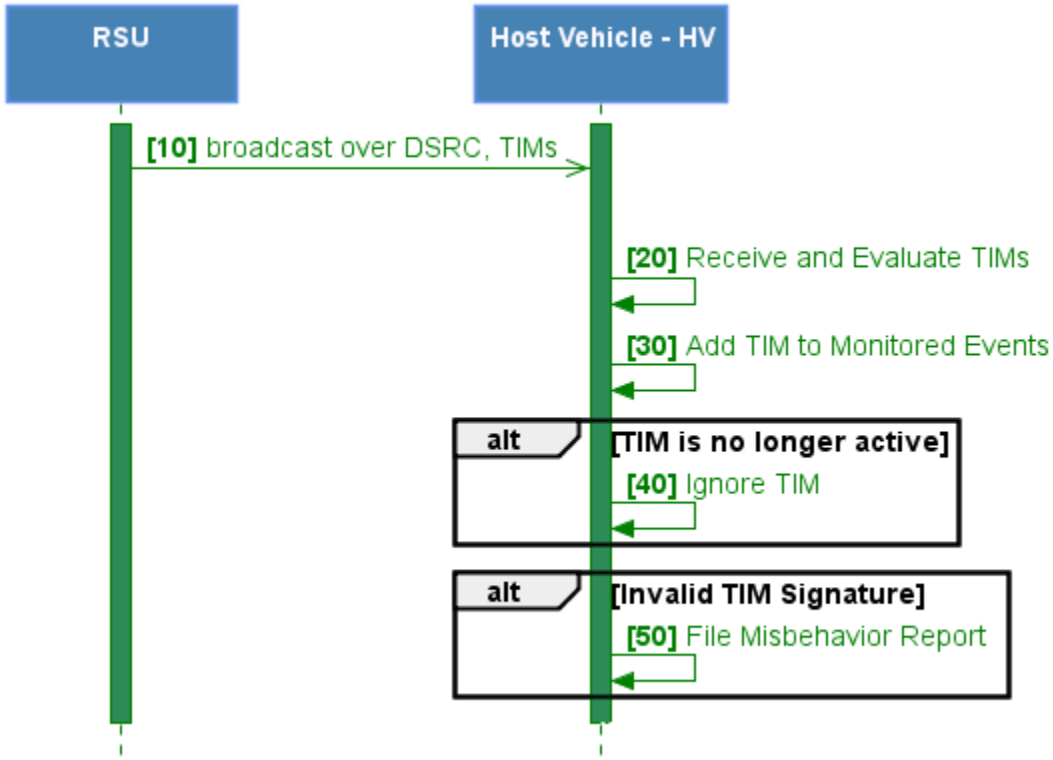


Figure 5-20. Sequence Diagram: RSU Broadcasts TIMs which are Received by OBUs. Source: WYDOT

[10-30] RSU broadcasts TIMs and HV receives them

RSUs broadcast digitally signed TIMS. HV receives TIMs and adds them to list of locations to monitor against the vehicle's position.

[40] OBU ignores the TIM if the TIM is no longer active.

Each TIM contains a start date and time as well as a duration. If the TIM is no longer active based on these fields then the OBU ignores the TIM.

[50] OBU handling it the TIM has an invalid signature.

Each TIM must be signed with a valid signature. If the OBU cannot validate the signature, then the OBU ignores the TIM and files a misbehavior report.

5.9.2.4 Messages

- Traveler Information Message: described in Section: **7.2**

5.9.2.5 Data Elements

- The ITIS codes and content of TIMs varies by type of notification. See **Table 7-2. Traveler Information Message (TIM) Fields**. which shows which fields are used for each different notification type. For the list of ITIS codes used, see Section: **7.4**.

5.9.2.6 Requirement Traceability

- WCVS-REQ-4 Contents of Alerts and Advisories
- WCVS-REQ-4.1 Precipitation Hazard
- WCVS-REQ-4.2 Road Condition Hazard
- WCVS-REQ-4.3 Visibility Hazard
- WCVS-REQ-4.4 Work Zone Hazard
- WCVS-REQ-4.5 Incident Hazard
- WCVS-REQ-4.6 Parking
- WCVS-REQ-10 Distribute signed TIM
- WCVS-REQ-10.1 Distribute signed TIM to VS
- VS-REQ-2 Receive TIM
- VS-REQ-2.1 Receive TIM through DSRC
- VS-REQ-11 SA TIM-Advisories
- VS-REQ-12 SA TIM-Speed Limit
- VS-REQ-13 SA TIM-Exit Services
- VS-REQ-14 SA TIM-Region
- VS-REQ-22 SWIW TIM-Region
- VS-REQ-45 VSM SCMS Sign
- VS-REQ-50 Safety Communication
- RSU-REQ-2 Distribute signed TIM to VS
- RSU-REQ-6 Safety Communication
- RSU-REQ-7 Broadcast

- MV-REQ-9 General
- HP-REQ-1 General
- IT-REQ-6 General
- RFV-REQ-5 General
- MV-REQ-4 Receive TIM over DSRC
- IT-REQ-1 Receive TIM over DSRC
- RFV-REQ-1 Receive TIM over DSRC
- HP-REQ-2 Receive TIM over DSRC

5.9.3 OBU Utilizes RSU Broadcast SCMS Services

The OBU uses wireless IPv6 communication with nearby RSUs to establish a connection with the SCMS system. The RSUs act as an IPv6 router for the OBU to reach the SCMS system. The nature of the traffic over the routed network is described in the Section: **5.13**.

5.9.3.1 External References

- SAE J2735
- IEEE 802.11p
- IEEE 1609.2 - WAVE Security Services
- IEEE 1609.3
- IEEE 1609.4
- IETF RFC 2460
- IETF RFC 793

5.9.3.2 Covered Information Flows

Table 5-16. Flows: RSU sending Security Credentials to OBUs.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
1	**Shared**	**30003**	**security credentials**	4-31	WYDOT RSUs	Highway Patrol Vehicle	WE1/VE1
					WYDOT RSUs	Integrated Comm Vehicle	WE1/VE1
					WYDOT RSUs	Retrofit Comm Vehicle	WE1/VE1
					WYDOT RSUs	WYDOT Maintenance Vehicle	WE1/VE1

5.9.3.3 Dialogs

Dialogs are as defined in the SCMS CV Pilots Documentation (https://wiki.campllc.org/display/SCP/SCMS+CV+Pilots+Documentation). The OBU uses wireless IPv6 communication with nearby RSUs in order to establish a connection with the SCMS system. The RSUs act as an IPv6 router. See https://wiki.campllc.org/display/SCP/EE-SCMS+Core+Communication+Requirements for details.

- For an example of how a WSA broadcast from an RSU to an OBU works see Sequence Diagram: **Figure 5-25**.

- For details on how the OBUs utilize the IPv6 route to the SCMS see the interfaces defined in Section: **5.13**

5.9.3.4 Requirement Traceability

- SCMS-REQ-2 Vehicle System SCMS Use
- SCMS-REQ-2.1 SCMS Vehicle System Certificates
- SCMS-REQ-2.2 SCMS Vehicle System Misbehavior Reporting
- SCMS-REQ-2.3 SCMS Vehicle System Certificates Revocation List (CRL)
- SCMS-REQ-2.4 SCMS Vehicle System Rejection

5.10 RSU <-> Field Location and Time Source (FLTS)

This section describes an interface within the RSU, which interacts with the GPS sub-system to add GPS location and time information to all WSMP messages sent from the RSU.

5.10.1 RSU retrieves location and time from LTS

The RSU will use the Location Time Service to obtain location and time information which it will included in all WSMP messages it sends.

5.10.1.1 External References

- The interface for location and time service interaction is detailed in the SAE J2945/1 standard. Specifically, position and timing standards are specified in section 6.2 of SAE J2945/1. Additional details for LTS to RSU can be found in the **SAD Section 4.5.7** and **SAD Figure 4-23**.
- RSU: USDOT RSU Specification 4.1.

5.10.1.2 Covered Information Flows

Table 5-17. Flow: FLTS to RSU.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30028**	**location and time**	4-19	Field Location and Time Data Source	WYDOT RSUs	WE2
2	**Shared**	**30031**	**[time]**	4-19	Field Location and Time Data Source	WYDOT RSUs	WE2

5.10.1.3 Dialogs

The following message flow diagram describes the message flow for the LTS<->RSU flow

5.10.1.3.1 Dialog: RSU Request for LTS

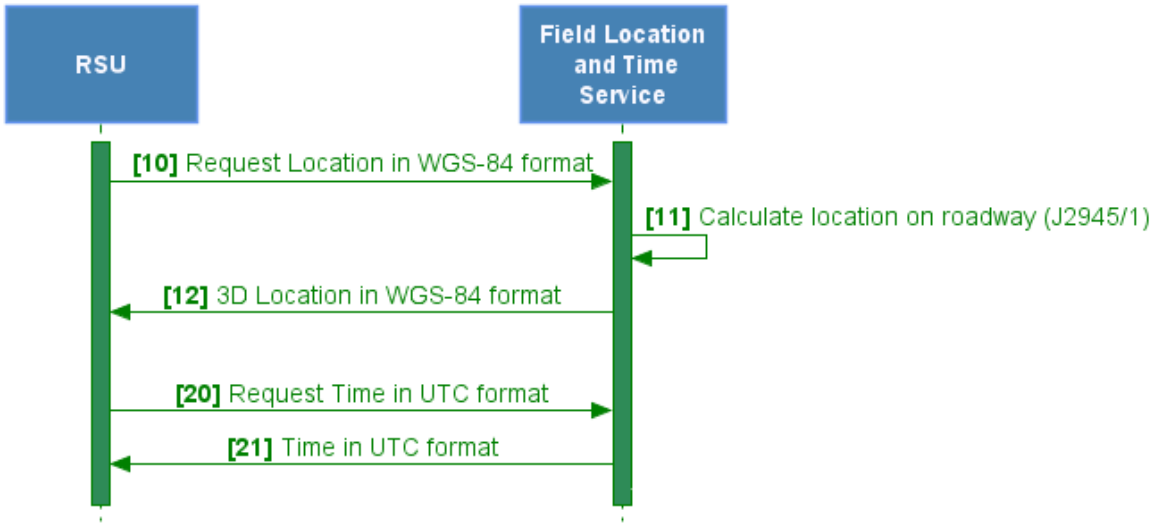


Figure 5-21. Sequence Diagram: RSU Request for LTS.
Source: WYDOT

5.10.1.4 Messages

- Message structures for the dialog can be found in section 6.2 of J2945/1.

5.10.1.5 Data Elements

- There are no optional data elements for this message flow.

5.10.1.6 Requirement Traceability

The following system and interface requirements from the WYDOT System Requirements document are met by this interface:

- LTS-REQ-1 WCVS Time
- LTS-REQ-1.1 WCVS LTS Time
- LTS-REQ-2 WCVS LTS Time Standard
- LTS-REQ-3 WCVS LTS Location
- RSU-REQ-4 LTS
- CSC-REQ-5 RSU Specification

5.11 Network Time Service (NTP) <-> RSU

5.11.1 RSU Synchronizes Time using NTP

The RSU will use NTP as a backup system for time services. The RSU operating software is configured to synchronize its date and time using the industry standard Network Time Protocol. The RSU communicates with NTP servers using IPv4 using the WYDOT network backbone.

5.11.1.1 External References

- The Network Time Protocol (NTP): IETF RFC 5905
- RSU: USDOT RSU Specification 4.1

5.11.1.2 Covered Information Flows

Table 5-18. Flow: NTP time synchronization for RSU.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30031**	**[time]**	4-19	Network Time Source	RSU	WE2

5.11.1.3 Dialogs

5.11.1.3.1 Dialog: RSU synchronizes time with NTP server.

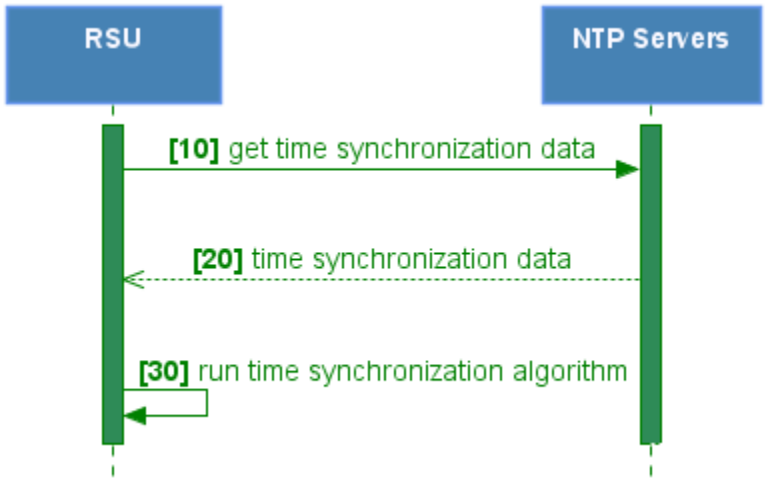


Figure 5-22. Sequence Diagram: RSU synchronizes time with NTP server.
Source: WYDOT

5.11.1.4 Messages

No data from the Connected Vehicle system is shared over the NTP interface. Only the existence of the Linux server's IP address is shared and this is only to the network time servers

5.11.1.5 Data Elements

- There are no optional data elements for this flow.

5.11.1.6 Requirement Traceability

- LTS-REQ-1 WCVS Time
- LTS-REQ-1.2 WCVS Time Synchronization
- RSU-REQ-4 LTS
- WCVS-REQ-20 Manage Safe Communications
- RSU-REQ-6 Safety Communication
- CSC-REQ-5 RSU Specification

5.12 Network Time Service (NTP) <-> ODE

The ODE server runs on an Ubuntu Linux operating system which is configured to synchronize its date and time using the Network Time Protocol.

5.12.1 ODE Synchronizes Time using NTP

5.12.1.1 External References

- The Network Time Protocol (NTP): IETF RFC 5905

5.12.1.2 Covered Information Flows

Table 5-19. Flow: NTP time synchronization for ODE Server.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30031**	**[time]**	4-19	Network Time Source	WYDOT ODE	WE3

5.12.1.3 Dialogs

5.12.1.3.1 Dialog: NTP time synchronization for ODE Server.

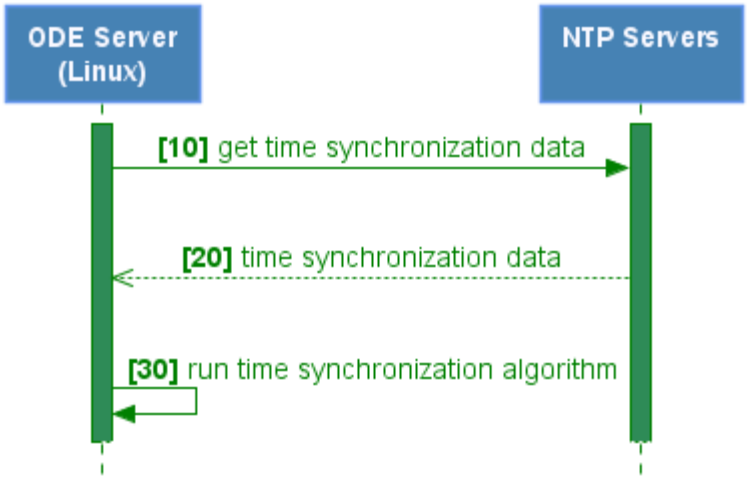


Figure 5-23. Sequence Diagram: NTP time synchronization for ODE Server.
Source: WYDOT

[10-11] Ubuntu Synchronizes Time with NTP servers

Ubuntu 16.04 is configured to use the following time servers:
0.ubuntu.pool.ntp.org
1.ubuntu.pool.ntp.org
2.ubuntu.pool.ntp.org
3.ubuntu.pool.ntp.org

5.12.1.4 Messages

No data from the Connected Vehicle system is shared over the NTP interface. Only the existence of the Linux server's IP address is shared and this is only to the network time servers

5.12.1.5 Data Elements

There are no optional data elements for this flow.

5.12.1.6 Requirement Traceability

- LTS-REQ-1 WCVS LTS Time
- LST-REQ-1.2 WCVS Time Synchronization
- LTS-REQ-2 WCVS LTS Time Standard
- ODE-REQ-5 LTS

5.13 SCMS <-> OBU

5.13.1 OBU Device Enrollment (Bootstrapping)

Details on the OBU to SCMS Bootstrapping can be found at the SCMS End Entity Wiki at: https://wiki.campllc.org/pages/viewpage.action?pageId=58589462. The process for bootstrapping devices with the SCMS is also detailed in the SCMS Proof of Concept (PoC) Governmental Management Concept of Operations (ConOps).

5.13.1.1 External References (Existing standards, protocols invocation)

The following are the existing standards that are being used to interface between OBUs and RSUs:

- IEEE 802.11p
- IEEE 1609.2 - WAVE Security Services
- IEEE 1609.3
- IEEE 1609.4
- IETF RFC 2460
- IETF RFC 793

5.13.1.2 Covered Information Flows

Table 5-20. Flows: SCMS OBU Device Enrollment.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
1	**Shared**	**30001**	**device enrollment information**	4-31	Highway Patrol Vehicle	SCMS	WE17-WE1/VE1
					Integrated Comm Vehicle	SCMS	WE17-WE1/VE1
					Retrofit Comm Vehicle	SCMS	WE17-WE1/VE1
					WYDOT Maintenance Vehicle	SCMS	WE17-WE1/VE1

5.13.1.3 Dialogs

The SCMS Bootstrapping and Enrollment process is a manual process that requires the end user to generate enrollment requests and submit them through a workflow approval software program. This process is identified in SCMS PoC Governmental Management ConOps and the SCMS End Entities Wiki at: https://wiki.campllc.org/pages/viewpage.action?pageId=58589462

5.13.1.3.1 Dialog 1

The dialogs associated with the device Bootstrapping can be found at: https://wiki.campllc.org/pages/viewpage.action?pageId=58589462 and in Sections 4.1.1.2 and 4.1.2.2 of the SCMS PoC Governmental Management ConOps.

5.13.1.4 Messages

The SignedEeEnrollmentCertRequest message can be found at: https://stash.campllc.org/projects/SCMS/repos/scms-asn/browse/scms-protocol.asn?at=refs/heads/1.2#585

The SignedEeEnrollmentCertResponse can be found at:
https://stash.campllc.org/projects/SCMS/repos/scms-asn/browse/scms-protocol.asn?at=refs/heads/1.2#598

5.13.1.5 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.13.1.6 Requirement Traceability

- SCMS-REQ-2 Vehicle System SCMS Use
- SCMS-REQ-2.1 SCMS Vehicle System Certificates
- VS-REQ-50 Safety Communication

5.13.2 OBU Pseudonym Certificate Provisioning

Details on the OBU Pseudonym Certificate Provisioning can be found at the SCMS End Entity Wiki at:
https://wiki.campllc.org/display/SCP/Use+Case+3%3A+OBE+Pseudonym+Certificates+Provisioning

5.13.2.1 External References (Existing standards, protocols invocation)

The following are the existing standards that are being used to interface between OBUs and RSUs:

- IEEE 802.11p
- IEEE 1609.2 - WAVE Security Services
- IEEE 1609.3
- IEEE 1609.4
- IETF RFC 2460
- IETF RFC 793

5.13.2.2 Covered Information Flows

Table 5-21. Flow: SCMS OBU Security Credentials.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
1	**Shared**	**30003**	**security credentials**	4-31	SCMS	Highway Patrol Vehicle	WE17-WE1/VE1
					SCMS	Integrated Comm Vehicle	WE17-WE1/VE1
					SCMS	Retrofit Comm Vehicle	WE17-WE1/VE1
					SCMS	WYDOT Maintenance Vehicle	WE17-WE1/VE1

5.13.2.3 Dialogs

OBU Pseudonym Certificate Provisioning contains three key dialogs:

- Requesting Pseudonym Certificates
- Initial Download of Pseudonym Certificates

- Top-off Pseudonym Certificates

5.13.2.3.1 Dialog 1 - Requesting Pseudonym Certificates

The dialog for requesting pseudonym certificates can be found at:
https://wiki.campllc.org/display/SCP/Step+3.1%3A+Request+for+Pseudonym+Certificates

5.13.2.3.2 Dialog 2 - Initial Download of Pseudonym Certificates

The dialog for the initial download of pseudonym certificates can be found at:
https://wiki.campllc.org/display/SCP/Step+3.3%3A+Initial+Download+of+Pseudonym+Certificates

5.13.2.3.3 Dialog 3 - Top-off Pseudonym Certificates

The dialog for the top-off pseudonym certificates can be found at:
https://wiki.campllc.org/display/SCP/Step+3.5%3A+Top-off+Pseudonym+Certificates

5.13.2.4 Messages (Specific Messages Utilized in Dialogs Section)

The Request Pseudonym Certificates messages can be found at:
https://wiki.campllc.org/display/SCP/RA+-+Request+Pseudonym+Certificate+Batch+Provisioning

The Download Pseudonym Certificates messages can be found at:
https://wiki.campllc.org/display/SCP/RA+-+Download+Pseudonym+Certificate+Batch

5.13.2.5 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.13.2.6 Requirement Traceability

- SCMS-REQ-2 Vehicle System SCMS Use
- SCMS-REQ-2.1 SCMS Vehicle System Certificates
- VS-REQ-43 VSM SCMS
- VS-REQ-50 Safety Communication

5.13.3 OBU Security Policy and Networking Information

The SCMS manager needs to set up a list of SCMS manager, technical, configuration choices and, therefore, will design technical, global policy files that are signed by the policy generator. The policy generator is an inherently centralized component.

The Policy Generator (PG) prepares a Global Policy File (GPF) that includes all global policies that are relevant to the EEs. The PG makes the GPF available to all SCMS components. The RA decides which of the global policies in the GPF are relevant for the EEs under that RA's jurisdiction, determines specific values within option ranges allowed in the GPF, and creates an RA-specific Local Policy File (LPF) containing this information. The RA sends its LPF to the PG for approval and signature. The RA updates its LPF whenever there is a change in the GPF that affects the information in its LPF, and subsequently makes its current LPF available to all EEs within its jurisdiction.

5.13.3.1 External References

- IEEE 1609.2 - WAVE Security Services
- Dedicated Short Range Communications (DSRC): ISO 15628, SAE J2735, SAE J2945/1, SAE J3067, IEEE 802.11p, IEEE 1609.3
- DSRC Multi-channel: IEEE 1609.4
- RSU: USDOT RSU Specification 4.1
- IPv6: IETF RFC 2460
- TCP: IETF RFC 793

5.13.3.2 Covered Information Flows

Table 5-22. Flow: SCMS Security Policy and Networking Information.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
1	**Shared**	**30002**	**security policy and networking information**	4-31	SCMS	Highway Patrol Vehicle	WE17-WE1/VE1
					SCMS	Integrated Comm Vehicle	WE17-WE1/VE1
					SCMS	Retrofit Comm Vehicle	WE17-WE1/VE1
					SCMS	WYDOT Maintenance Vehicle	WE17-WE1/VE1

5.13.3.3 Dialogs

OBUs will establish an IPv6 network connection with the RSU, then they will download Local Policy Configuration file from the SCMS Registration Authority using HTTPs.

5.13.3.3.1 OBU Downloads Signed Local Policy File

The service for downloading the Local Policy File is described at the SCMS wiki:
https://wiki.campllc.org/display/SCP/RA+-+Download+Local+Policy+File

5.13.3.4 Messages

The format of a signed Local Policy File is documented at the following SCMS wiki:
https://stash.campllc.org/projects/SCMS/repos/scms-asn/browse/scms-protocol.asn?at=refs/heads/1.2#866

5.13.3.5 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.13.3.6 Requirement Traceability

- SCMS-REQ-2 Vehicle System SCMS Use

- SCMS-REQ-2.1 SCMS Vehicle System Certificates
- VS-REQ-50 Safety Communication

5.13.4 OBU Misbehavior Reporting

Details on the Misbehavior reporting can be found at the SCMS End Entity Wiki at:
https://wiki.campllc.org/display/SCP/Use+Case+5%3A+Misbehavior+Reporting

5.13.4.1 External References

The following are the existing standards that are being used to interface between OBUs and RSUs:

- IEEE 802.11p
- IEEE 1609.2 - WAVE Security Services
- IEEE 1609.3
- IEEE 1609.4
- IETF RFC 2460
- IETF RFC 793

The SCMS interfaces are described in detail in the SCMS CV Pilots Documentation (https://wiki.campllc.org/display/SCP/SCMS+CV+Pilots+Documentation).

5.13.4.2 Covered Information Flows

Table 5-23. Flow: SCMS OBU Misbehavior Reporting.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30029**	**misbehavior report**	4-31	Highway Patrol Vehicle	SCMS	WE17-WE1/VE1
					Integrated Comm Vehicle	SCMS	WE17-WE1/VE1
					Retrofit Comm Vehicle	SCMS	WE17-WE1/VE1
					WYDOT Maintenance Vehicle	SCMS	WE17-WE1/VE1

5.13.4.3 Dialogs, Messages

https://wiki.campllc.org/display/SCP/RA+-+Submit+Misbehavior+Report

5.13.4.4 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.13.4.5 Requirement Traceability

- SCMS-REQ-2 Vehicle System SCMS Use
- SCMS-REQ-2.2 SCMS Vehicle System Misbehavior Reporting

- VS-REQ-50 Safety Communication

5.13.5 OBU Security Credential Revocations

This interface defines how OBUs communicate with SCMS service to receive CRL files.

The WYDOT pilot is considering using the capability to deliver Certificate Revocation Lists over satellite.

5.13.5.1 External References

The following are the existing standards that are being used to interface between OBUs and RSUs:

- IEEE 802.11p
- IEEE 1609.2 - WAVE Security Services
- IEEE 1609.3
- IEEE 1609.4
- IETF RFC 2460
- IETF RFC 793

5.13.5.2 Covered Information Flows

Table 5-24. Flow: SCMS OBU Security Credential Revocations.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	**Custom**	**33020**	**security credential revocations**	4-31	SCMS	Highway Patrol Vehicle	WE17-WE1/VE1
					SCMS	Integrated Comm Vehicle	WE17-WE1/VE1
					SCMS	Retrofit Comm Vehicle	WE17-WE1/VE1
					SCMS	WYDOT Maintenance Vehicle	WE17-WE1/VE1

5.13.5.3 Dialogs

5.13.5.3.1 Dialog 1 – CRL Download

The dialog for downloading CRLs can be found at:
https://wiki.campllc.org/display/SCP/Use+Case+6%3A+CRL+Download

5.13.5.3.2 Dialog 2 – CRL Check

The dialog for the CRL check can be found at:
https://wiki.campllc.org/display/SCP/Step+8.4%3A+OBE+CRL+Check

5.13.5.4 Messages

The CRL Download messages can be found at: https://wiki.campllc.org/display/SCP/MA+-+Download+CRL

5.13.5.5 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.13.5.6 Requirement Traceability

- SCMS-REQ-2 Vehicle System SCMS Use
- SCMS-REQ-2.3 SCMS Vehicle System Certificates Revocation List (CRL)
- SCMS-REQ-2.4 SCMS Vehicle System Rejection
- VS-REQ-50 Safety Communication

5.14 SCMS <-> RSU

5.14.1 RSU Device Enrollment Information (Bootstrapping)

Details on the RSU to SCMS Bootstrapping can be found at the SCMS End Entity Wiki at: https://wiki.campllc.org/pages/viewpage.action?pageId=58589462. The process for bootstrapping devices with the SCMS is also detailed in the SCMS PoC Governmental Management ConOps. This process is the same process that OBUs utilize.

5.14.1.1 External References

- IEEE 1609.2 - WAVE Security Services
- USDOT RSU Specification 4.1

5.14.1.2 Covered Information Flows

Table 5-25. Flow: SCMS RSU Device Enrollment Information.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
1	**Shared**	**30001**	**device enrollment information**	4-31	WYDOT RSUs	SCMS	WE17

5.14.1.3 Dialogs

The SCMS Bootstrapping and Enrollment process is a manual process that requires the end user to generate enrollment requests and submit them through a workflow approval software program. This process is identified in SCMS PoC Governmental Management ConOps and the SCMS End Entities Wiki at: https://wiki.campllc.org/pages/viewpage.action?pageId=58589462

5.14.1.3.1 Dialog 1

The dialogs associated with the device Bootstrapping can be found at: https://wiki.campllc.org/pages/viewpage.action?pageId=58589462 and in Sections 4.1.1.2 and 4.1.2.2 of the SCMS PoC Governmental Management ConOps.

5.14.1.4 Messages

The SignedEeEnrollmentCertRequest message can be found at:
https://stash.campllc.org/projects/SCMS/repos/scms-asn/browse/scms-protocol.asn?at=refs/heads/1.2#585

The SignedEeEnrollmentCertResponse can be found at:
https://stash.campllc.org/projects/SCMS/repos/scms-asn/browse/scms-protocol.asn?at=refs/heads/1.2#598

5.14.1.5 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.14.1.6 Requirement Traceability

- SCMS-REQ-1 Wyoming CV System (WCVS) SCMS Use
- SCMS-REQ-1.1 SCMS Wyoming CV System Certificates
- WCVS-REQ-20 Manage Safe Communications
- RSU-REQ-3 SCMS
- RSU-REQ-6 Safety Communication

5.14.2 RSU Application Certificate Provisioning

Details on the RSU Application Certificate Provisioning can be found at the SCMS End Entity Wiki at:
https://wiki.campllc.org/display/SCP/Use+Case+13%3A+RSE+Application+Certificate+Provisioning

5.14.2.1 External References (Existing standards, protocols invocation)

- IEEE 1609.2 - WAVE Security Services
- USDOT RSU Specification 4.1
- IETF RFC 2818 – HTTPS
- IETF RFC 7525 - TLS

5.14.2.2 Covered Information Flows (Maps to Triples)

Table 5-26. Flow: SCMS RSU Security Credentials.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
1	**Custom**	**30003**	**security credentials**	4-31	SCMS	WYDOT RSUs	WE17

5.14.2.3 Dialogs

There are two dialogs associated with RSU Application Provisioning:

- Request RSU Application Certificate
- Download RSU Application Certificate

5.14.2.3.1 Dialog 1 – Request RSU Application Certificate

The dialog for requesting application certificates can be found at:
https://wiki.campllc.org/display/SCP/Step+13.1%3A+Request+RSE+Application+Certificate

5.14.2.3.2 Dialog 2 – Download RSU Application Certificate

The dialog for downloading application certificates can be found at:
https://wiki.campllc.org/display/SCP/Step+13.3%3A+Download+RSE+Application+Certificate

5.14.2.4 Messages

The Request Application Certificates messages can be found at:
https://wiki.campllc.org/display/SCP/RA+-+Request+Application+Certificate+Provisioning.

The Download Application Certificates messages can be found at:
https://wiki.campllc.org/display/SCP/RA+-+Download+Application+Certificate

5.14.2.5 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.14.2.6 Requirement Traceability

- SCMS-REQ-1 Wyoming CV System (WCVS) SCMS Use
- SCMS-REQ-1.1 SCMS Wyoming CV System Certificates
- WCVS-REQ-20 Manage Safe Communications
- RSU-REQ-3 SCMS
- RSU-REQ-6 Safety Communication

5.14.3 RSU Security Policy and Networking Information

The SCMS manager needs to set up a list of SCMS manager, technical, configuration choices and, therefore, will design technical, global policy files that are signed by the policy generator. The policy generator is an inherently centralized component.

The Policy Generator (PG) prepares a Global Policy File (GPF) that includes all global policies that are relevant to the EEs. The PG makes the GPF available to all SCMS components. The RA decides which of the global policies in the GPF are relevant for the EEs under that RA's jurisdiction, determines specific values within option ranges allowed in the GPF, and creates an RA-specific Local Policy File (LPF) containing this information. The RA sends its LPF to the PG for approval and signature. The RA updates its LPF whenever there is a change in the GPF that affects the information in its LPF, and subsequently makes its current LPF available to all EEs within its jurisdiction.

5.14.3.1 External References

- IEEE 1609.2 - WAVE Security Services
- USDOT RSU Specification 4.1

- IETF RFC 2818 – HTTPS
- IETF RFC 7525 – TLS

5.14.3.2 Covered Information Flows

Table 5-27. Flow: SCMS RSU Security Policy and Networking Information.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
1	**Shared**	**30002**	**security policy and networking information**	4-31	SCMS	WYDOT RSUs	WE17

5.14.3.3 Dialogs

RSUs will download the Local Policy Configuration file from the SCMS Registration Authority using HTTPs.

5.14.3.3.1 RSU Downloads Signed Local Policy File

The service for downloading the Local Policy File is described at the SCMS wiki:
https://wiki.campllc.org/display/SCP/RA+-+Download+Local+Policy+File

5.14.3.4 Messages

The format of a signed Local Policy File is documented at the following SCMS wiki:
https://stash.campllc.org/projects/SCMS/repos/scms-asn/browse/scms-protocol.asn?at=refs/heads/1.2#866

5.14.3.5 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.14.3.6 Requirement Traceability

- SCMS-REQ-1 Wyoming CV System (WCVS) SCMS Use
- SCMS-REQ-1.1 SCMS Wyoming CV System Certificates
- WCVS-REQ-20 Manage Safe Communications
- RSU-REQ-3 SCMS
- RSU-REQ-6 Safety Communication

5.14.4 RSU Misbehavior Reporting

Details on the Misbehavior reporting can be found at the SCMS End Entity Wiki at:
https://wiki.campllc.org/display/SCP/Use+Case+5%3A+Misbehavior+Reporting

5.14.4.1 External References

- IEEE 1609.2 - WAVE Security Services
- USDOT RSU Specification 4.1
- IETF RFC 2818 – HTTPS
- IETF RFC 7525 - TLS

5.14.4.2 Covered Information Flows

Table 5-28. Flow: SCMS RSU Misbehavior Reporting.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30029**	**misbehavior report**	4-31	WYDOT RSUs	SCMS	WE17

5.14.4.3 Dialogs

5.14.4.3.1 RSU Uploads a Signed Misbehavior Report

The service for uploading a signed misbehavior report is described at the SCMS wiki:
https://wiki.campllc.org/display/SCP/RA+-+Submit+Misbehavior+Report

5.14.4.4 Messages

Per the SCMS Wiki: ASN.1 interface specifications for misbehavior reports will be finalized with the to-be-awarded "Misbehavior Authority Integration" sub project. Until then the interface given is to be handled as draft.

5.14.4.5 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.14.4.6 Requirement Traceability

- SCMS-REQ-1 Wyoming CV System (WCVS) SCMS Use
- SCMS-REQ-1.2 SCMS Wyoming CV System Misbehavior Reporting
- WCVS-REQ-20 Manage Safe Communications
- RSU-REQ-3 SCMS
- RSU-REQ-6 Safety Communication

5.14.5 RSU Security Credentials Revocations

Details on the CRL Download can be found at the SCMS End Entity Wiki at:
https://wiki.campllc.org/display/SCP/Use+Case+6%3A+CRL+Download

Details on the CRL Check can be found at the SCMS End Entity Wiki at:
https://wiki.campllc.org/display/SCP/Step+8.4%3A+OBE+CRL+Check

5.14.5.1 External References

- IEEE 1609.2 - WAVE Security Services
- USDOT RSU Specification 4.1
- IETF RFC 2818 – HTTPS
- IETF RFC 7525 - TLS

5.14.5.2 Covered Information Flows

Table 5-29. Flow: SCMS RSU Security Credentials Revocations.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33020**	**security credential revocations**	4-31	SCMS	WYDOT RSUs	WE17

5.14.5.3 Dialogs

5.14.5.3.1 Dialog 1 – CRL Download

The dialog for downloading CRLs can be found at:
https://wiki.campllc.org/display/SCP/Use+Case+6%3A+CRL+Download

5.14.5.3.2 Dialog 2 – CRL Check

The dialog for the CRL check can be found at:
https://wiki.campllc.org/display/SCP/Step+8.4%3A+OBE+CRL+Check

5.14.5.4 Messages

The CRL Download messages can be found at: https://wiki.campllc.org/display/SCP/MA+-+Download+CRL

5.14.5.5 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.14.5.6 Requirement Traceability

- SCMS-REQ-1 Wyoming CV System (WCVS) SCMS Use
- SCMS-REQ-1.3 SCMS Wyoming CV System Certificates Revocation List (CRL)
- SCMS-REQ-1.4 SCMS Wyoming CV System Rejection
- WCVS-REQ-20 Manage Safe Communications
- RSU-REQ-3 SCMS
- RSU-REQ-6 Safety Communication

5.15 ODE <-> HSM

This section describes the interface between the ODE and the HSM. The HSM is a black box hardware security module in the Cheyenne TMC. The HSM is rented from IIS/GHS[3]. The HSM will manage the Wyoming CV System's certifications.

5.15.1 ODE uses HSM to sign TIMs

The HSM has a Representational State Transfer (RESTful)[4] endpoint that receives an unsigned TIM and outputs a signed TIM. This is a WYDOT internal interface which operates within the WYDOT TMC.

Further information on the process of interacting with the HSM and the signing and sending of signed TIMs can be found at the following links:

- ODE user manual https://github.com/usdot-jpo-ode/jpo-ode/blob/develop/docs/JPO_ODE_UserGuide.docx
- https://github.com/usdot-jpo-ode/jpo-security-svcs

5.15.1.1 External References

- Traveler Information Message: SAE J2735, SAE J2540-2
- BSM, TIM, DNM signatures: IEEE 1609.2
- ASN.1:2015: Abstract Syntax Notation
- IETF RFC 7230: Hypertext Transfer Protocol (HTTP/1.1)
- IETF RFC 4648: The Base16, Base32, and Base64 Data Encodings

5.15.1.2 Covered Information Flows

Table 5-30. Flow: ODE uses HSM to sign TIMs.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Custom**	**30003**	**ODE uses HSM to sign TIM**	4-31	WYDOT ODE	HSM	WI-8

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

[4] https://en.wikipedia.org/wiki/Representational_state_transfer

5.15.1.3 Dialogs

5.15.1.3.1 Dialog: ODE uses HSM to sign TIM

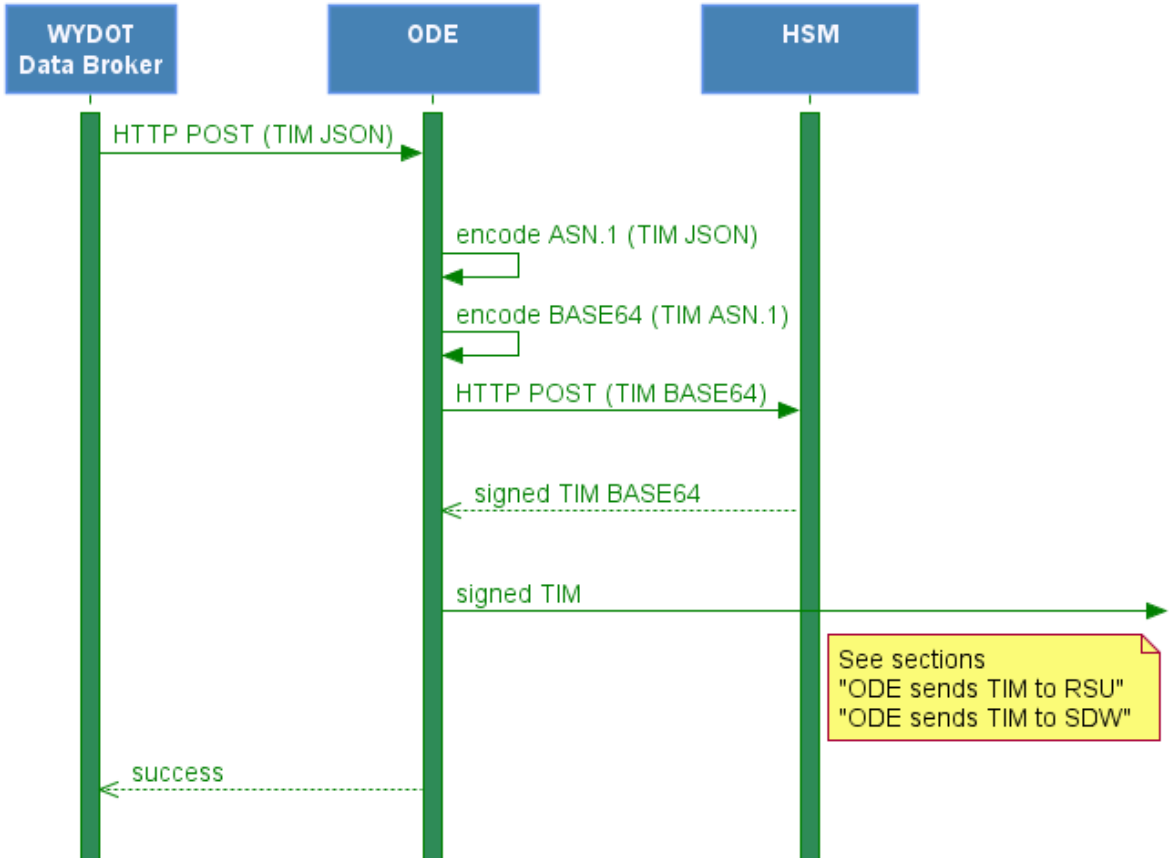


Figure 5-24. Sequence Diagram: ODE uses HSM to sign TIM.
Source: WYDOT

The WYDOT Data Broker sends messages to the ODE HTTP REST endpoint `/tim` in JSON format (*see Section: 5.21.2*). The ODE generates the ASN.1 representation of the TIM, encodes it as BASE64 then sends it to the HSM HTTP REST endpoint. The HSM signs the TIM according to IEEE 1609.2 and returns a signed TIM in BASE64 encoding.

5.15.1.4 Messages

- Traveler Information Message: described in Section: **7.2**.

5.15.1.5 Data Elements

- The fields used in the DNM are defined in: **Table 7-2. Traveler Information Message (TIM) Fields.**

5.15.1.6 Requirement Traceability

- HSM-REQ-1 Receive from ODE – The HSM shall receive unsigned TIMs from the ODE
- HSM-REQ-2 Share with ODE – The HSM shall provide signed TIMs to the ODE

- HSM-REQ-3 Receive from SCMS
- HSM-REQ-4 Share with SCMS

5.16 ODE <-> OBU

This section describes the interface between the Operational Data Environment and the OBU.

5.16.1 OBU Copies Log File to ODE

Vehicle/OBU Applicability: [Integrated Commercial Vehicles, WYDOT Maintenance]

The OBU maintains a series of log files. When the OBU comes within range of an RSU which advertises ODE Log Service, any stored log files will be copied up to the ODE based on log priority. The purpose of these log files is to provide traffic situational awareness information to the WYDOT TMC in support of traffic management and road weather reporting. RSUs serve the role of a network router during log file transfers so logs are not stored on the RSU other than as necessary during store and forward routing.

The OBU will sign and encrypt or password protect log files to avoid the possibility that PII data becomes exposed. OBUs use ***RSYNC*** to copy log files to the ODE. Please see the JPO ODE User Guide located in JPO ODE GitHub[5] docs folder for details of the user interface implementation and setup.

5.16.1.1 External References

- Basic Safety Message: SAE J2735
- BSM, TIM, DNM signatures: IEEE 1609.2
- Dedicated Short Range Communications (DSRC): ISO 15628, SAE J2735, SAE J2945/1, SAE J3067, IEEE 802.11p, IEEE 1609.3
- DSRC Multi-channel: IEEE 1609.4
- RSU: USDOT RSU Specification 4.1
- IPv6: IETF RFC 2460
- ***RSYNC***: IETF 5781, IETF 4253

[5] https://github.com/usdot-jpo-ode/jpo-ode

5.16.1.2 Covered Information Flows

Table 5-31. Flows: OBU Copies Log file to ODE.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
1	**Shared**	**30006**	**vehicle location and motion for surveillance**	4-12	Highway Patrol Vehicle	ODE	WI7-WE1/VE1
					Integrated Comm Vehicle	ODE	WI7-WE1/VE1
					Retrofit Comm Vehicle	ODE	WI7-WE1/VE1
					WYDOT Maintenance Vehicle	ODE	WI7-WE1/VE1
		30007	**emergency notification**	4-10	Vehicle (distressed)	ODE	WI7-WE1/VE1
					Vehicle (receive and relay)	ODE	WI7-WE1/VE1

5.16.1.3 Dialogs

5.16.1.3.1 Dialog: OBU Copies Log File(s) to ODE via RSU.

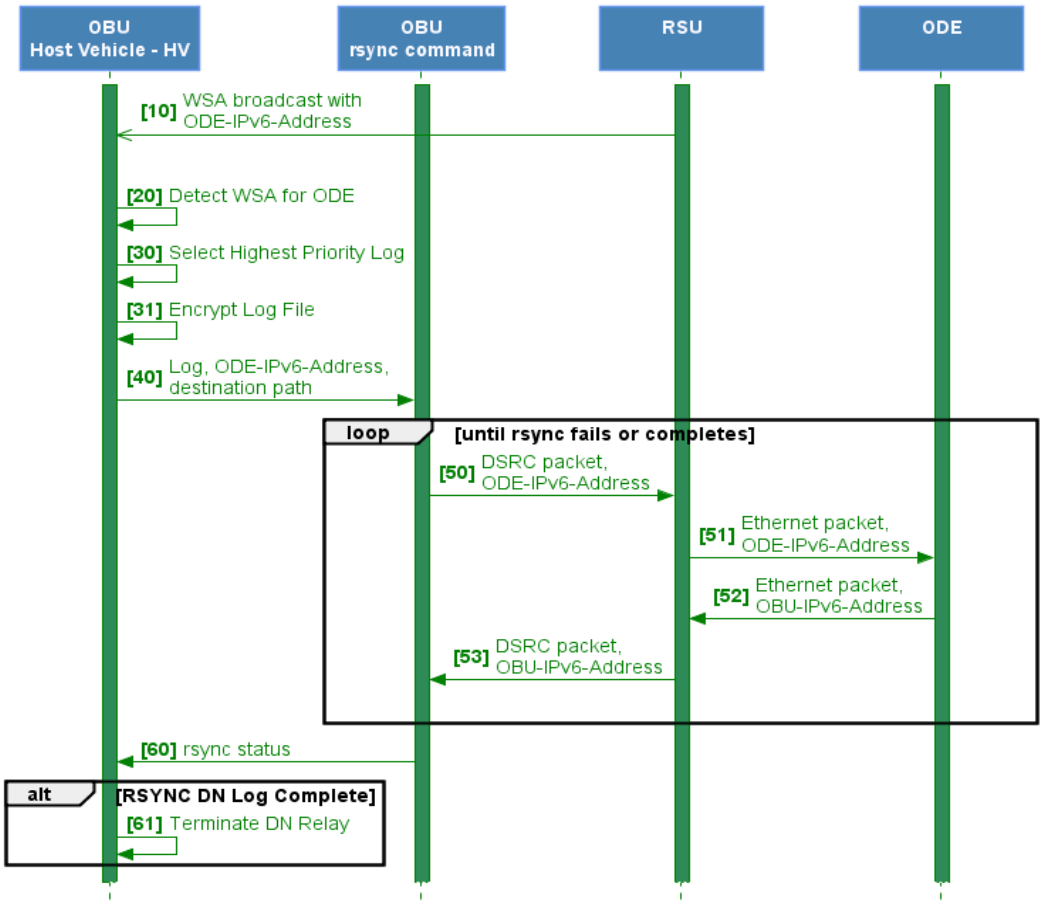


Figure 5-25. Sequence Diagram: OBU Copies Log File(s) to ODE via RSU.
Source: WYDOT

[10] RSU continuously broadcasts WSA advertisement with ODE's IPv6 address

RSU actively broadcast WSA service announcements containing the IPv6 address of the ODE server. This broadcast occurs on **DSRC channel 178.**

[20] OBU Detects WSA Message with ODE's IPv6 Address

When an OBU receives WSA advertisement with ODE server address the OBU checks whether it has any log files to upload to the ODE.

[30-31] Choose Highest Priority Log file for Sending to ODE

Each log file has a designated upload priority. Depending on which log files an OBU is ready to upload, higher priority logs files are uploaded first. Priorities insure the most time sensitive data is uploaded first. **Table 7-16: OBU Log Files** shows the upload priority of each log file type.

Details on the log file names and contents may be found in Section: **7.13**.

Log files are encrypted before they are uploaded.

[40] OBU Invokes *RSYNC* to transfer log file

The OBU invokes the ***RSYNC*** command to transfer files to the ODE using the following parameters:

- ODE server IPv6 address: provided by the WSA advertisement
- SSH credentials for ***RSYNC***: No SSH credentials are required because the OBU public keys are loaded on the ODE server.
- Destination path and log file name as determined in **Step [30]**.

[50-54] *RSYNC* Transfers File over DSRC to the RSU

WAVE messages with IPv6 destinations are routed by the RSU to its Ethernet interface which is connected to the ODE. As the ODE server services the ***RSYNC*** command traffic response data is sent back to the OBU's IPv6 address. The RSU again performs routing service, but this time from Ethernet to DSRC for the OBU.

This continues until either the ***RSYNC*** command completes successfully or the OBU is out of range of the RSU and the ***RSYNC*** command exits with incomplete status.

[31-32] *RSYNC* Command Returns Status to OBU

If the ***RSYNC*** command completed successfully then the OBU purges the log file, message **[50]**. Otherwise, the OBU remains in a state that when it next receives a WSA advertisement for ODE Server, the OBU will invoke ***RSYNC*** with the existing log file.

5.16.1.4 Messages

- A description of each type of log file copied up to the ODE may be found in Section: **7.13**.

5.16.1.5 Data Elements

- The fields used in the BSM are defined in: **Table 7-1: BSM Message Fields**

5.16.1.6 Requirement Traceability

- WCVS-REQ-1 Collect CV Data
- WCVS-REQ-1.1 Collect BSM Data
- WCVS-REQ-2 Validate Data
- VS-REQ-15 Distress Notification ID
- VS-REQ-15.1 Log
- VS-REQ-36 Transmit Data
- VS-REQ-36.2 TVI Data Management-Log
- VS-REQ-39 SLD Rolling Log
- VS-REQ-40 SLD Log Format
- VS-REQ-41 SLD Log Data
- VS-REQ-45 VSM SCMS Encryption-Log
- VS-REQ-46 VSM SCMS Sign-Log
- VS-REQ-47 VSM App Availability Log
- VS-REQ-50 Safety Communication
- RSU-REQ-6 Safety Communication
- ODE-REQ-1 Collect CV Data
- MV-REQ-9 General
- IT-REQ-6 General
- RFV-REQ-5 General
- HP-REQ-1 General

5.16.1.7 Security Framework

ODE will comply and/or interface with the US DOT Security Credential Management System (SCMS)[6] to authenticate and decrypt, if needed, the BSM MessageFrame data received from the OBU.

5.16.2 ODE Updates OBU Firmware OTA

Vehicle/OBU Applicability: [Integrated Commercial Vehicles, Highway Patrol, WYDOT Maintenance]

This sub-section describes how OBU will receive updated firmware.

When the OBU comes within range of an RSU which advertises OTA update service the OBU will connect to the service to determine if there is newer software than the OBU has, if so, the OBU will begin the firmware update process.

Upon successful download, the Upgrade application extracts the software and its installation scripts. Upgrade applications prepare the environment to upgrade to the latest software. It also maintains the state of upgrade process. The downloaded firmware will be upgraded when the device restarts by Ignition off and on, the HMI will prompt the user on the HMI prior to upgrade. The firmware will be upgraded to the alternate partition of OBU/ASD.

Note, RSUs serve the role of a network router in this data transfer between the OBU and the ODE.

[6] https://wiki.campllc.org/display/SCP/SCMS+CV+Pilots+Documentation

5.16.2.1 External References

- Dedicated Short Range Communications (DSRC): ISO 15628, SAE J2735, SAE J2945/1, SAE J3067, IEEE 802.11p, IEEE 1609.3
- DSRC Multi-channel: IEEE 1609.4
- RSU: USDOT RSU Specification 4.1
- IPv6: IETF RFC 2460

5.16.2.2 Covered Information Flows

Table 5-32. Flows: OBU Retrieves Firmware Updates from the ODE.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	**Custom**	**Custom**	**OTA Updates**	4-4	Integrated Comm Vehicle	ODE	WE1/VE1
					WYDOT Maintenance Vehicle	ODE	WE1/VE1

5.16.2.3 Dialogs

5.16.2.3.1 Dialog: OBU Retrieves Firmware Updates from the ODE.

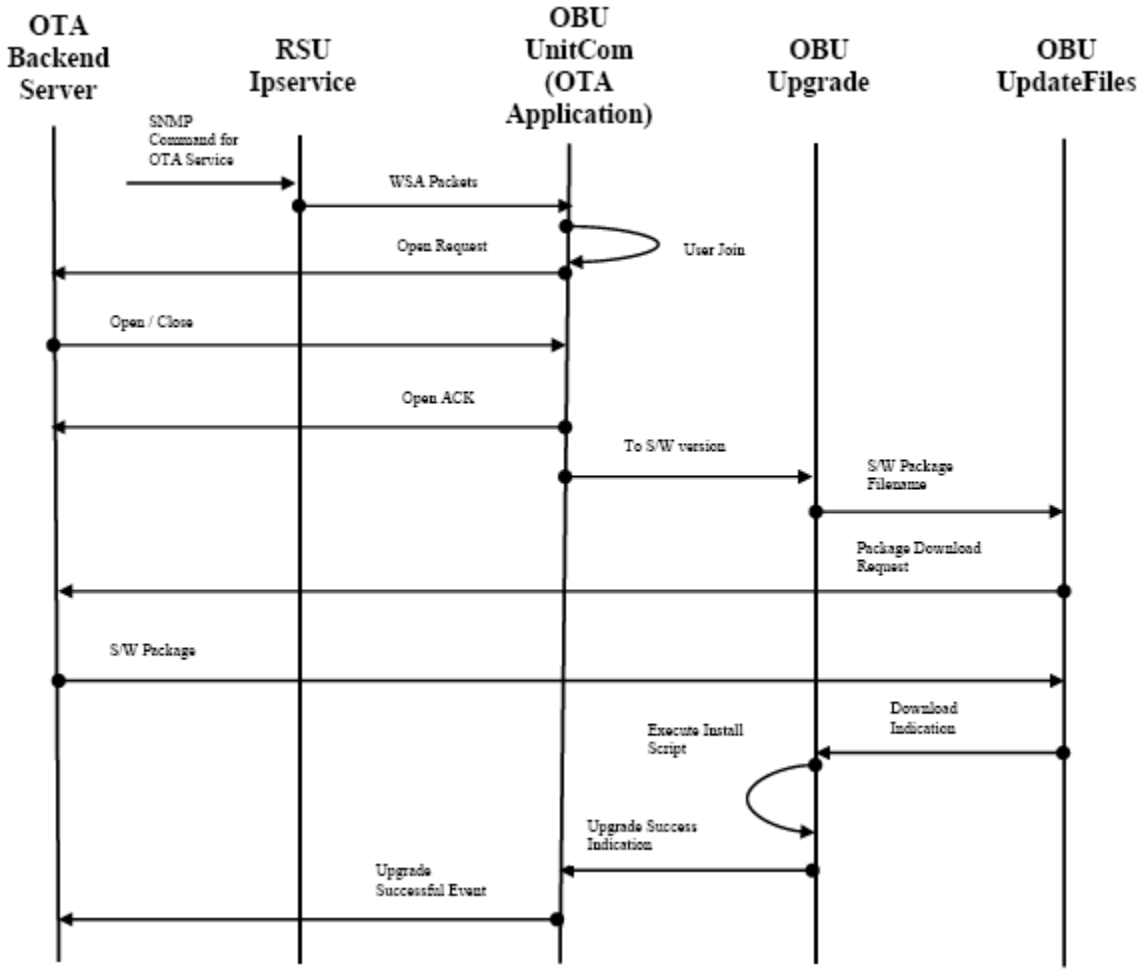


Figure 5-26. Sequence Diagram: OBU Retrieves Firmware Updates from the ODE.
Source: Lear

OBU/ASD will get IP connectivity as the vehicle moves into RSU's range. RSU advertises OTA service which includes OTA server IP, port number and Routing information to reach the server.

Upgrade application maintains the state of upgrade process, which is persistent over reboots.

As the upgrade state is maintained by upgrade application, UpdateFiles application either starts new or continues previous download.

5.16.2.4 Requirement Traceability

- WCVS-REQ-25 Update VS Equipment
- VS-REQ-48 VSM Updates
- VS-REQ-51 VS Equipment
- HP-REQ-7 OTA Updates

- MV-REQ-6 OTA Updates
- IT-REQ-3 OTA Updates
- RFV-REQ-7 OTA Updates

5.17 ODE <-> WY Maintenance Vehicle (OBU)

This section describes the interface between the Operational Data Environment and the WYDOT Maintenance Vehicle's OBUs.

5.17.1 OBU Copies Environmental Sensor Data to ODE

WYDOT Maintenance Vehicles collect logs of environmental data from weather sensors mounted to the vehicle (Section: 5.5). When the OBU comes within range of an RSU which can forward log files to the ODE, the log files will be copied into a directory on the ODE for message verification decoding and publishing. The purpose of these log files is to provide environmental situational awareness information to the WYDOT TMC in support of traffic management and road weather reporting.

Note, RSUs serve the role of a network router in this data transfer and the environmental logs are not stored on the RSU other than as necessary during store and forward routing.

The OBU will not encrypt the environmental log files but will digital sign the files. The OBU will use ***RSYNC*** to copy the log file to the ODE. The ODE will validate the log files signature and if valid, publish the environmental data to a Kafka topic. ODE clients will be able to subscribe to that data stream as described in the JPO ODE User Guide.

5.17.1.1 External References

- BSM, TIM, DNM signatures: IEEE 1609.2
- Dedicated Short Range Communications (DSRC): ISO 15628, SAE J2735, SAE J2945/1, SAE J3067, IEEE 802.11p, IEEE 1609.3
- DSRC Multi-channel: IEEE 1609.4
- RSU: USDOT RSU Specification 4.1
- IPv6: IETF RFC 2460
- ***RSYNC***: IETF 5781, IETF 4253

5.17.1.2 Covered Information Flows

Table 5-33. Flow: OBU copies environmental sensor data to ODE.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33006**	**environmental sensor data**	4-12	WYDOT Maintenance Vehicle	WYDOT ODE	WI7-WE1/VE1

5.17.1.3 Dialogs

5.17.1.3.1 Dialog: OBU Transfers Environmental Sensor Data Logs to ODE.

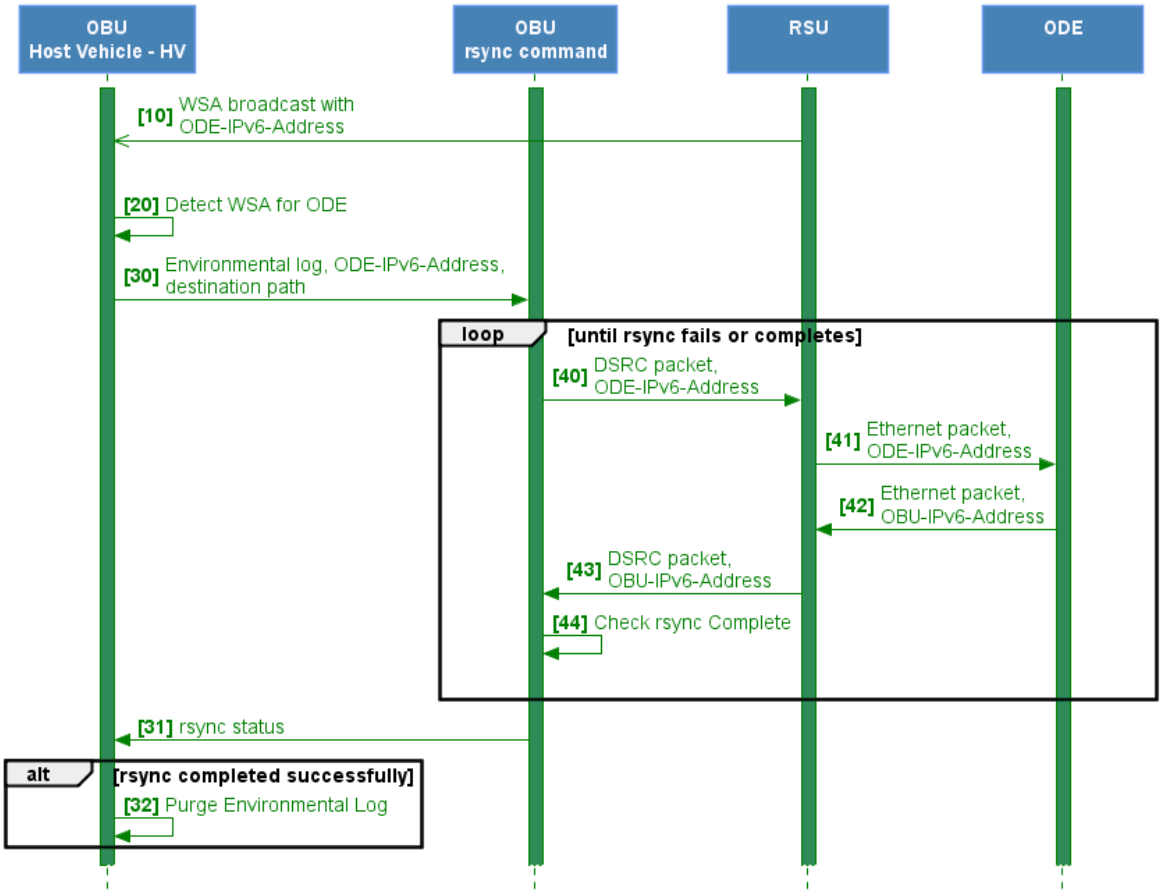


Figure 5-27. Sequence Diagram: OBU Transfers Environmental Data Logs to ODE.
Source: WYDOT

[10] RSU continuously broadcasts WSA advertisement with ODE's IPv6 address

The RSU is actively broadcasting it can forward BSM logs to ODE. This broadcast occurs on **DSRC channel 172.**

[20] OBU Detects WSA Message with ODE's IPv6 Address

Once the OBU detects the RSU can forward logs, the OBU begins the process of transferring its environmental data log files to the ODE. The OBU saves the IPv6 address. If the OBU has an incomplete transfer in progress then the existing log file continues to copy through ***RSYNC*** when connectivity is available, after the entire file is copied it is then deleted and the next log file begins transfer.

[30] OBU Invokes *RSYNC* to transfer environmental log file

The OBU invokes the ***RSYNC*** command to transfer of the log file to the ODE using the following parameters:

- ODE server IPv6 address: provided by the WSA advertisement
- SSH credentials for ***RSYNC***: The OBU's public key will have been saved on the ODE server so no SSH credentials are required.

Details on the log file transfer to the ODE may be found in Section: **5.16.1**.

[40-44] *RSYNC* Transfers File over DSRC to the RSU

WAVE messages with IPv6 destinations are routed by the RSU to its Ethernet interface which is connected to the ODE. As the ODE server services the ***RSYNC*** command traffic response data is sent back to the OBU's IPv6 address. The RSU again performs routing service, but this time from Ethernet to DSRC for the OBU.

This continues until either the ***RSYNC*** command completes successfully or the OBU is out of range of the RSU and the ***RSYNC*** command exits with incomplete status.

[31-32] *RSYNC* Command Returns Status to OBU

If the ***RSYNC*** command completed successfully then the OBU purges the log file, message **[50]**. Otherwise, the OBU remains in a state that when it next receives a WSA advertisement for ODE Server, the OBU will invoke ***RSYNC*** with the existing log file.

Note, when the ODE server detects that a new environmental log file exists in the upload directory, the ODE server will check the signature of the log file and import environmental records and publish them on the Kafka stream.

5.17.1.4 Messages

- A description of each type of log file copied up to the ODE may be found in Section: **7.13**.

5.17.1.5 Data Elements

There are no optional data elements for this flow. All data fields specified must be included for each record.

5.17.1.6 Requirement Traceability

- WCVS-REQ-1 Collect CV Data
- WCVS-REQ-1.2 Collect Environmental Sensor Data
- WCVS-REQ-2 Validate Data
- VS-REQ-36 Transmit Data
- VS-REQ-36.1 Transmit Environmental Data
- VS-REQ-39 SLD Rolling Log
- VS-REQ-40 SLD Log Format
- VS-REQ-41 SLD Log Data
- VS-REQ-45 VSM SCMS Encryption
- VS-REQ-46 VSM SCMS Sign
- VS-REQ-47 VSM App Availability Log
- VS-REQ-50 Safety Communication
- RSU-REQ-6 Safety Communication

- ODE-REQ-1 Collect CV Data
- MV-REQ-1 Environmental Sensors
- MV-REQ-1.1 Environmental Sensor Equipment
- MV-REQ-9 General

5.18 ODE <-> RSU

This section describes the interface between RSUs and the ODE. This interface operates over the WYDOT backhaul Ethernet network which connects RSUs in the field with the ODE server. This interface supports the following activities:

- RSU's upload logs of BSMs received from OBUs in passing vehicles. (OBU->RSU flow, Section: **5.9.1**)
- ODE sends TIMs along with delivery instructions to RSUs. The RSUs are to broadcast these TIMs to passing OBUs.

5.18.1 RSU Sends Traffic Situation Data to the ODE

As vehicles participating in the CV Pilot broadcast BSMs they will be captured by nearby RSUs. The RSUs are configured to collect received BSMs, save them in log files and copy them to the ODE server using ***RSYNC***.

5.18.1.1 External References

RSYNC is defined by the following standard protocols defined by the Internet Engineering Task Force (ITEF):

- The ***RSYNC*** URI Scheme (https://tools.ietf.org/html/rfc5781)
- The Secure Shell (SSH) Transport Layer Protocol (https://tools.ietf.org/html/rfc4253)
- SAE J2735 MAR2016
- SAE J3067 AUG2014

5.18.1.2 Covered Information Flows

Table 5-34. Flow: RSUs sending Traffic Situation Data to ODE.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Figure Number	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30035**	**traffic situation data**	4-12	WYDOT RSUs	WYDOT ODE	WI7

5.18.1.3 Dialogs

5.18.1.3.1 Dialog: RSU periodically copies BSM log files to ODE

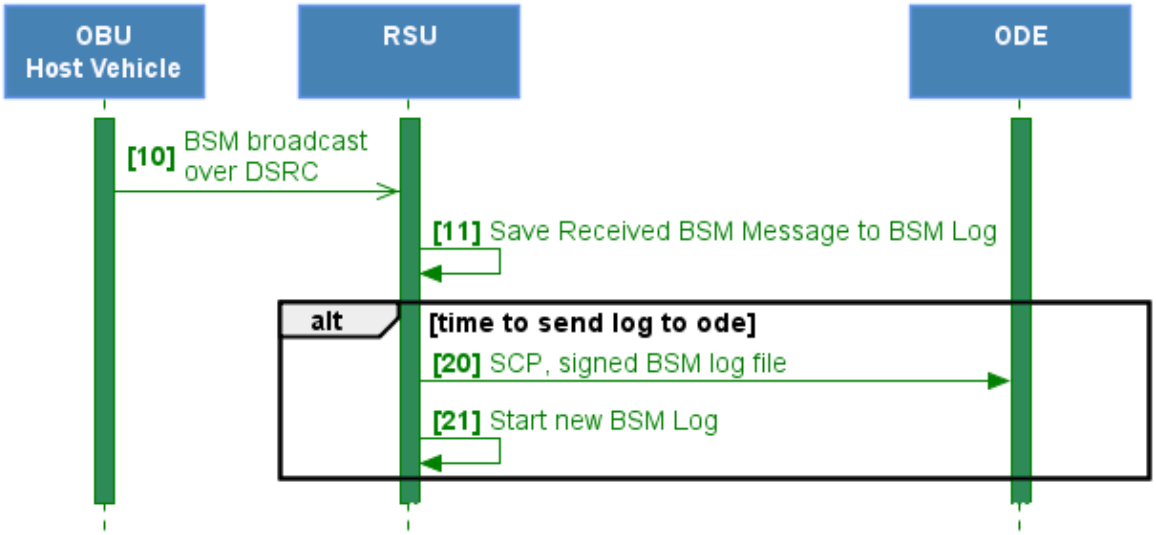


Figure 5-28. Sequence Diagram: RSU periodically copies BSM log files to ODE.
Source: WYDOT

[10-11] Host Vehicle broadcasts BSM and RSU receives it

The RSU will append received BSMs to a rolling log.

[20] OBU Invokes *SCP* to transfer log file containing received BSMs to ODEW

The RSU periodically copies its log of received BSMs to the ODE server. The RSU invokes the ***SCP*** command to transfer of the log file to the ODE:

- The BSM log file is first signed by the RSU.
- The RSU public keys are loaded on the ODE server so no SSH credentials are required.

Details on the log file name and the destination path on the ODE where the file is to be delivered are in Section: **7.13**.

[21] Start a new BSM Log File

Note, when the ODE server detects that a new BSM log file exists in the upload directory, the ODE server will decrypt the log file and decode inbound message packets and publish them on the Kafka stream.

5.18.1.4 Messages

- A description of each type of log file copied up to the ODE may be found in Section: **7.13**.

5.18.1.5 Data Elements

All mandatory and optional fields of BSMs are processed by this interface.

5.18.1.6 Requirement Traceability

- WCVS-REQ-8 Internal Brokerage
- RSU-REQ-11 Distribute to ODE
- ODE-REQ-1 Collect CV Data

5.18.2 ODE Sends TIMs to RSUs

ODE transmits TIMs along with delivery instructions to the RSU. ODE uses Simple Network Management Protocol version 3 (SNMPv3) which is an interoperable, standards-based protocol. The TIMs are subsequently broadcast by the RSU to the OBUs.

5.18.2.1 External References

- Traveler Information Message: SAE J2735, SAE J2540-2
- ASN.1:2015: Abstract Syntax Notation
- RSU: USDOT RSU Specification 4.1 (Describes the requirements for TIM delivery instructions)
- SNMP: IETF RFC 3411, IETF RFC 3418

5.18.2.2 Covered Information Flows

Table 5-35. Flow: ODE sends TIMs to RSU.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30023**	**I2V Situational Awareness TIM (C2C and C2I)**	4-13	WYDOT ODE	WYDOT RSUs	WI7

5.18.2.3 Dialogs

Traveler Information Message (TIM) is an SAE J2735 message structure that the WYDOT Data Broker uses to send useful traffic information to Connected Vehicles. For the scope of this dialog, the TIM destination is the store-and-repeat message directory of a Roadside Unit (RSU). The ODE is procedurally located in the middle of this pipeline and acts as a packing and distribution system.

5.18.2.3.1 Dialog: ODE Sends TIMs to RSUs

Messages arrive at the ODE at a HTTP(S) REST endpoint in a JSON containing the TIM itself as well as a list of destination RSUs. The ODE translates the TIM into an ASN.1-encoded hex string and then sends it to each RSU.

The following illustrates the dialogs involved in the execution of the TIM broadcast, The ODE<->RSU dialog is highlighted by the rectangular red box.

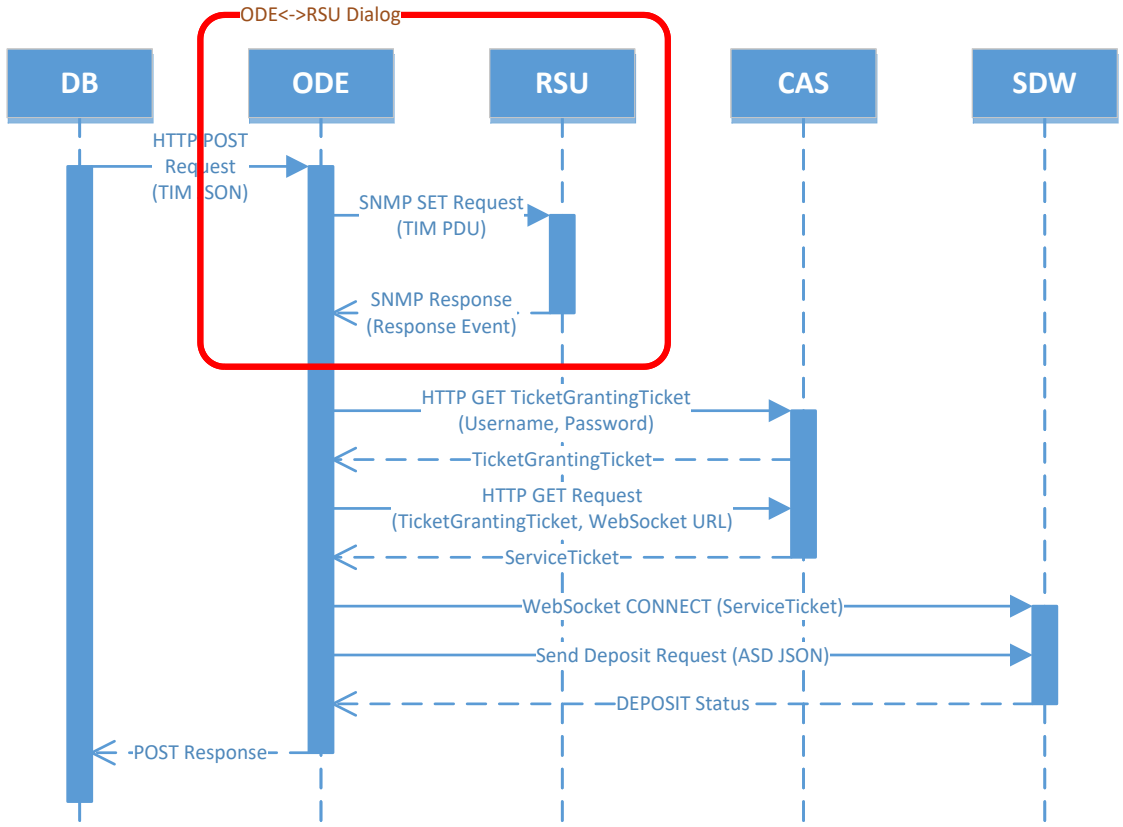


Figure 5-29. Sequence Diagram: ODE sends TIMs to RSUs.
Source: WYDOT

The WYDOT Data Broker sends messages to the ODE HTTP REST endpoint `/tim` in JSON format (*see Section: 5.21.2*). The ODE writes the messages into the relevant SNMP MIB OIDs and sends a SNMP SET requests to the RSUs specified in the JSON message. The SET request results in an SNMP PDU containing relevant OIDs and their assigned values to be sent to each RSU. The RSU then responds with an error status (0 indicating no error) as well as a list of assigned OIDs.

5.18.2.4 Messages

- Traveler Information Message: described in Section: **7.2**.

The WYDOT Data Broker JSON contains a TIM as specified in SAE J2735 MAR2016, Section **5.14**, an SNMP parameters section (for store-and-repeat configuration information on the RSU), and a list of RSUs the message is to be sent to. See the following link for a sample JSON document.
https://github.com/usdot-jpo-ode/jpo-ode/tree/develop/data/TIM_Message_Testing_Files
The TIM itself is populated as specified in SAE J2735 MAR2016, Section **5.14**.

5.18.2.5 Data Elements

ODE implements all required and optional elements defined in SAE J2735 MAR2016. The ODE provides user friendly data types in its TIM interface and converts the data to the specific types required by SAE J2735 MAR2016. For ODE defined data elements, refer to ODE REST API documentation found in https://github.com/usdot-jpo-ode/jpo-ode/blob/develop/docs/ODESwagger.yaml.

- The ITIS codes and content of TIMs varies by type of notification. See **Table 7-2. Traveler Information Message (TIM) Fields.** which shows which fields are used for each different notification type. For the list of ITIS codes used, see Section: **7.4**.

5.18.2.6 Requirement Traceability

- WCVS-REQ-8 Internal Brokerage
- RSU-REQ-2 Distribute TIM to VS
- ODE-REQ-3 Distribute Data
- ODE-REQ-3.1 Distribute TIM to VS

5.18.2.7 Security Framework

ODE will comply and/or interface with the US DOT Security Credential Management System (SCMS) to sign and encrypt, if needed, the TIMs sent to the RSU.

5.19 ODE <-> Pikalert

This section describes the interface between the ODE and the Pikalert System. This is a WYDOT internal interface which operates over the WYDOT intranet.

5.19.1 ODE Sends Vehicle Environmental Data to Pikalert System

The ODE server receives Vehicle Environmental Data from OBUs and RSUs in the form of BSMs and DNMs. The ODE makes this data available to the Pikalert System to use as input data for forecasts and alerts. The volume of data received by the ODE may be significant so a Kafka topic is published for the Pikalert System.

5.19.1.1 External References

- SAE J2735
- SAE J3067
- SAE J2540-2
- ISO 11898-1
- SAE J2945/1
- IEEE 1609.4
- IEEE 802.11p
- IEEE 1609.2 - WAVE Security Services
- RSU v4.1
- Kafka is a top level Apache project. The APIs and security model are documented at the following location: https://kafka.apache.org/.

5.19.1.2 Covered Information Flows

Table 5-36. Flow: ODE sends Vehicle Environmental Data to Pikalert.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30035**	**traffic situation data**	4-12	WYDOT ODE	WYDOT Pikalert System (PA)	WI6

5.19.1.3 Dialogs

5.19.1.3.1 Dialog: ODE sends Vehicle Environmental Data to Pikalert

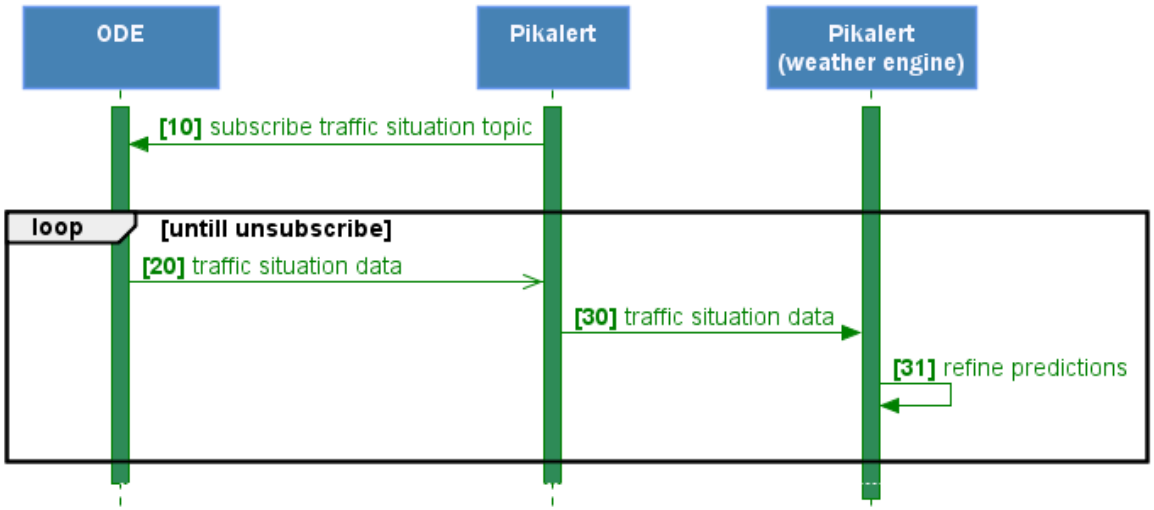


Figure 5-30. Sequence Diagram: ODE sends Vehicle Environmental Data to Pikalert. Source: WYDOT

5.19.1.4 Messages

The following subset of BSM Part I data is provided on the Kafka topic for Pikalert:

- YawRate
- Speed
- Heading
- Latitude
- Longitude
- Elevation

5.19.1.5 Data Elements

The following subset of BSM Part II data is optionally provided on the Kafka topic for Pikalert:

- ExteriorLights
- TractionControlStatus
- AntiLockBrakeStatus
- StabilityControlStatus

5.19.1.6 Requirement Traceability

- WCVS-REQ-8 Internal Brokerage
- ODE-REQ-3 Distribute Data
- ODE-REQ-3.3 Distribute to Pikalert
- PA-REQ-2 Wyoming CV Sub-Systems Data
- PA-REQ-2.1 ODE Data

5.19.2 ODE Sends Weather Environmental Situation Data to Pikalert System

The ODE server receives environmental weather data from WYDOT Maintenance Vehicles in the form of log files. The ODE copies environmental sensor data in log files received from WYDOT Maintenance vehicles to the Pikalert System to use as input data for forecasts and alerts.

5.19.2.1 External References

- ***SCP***: IETF SSH File Transfer Protocol

5.19.2.2 Covered Information Flows

Table 5-37. Flow: ODE sends Weather Environmental Situation Data Pikalert.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33021**	**environmental situation data**	4-12	WYDOT ODE	WYDOT Pikalert System (PA)	WI6

5.19.2.3 Dialogs

5.19.2.3.1 Dialog: ODE sends Weather Environmental Situation Data to Pikalert.

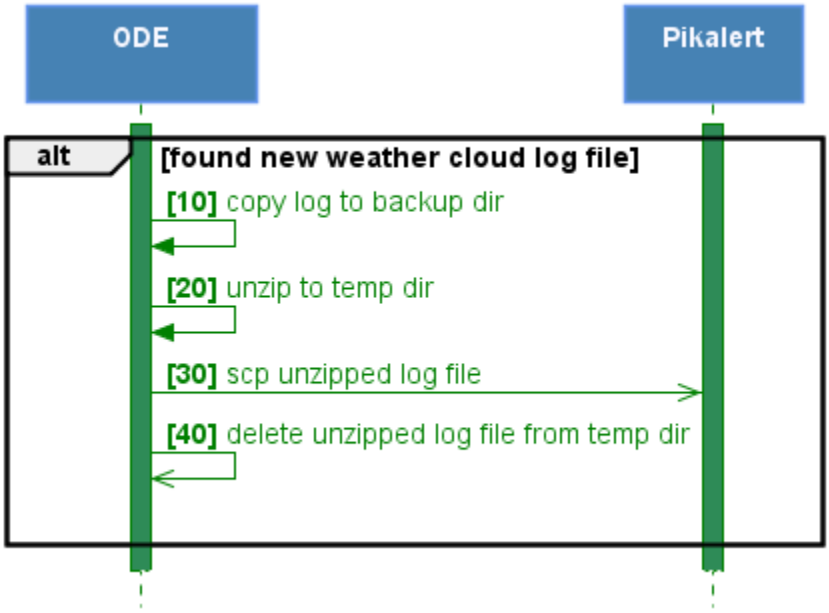


Figure 5-31. Sequence Diagram: ODE sends Weather Environmental Situation Data to Pikalert. Source: WYDOT

Note, the weather sensor log files from message [10] in the above sequence diagram will be retained for the duration of the WYDOT CV Pilot.

5.19.2.4 Messages

The source of the data in this message was obtained from the WYDOT Maintenance Vehicle Environmental Weather Sensor Data (Weathercloud sensors) whose content and format are described in Section: **7.7**.

The following data is provided on the Kafka topic for Pikalert:

- Precipitation Type
- Solar Radiation
- Windshield Wiper Frequency
- Orientation
- GPS Coordinates
- Ground Temperature
- Ground Profile
- Ambient Temperature
- Barometric Pressure

5.19.2.5 Data Elements

There are no optional data elements for this message flow.

5.19.2.6 Requirement Traceability

- WCVS-REQ-8 Internal Brokerage
- ODE-REQ-3 Distribute Data
- ODE-REQ-3.3 Distribute to Pikalert
- PA-REQ-2 Wyoming CV Sub-Systems Data
- PA-REQ-2.1 ODE Data

5.20 ODE <-> WYDOT Data Warehouse

This section describes the interface between the ODE and the WYDOT Data Warehouse. This is a WYDOT internal interface which operates over the WYDOT intranet.

5.20.1 ODE Sends Traffic Situation Data to WYDOT DW

This sub-section describes how the ODE interacts with the WYDOT DW to archive BSM and DNM message data it receives from Connected Vehicles and RSUs. The following sources contributed the data which the ODE will be archiving:

- As vehicles participating in the CV Pilot broadcast BSMs they will be captured by nearby RSUs. The RSUs are configured to collect received BSMs into log files and copy them to the ODE server. This data provides a picture of traffic flow in the area around the RSU. For more details on this OBU-RSU activity see Section: **5.9.1**.
- Connected Vehicles maintain a rolling log of their own BSMs. These logs are copied up to the ODE as the vehicles pass by. For more details on this OBU-ODE activity see Section: **5.16.1**.
- Connected Vehicles copy logs for received DNMs to the ODE. For more details on OBU-ODE activity see Section: **5.16.1**.

5.20.1.1 External References

- Basic Safety Message: SAE J2735
- Traveler Information Message: SAE J2735, SAE J2540-2
- Distress Notification: SAE J3067, SAE J2735, SAE J2540-2
- BSM, TIM, DNM signatures: IEEE 1609.2
- Java Database Connectivity (JDBC) API: See Section: **6.2.1**.

5.20.1.2 Covered Information Flows

Table 5-38. Flow: ODE archives Vehicle Environmental Data to DW.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30035**	**traffic situation data**	4-12	WYDOT ODE	WYDOT Data Warehouse (DW)	WI5

5.20.1.3 Dialogs

5.20.1.3.1 Dialog: ODE archives BSM Data to WYDOT DW.

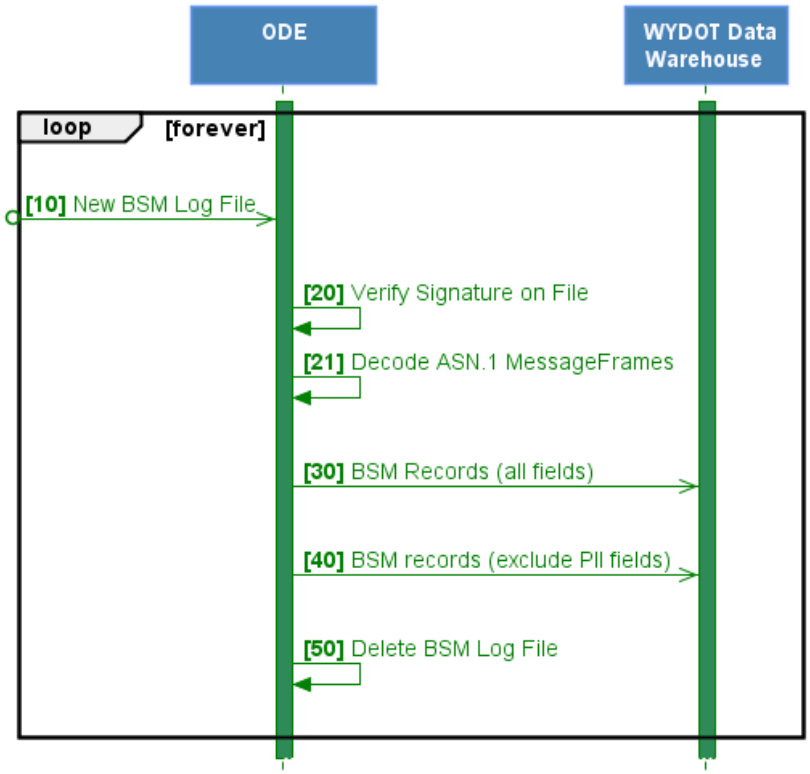


Figure 5-32. Sequence Diagram: ODE archives BSM Data to WYDOT DW.
Source: WYDOT

The ODE Server writes to the DW using the Java Database Connectivity (JDBC) API, which is documented here:
http://download.oracle.com/otndocs/jcp/jdbc-4_2-mrel2-spec/index.html

5.20.1.3.2 Dialog: ODE archives DNM to WYDOT DW.

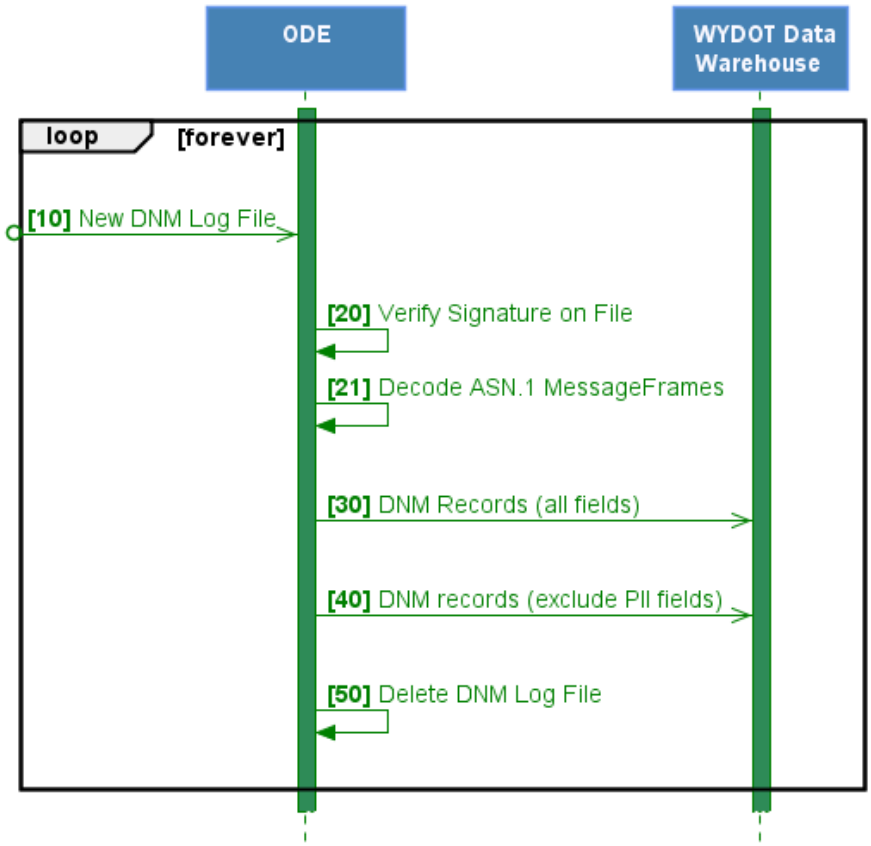


Figure 5-33. Sequence Diagram: ODE archives DNM to WYDOT DW.
Source: WYDOT

5.20.1.4 Messages

- Basic Safety Message: described in Section: **7.1**.
- The Oracle Data Tables used to store BMSs are described in Sections: **7.1.2** and **7.1.3**.
- The DNM format is described in Section **7.5: Distress Notification Message**.

5.20.1.5 Data Elements

- This interface archives all mandatory and optional fields contained in the BSMs and DNMs received.

5.20.1.6 Requirement Traceability

- WCVS-REQ-8 Internal Brokerage
- ODE-REQ-3 Distribute Data
- ODE-REQ-3.4 Distribute to Data Warehouse
- ODE-REQ-3.4.1 Distribute to Data Warehouse-BSM
- ODE-REQ-3.4.2 Distribute to Data Warehouse-DNM
- DW-REQ-4 Receive Data

5.20.2 ODE Sends Environmental Sensor Data to WYDOT DW

This sub-section describes how the ODE interacts with the WYDOT DW to archive environmental sensor data it receives from Connected Vehicles. WYDOT Maintenance Vehicles maintain logs environmental sensor data. These logs are copied up to the ODE as the vehicles pass by RSUs. For more details on this OBU-ODE activity see Section: **5.16.1**. The ODE processes these logs and saves the data to the WYDOT Data Warehouse.

5.20.2.1 External References

- IETF RFC 6455
- Java Database Connectivity (JDBC) API: See Section: **6.2.1**.

5.20.2.2 Covered Information Flows

Table 5-39. Flow: ODE archives Environmental Sensor Data to DW.

Interop Cat Num	Shared/ Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33021**	**environmental situation data**	4-12	WYDOT ODE	WYDOT Data Warehouse (DW)	WI5

5.20.2.3 Dialogs

5.20.2.3.1 Dialog: ODE archives Environmental Sensor data to WYDOT DW.

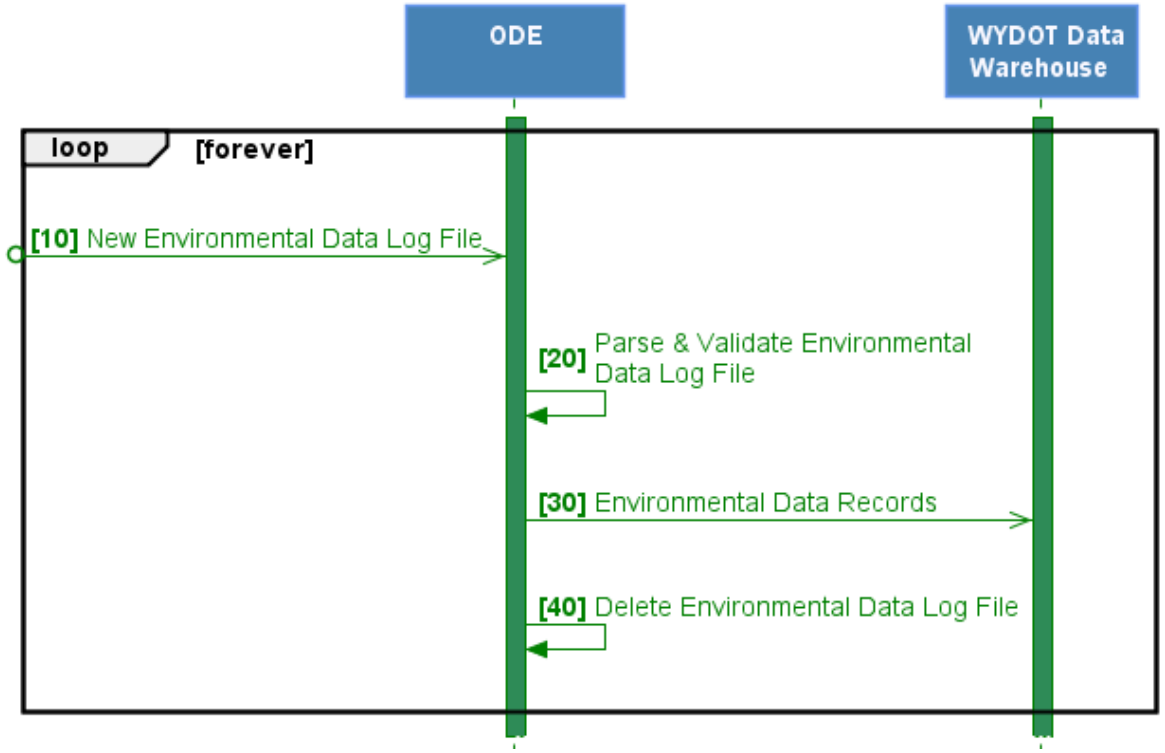


Figure 5-34. Sequence Diagram: ODE archives Environmental Sensor data to WYDOT DW. Source: WYDOT

5.20.2.4 Messages

- The source of the data in this message was obtained from the WYDOT Maintenance Vehicle Environmental Weather Sensor Data (Weathercloud sensors) whose content and format are described in Section: **7.7**.

5.20.2.5 Data Elements

- There are no optional data elements for this message flow.

5.20.2.6 Requirement Traceability

- WCVS-REQ-8 Internal Brokerage
- ODE-REQ-3 Distribute Data
- ODE-REQ-3.4.3 Distribute to Data Warehouse-ES
- DW-REQ-4 Receive Data

5.21 ODE <-> WYDOT Data Broker

This section describes the interface between the ODE and the WYDOT Data Broker. This is a WYDOT internal interface which operates within the WYDOT intranet.

5.21.1 ODE Sends DNM to WYDOT DB

This sub-section describes how the ODE sends DNMs to the WYDOT Data Broker.

Connected Vehicles broadcast DNMs to RSUs. The RSUs deliver DNMs to the ODE. When the ODE receives a DNM it will store the DNM to the WYDOT Data Warehouse. Then it will notify the DB there is a new DNM by posting the DNMs unique ID to the REST end-point on the DB. The DB posts new DNMs to the TRAC system which WYDOT Traffic Management operators will evaluate the notification and take appropriate action.

5.21.1.1 External References

- Distress Notification: SAE J3067, SAE J2735, SAE J2540-2
- REST interface standards are described in Section **6.2**.

5.21.1.2 Covered Information Flows

Table 5-40. Flow: ODE sends DNM to WYDOT DB.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
1	**Shared**	**30007**	**emergency notification**	4-10	WYDOT ODE	WYDOT Data Broker (DB)	WI2

5.21.1.3 Dialogs

5.21.1.3.1 Dialog: ODE sends DNM to WYDOT DB

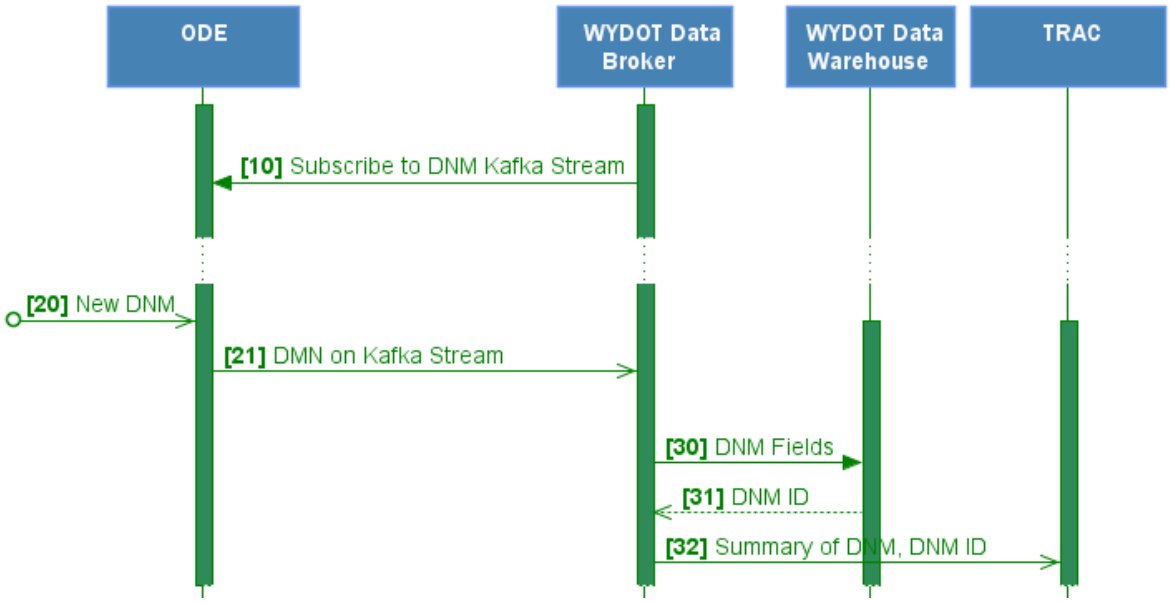


Figure 5-35. Sequence Diagram: ODE sends DNM to WYDOT DB.
Source: WYDOT

[10-11] DB Subscribes to DNM Kafka Stream

The Data Broker will subscribe to the Kafka Stream produced by the ODE. The DB will automatically subscribe to the Kafka stream the DB starts and will remain subscribed as long as the DB is running.

[20-21] A new DNM Arrives at the ODE

A new DNM arrives at the ODE. For details on how DNMs are delivered to the ODE see Section: **5.16.1**. When the ODE receives a new DNM the ODE will validate the signature of the DNM. If the DNM contains a valid signature the ODE will then publish the DNM on the associated Kafka stream.

[30-32] DB sees DNM on the Kafka Stream

When the DB receives a new DNM on the Kafka stream the DB will save the DNM to the Data Warehouse. The DNM will get a unique identifier from Oracle once it has been saved. Finally, the DB will generate a summary of the DNM and send this to the TRAC system. At this point the DB is finished with the DNM. Once in the TRAC system, a TMC operator will decide what to do about the DNM notification. For details on how the TRAC system manages issues see Section: **5.28.2**.

5.21.1.4 Messages

- The content and format of a DNM is described in Section: **7.5**.

5.21.1.5 Data Elements

- The fields used in the DNM are defined in: **Table 7-2. Traveler Information Message (TIM) Fields.**

5.21.1.6 Requirement Traceability

- WCVS-REQ-8 Internal Brokerage
- ODE-REQ-3 Distribute Data
- ODE-REQ-3.5 Distribute to Data Broker
- DB-REQ-6 Receive from ODE

5.21.2 WYDOT Data Broker sends TIMs to ODE

This sub-section describes how the WYDOT Data Broker sends TIMs, along with delivery instructions to the ODE via a REST API.

The ODE will deliver the TIMs to the specified RSUs, as well as the SDX as described in Sections: **5.18.2** and **5.22.1**.

5.21.2.1 External References

- Traveler Information Message: SAE J2735, SAE J2540-2
- REST interface standards are described in Section **6.2**.
- RSU: USDOT RSU Specification 4.1 (Describes the requirements for TIM delivery instructions)

5.21.2.2 Covered Information Flows

Table 5-41. Flow: WYDOT DB sends TIMs to ODE

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30023**	**I2V Situational Awareness TIM (C2C and C2I)**	4-13	WYDOT Data Broker (DB)	WYDOT ODE	WI2

5.21.2.3 Dialogs

5.21.2.3.1 Dialog: WYDOT DB sends TIMs to ODE

The following sequence diagram illustrates the dialogs involved in the execution of the TIM broadcast in a UML Sequence Diagram notation with the WYDOT Data Broker<->ODE segment of the dialog highlighted inside the rectangular red box.

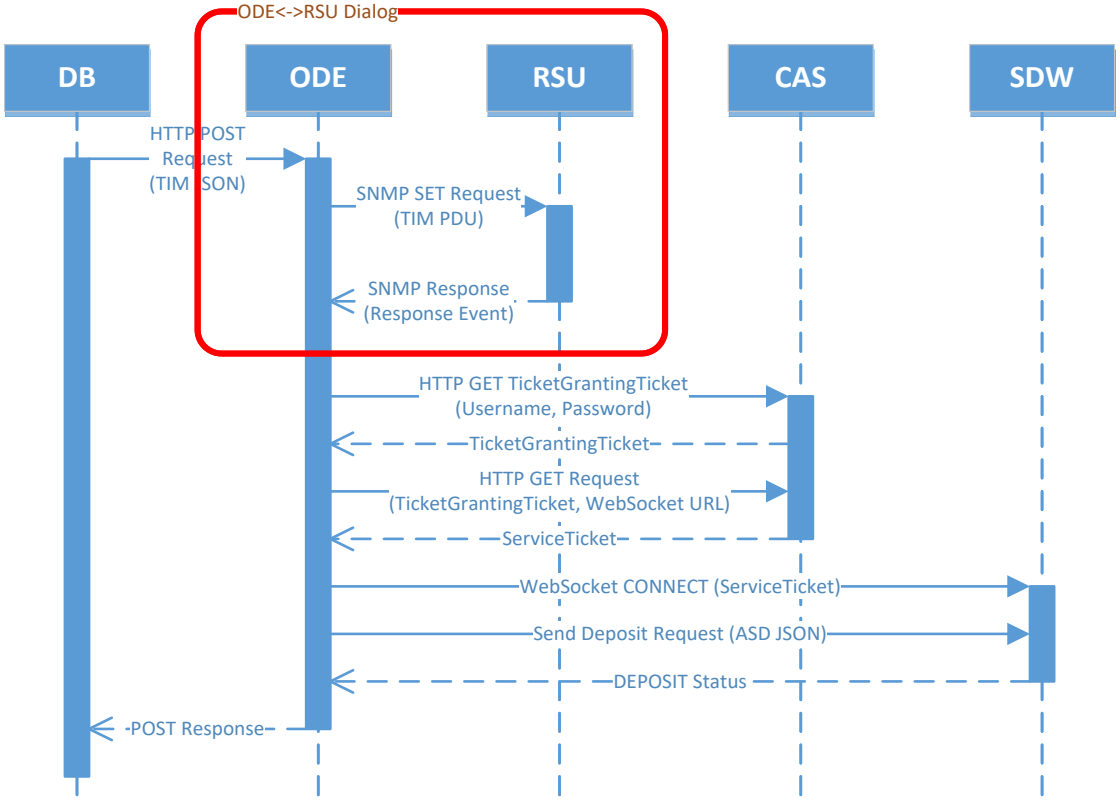


Figure 5-36. Sequence Diagram: WYDOT DB sends TIMs to ODE.
Source: WYDOT

The WYDOT Data Broker sends messages to the ODE HTTP REST endpoint `/tim` in JSON format. The ODE processes the messages as responds to the WYDOT Data Broker with an appropriate HTTP Response Code. See ODE Swagger documentation for details.

Detailed and up-to-date documentation of the ODE RESTful API is provided in a swagger file: https://github.com/usdot-jpo-ode/jpo-ode/blob/develop/docs/ODESwagger.yaml

5.21.2.4 Messages

- Traveler Information Message: described in Section: **7.2**.
- The ODE JSON contains a user-friendly representation of a TIM. Example: https://github.com/usdot-jpo-ode/jpo-ode/blob/develop/docs/ODESwagger.yaml.
- The RSU delivery instructions are defined in an SNMP parameters section (for store-and-repeat configuration information on the RSU).
- A list of RSUs the message is to be sent to.

See the following link for a sample JSON document. https://github.com/usdot-jpo-ode/jpo-ode/tree/develop/data/TIM_Message_Testing_Files

5.21.2.5 Data Elements

- The ITIS codes and content of TIMs varies by type of notification. See ***Table 7-2. Traveler Information Message (TIM) Fields***. which shows which fields are used for each different notification type. For the list of ITIS codes used, see Section: **7.4**.
- ODE implements all required and optional elements defined in SAE J2735 MAR2016. The ODE provides user friendly data types in its TIM interface and converts the data to the specific types required by SAE J2735 MAR2016. For ODE defined data elements, refer to ODE REST API documentation found in https://github.com/usdot-jpo-ode/jpo-ode/blob/develop/docs/ODESwagger.yaml.

5.21.2.6 Requirement Traceability

- WCVS-REQ-8 Internal Brokerage
- DB-REQ-5 Distribute to ODE
- ODE-REQ-7 Receive from Data Broker
- ODE-REQ-8 Generate TIM for Connected Vehicles

5.21.2.7 Security Framework

ODE supports SSL when interfacing with external applications through the HTTP protocol (i.e. HTTPS).

5.22 ODE <-> Situation Data Exchange (SDX)

This Device to Device section describes the interface between the ODE and Situation Data Exchange (SDX).

5.22.1 ODE Transmits TIM to SDX

The ODE transmits TIMs, along with delivery instructions to the SDX.

5.22.1.1 External References

- Traveler Information Message: SAE J2735, SAE J2540-2
- REST interface standards are described in Section **6.2**.
- RSU: USDOT RSU Specification 4.1 (Describes the requirements for TIM delivery instructions)
- ODE uses WebSocket interface which is a standards-based protocol defined in IETF RFC 6455.
- SDX uses open source, single sign-on (SSO) software to authenticate users of their web applications. https://www.apereo.org/projects/cas
- Section 3.5.8 SAE J3067 AUG2014

5.22.1.2 Covered Information Flows

Table 5-42. Flow: ODE sends TIMs to SDX.

Interop Cat Num	Shared/ Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30023**	**I2V Situational Awareness TIM (C2C and C2I)**	4-13	WYDOT ODE	Situation Data Exchange	WE15

5.22.1.3 Dialogs

5.22.1.3.1 Dialog: ODE sends TIMs to SDX

The ODE deposits TIMs to the Situation Data Exchange via HTTP(s) web sockets as shown in the area highlighted with the rectangular red box in the following UML.

SDX uses open source, single sign-on (SSO) software to authenticate users of their web applications. The SSO software allows session sharing across web applications. For example, if you connect to webapp1 you get redirected to the authentication server (CAS) where you provide your credentials, after you are successfully authenticated you are returned back to the original page. Later, within the same browser application, if you connect to webapp2 which is hosted on the same server, you will directly access webap2 and not be redirected to CAS.

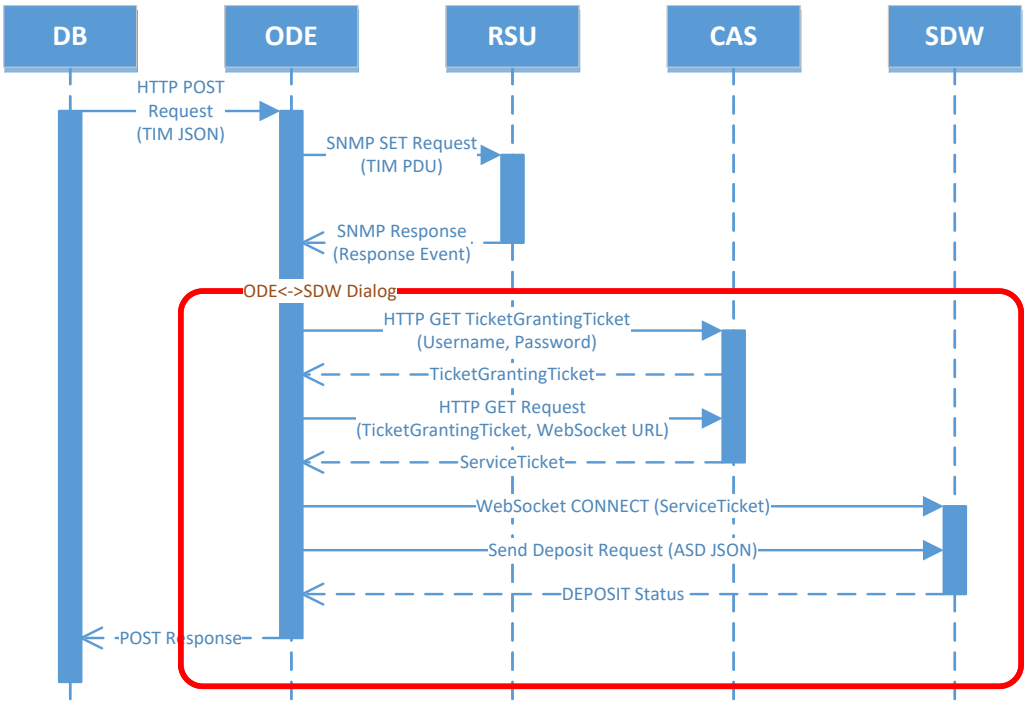


Figure 5-37. Sequence Diagram: ODE sends TIMs to SDX.
Source: WYDOT

ODE uses WebSocket interface which is a standards-based protocol defined in RFC 6455 (https://tools.ietf.org/html/rfc6455) to deposit TIMs to the SDX. The TIMs will subsequently be broadcast by a satellite provider to the OBUs.

SDX uses open source, single sign-on (SSO) software to authenticate users of their web applications. Here are links to the software description and download https://www.apereo.org/projects/cas and the source can be downloaded from here: https://github.com/apereo/cas.

5.22.1.3.2 Obtain Ticket Granting Ticket from CAS

ODE provides the CAS server the credentials (username/password) to authenticate itself.

5.22.1.3.3 Obtain Service Ticket from CAS

ODE provides a valid TicketGrantingTicket to CAS server to obtain a ServiceTicket authorizing it to connect to the WebSocket interface.

5.22.1.3.4 Connect to WebSocket server

ODE connects to WebSocket server and sends a DEPOSIT request containing an Advisory Situation Data (ASD) message as defined by US DOT SDX. ODE builds the ASD message based on parameters provided in the TIM REST call as specified in the ODE REST API documented in https://github.com/usdot-jpo-ode/jpo-ode/blob/develop/docs/ODESwagger.yaml. An ASD message contains the following parameter:

```
SemiDialogID dialogID;
SemiSequenceID seqID;
GroupID groupID;
us.dot.its.jpo.ode.j2735.dsrc.TemporaryID requestID;
us.dot.its.jpo.ode.j2735.dsrc.TemporaryID recordID;
TimeToLive timeToLive;
GeoRegion serviceRegion;
AdvisoryDetails asdmDetails;
```

The above data structures are defined in the USDOT ASN.1 extensions to SAE J2735 MAR2016.

5.22.1.4 Messages

- Traveler Information Message: described in Section: **7.2**.
- The ODE JSON contains a user-friendly representation of a TIM. Example: https://github.com/usdot-jpo-ode/jpo-ode/blob/develop/docs/ODESwagger.yaml.
- The RSU delivery instructions are defined in an SNMP parameters section (for store-and-repeat configuration information on the RSU).
- A list of RSUs the message is to be sent to.
- See the following link for a sample JSON document. https://github.com/usdot-jpo-ode/jpo-ode/tree/develop/data/TIM_Message_Testing_Files
- Additionally, this TIM is wrapped with a SDX specific element to create an ASD message and sent to SDX. The structure of a SDX deposit message is as follows:

```
DEPOSIT: { "systemDepositName": "SDC 2.3", "encodeType": "HEX",
"encodedMsg":
"c44000000000001869f0001869f2a7708a771ce49929080029dc1f6be7392b07e20
0000000ad9a010a44020000000000006785b3b2100e53b84269ce724efac800000005f
```

```
844a8082d960000480001253b84269ce724efac800063ff9c00ca010200050000ffb
a7ff07fe93fe8bffe1fff200610007004c10800311400" }

Where

“encodeMessage” element is the ASN.1 UPER encoding of the ASD message.
```

5.22.1.5 Data Elements

- The ITIS codes and content of TIMs varies by type of notification. See **Table 7-2. Traveler Information Message (TIM) Fields.** which shows which fields are used for each different notification type. For the list of ITIS codes used, see Section: **7.4**.

- ODE implements all required and optional elements defined in SAE J2735 MAR2016. The ODE provides user friendly data types in its TIM interface and converts the data to the specific types required by SAE J2735 MAR2016. For ODE defined data elements, refer to ODE REST API documentation found in https://github.com/usdot-jpo-ode/jpo-ode/blob/develop/docs/ODESwagger.yaml.

- Please refer to traveler_situation_data_deposit_2.2_R9.xlsx (https://usdotjpoode.atlassian.net/secure/attachment/11505/traveler_situation_data_deposit_2.2_R9.xlsx).

5.22.1.6 Requirement Traceability

- WCVS-REQ-10 Distribute signed TIM
- WCVS-REQ-10.2 Distribute signed TIM to SDX
- ODE-REQ-3 Distribute Data
- ODE-REQ-3.2 Distribute TIM to SDX
- SDX-REQ-1 Data Provided to the SDX

5.22.1.7 Security Framework

ODE will comply and/or interface with the US DOT Security Credential Management System (SCMS) to sign and encrypt, if needed, the TIMs sent to SDX.

5.23 Situation Data Exchange <-> Satellite

This section describes the interface which provides communication capabilities from the Trihydro Situation Data Exchange to Satellite Service Providers. **This interface is outside our scope of control and provided here for completeness.**

5.23.1 Delivery of Traveler Information to Satellite Service Provider

This interface is outside our scope of control and provided here for completeness.
USDOT provides tools create Traveler Information Message and deposit this message to Situation Data Exchange (SDX) store. These messages will then be encapsulated in Advisory Situation Data Bundles.

These messages will be picked up by the SiriusXM Transmitter through Web/socket interface. From there it will be uploaded to the Satellite for distribution to satellite enable OBUs.

5.23.1.1 Covered Information Flows

Table 5-43. Flow: USDOT to SSP TIMs.

Interop Cat Num	Shared/ Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30023**	**I2V Situational Awareness TIM (C2C and C2I)**	4-13	Situation Data Exchange	Satellite Service Provider	USDOT Owned Interface

5.23.1.2 Requirement Traceability

This interface is outside our scope of control and provided here for completeness.

5.24 Satellite <-> OBU

The content in this section was provided by vendors SiriusXM and Lear. The information format of this information is not consistent with the rest of the ICD; however, the content is valuable.

This section deals with VE2 interface defined in the System Architecture Document which provides communication capabilities through satellites that allow the system to transmit TIM traveler-related information and SCMS data to satellite enabled OBUs. The specifications for this interface are proprietary to the satellite service provider and are provided to equipment vendors through a royalty-free license.

5.24.1 Delivery of Traveler Information to Vehicles

This section provides the information flows that show the delivery of TIMs to OBUs via a Satellite Service Provider.

An application on the OBU which receives messages through SiriusXM periodically, decodes the Situation Awareness Advisory and extracts the TIMs. These extracted TIMs will be stored in the OBU. As soon as the device enters the TIM based on zone, data will be sent to HMI.

5.24.1.1 External References

This flow uses the following standards/protocols:

- ASN.1:2015: Abstract Syntax Notation
- SEMI_ASN.1 Structure_2.1.txt defines the AdvisorySituationDataBundle, Traveler Information Message format defined in SAE J2735 MAR2016.
- USDOT SDX Clearing House Dialogs and related SEMI v2.3.0 ASN.1 definitions
  This information is available on request from https://cvcs.samanage.com/welcome.portal
- Traveler Information Message: SAE J2735, SAE J2540-2
- BSM, TIM, DNM signatures: IEEE 1609.2

5.24.1.2 Covered Information Flows

Table 5-44. Flows: SSP to OBUs.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30025**	**I2V Situational Awareness TIM (S2V)**	4-13	Satellite Service Provider	Highway Patrol Vehicle	VE2
					Satellite Service Provider	Integrated Comm Vehicle	VE2
					Satellite Service Provider	Retrofit Comm Vehicle	VE2
					Satellite Service Provider	WYDOT Maintenance Vehicle	VE2

5.24.1.3 Dialogs

The TIM data that is delivered via satellite is delivered to OBUs (or any device) via a software library and Application Programming Interface (API) made available to vendors by the satellite service provider.

All TIMs that are present in the SDX are broadcast over satellite, it is the job of the application to discard TIMs that do not apply to the vehicle due to the vehicle location and/or direction of travel.

5.24.1.3.1 Dialog: Satellite sends Situation Awareness Data to OBU

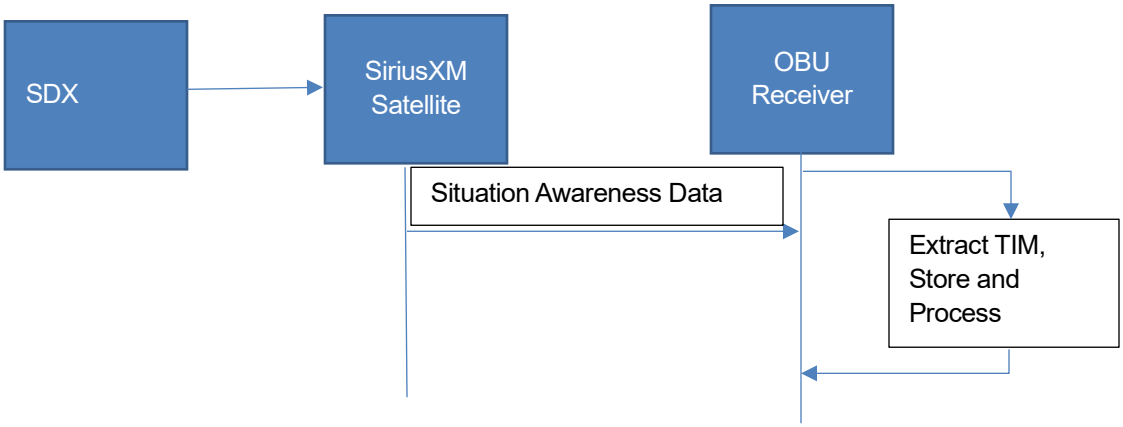


Figure 5-38. Satellite sends Situation Awareness Data to OBU
Source: SiriusXM

5.24.1.3.2 Dialog: Satellite TIM Delivery Service Starts

To initialize the Satellite TIM Delivery Service, it must be started.

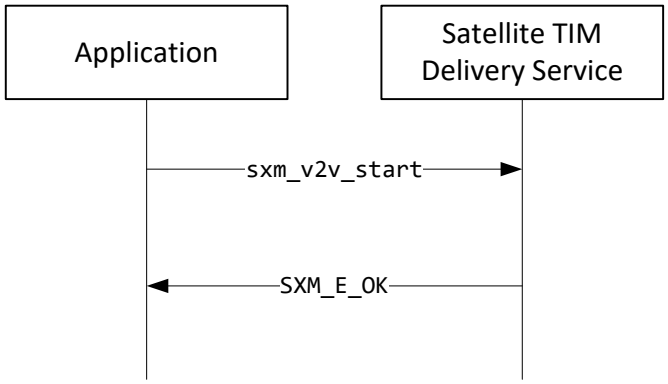


Figure 5-39. Sequence Diagram: Satellite TIM Delivery Service Starts.
Source: SiriusXM

5.24.1.3.3 Dialog: Application requests data from the Satellite TIM Delivery Service

To receive TIM data the application must first request TIM data from the Satellite TIM Delivery Service.

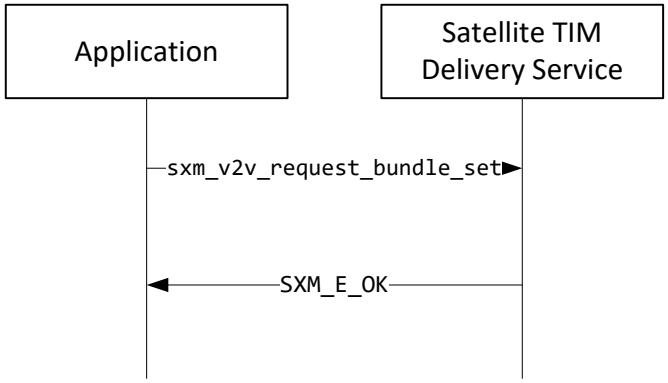


Figure 5-40. Sequence Diagram: Application requests data from the Satellite TIM Delivery Service.
Source: SiriusXM

5.24.1.3.4 Dialog: Application receives Data from the Satellite TIM Delivery Service

When new TIM data is available, the Satellite TIM Delivery Service will notify the application and the application will then retrieve the TIM data.

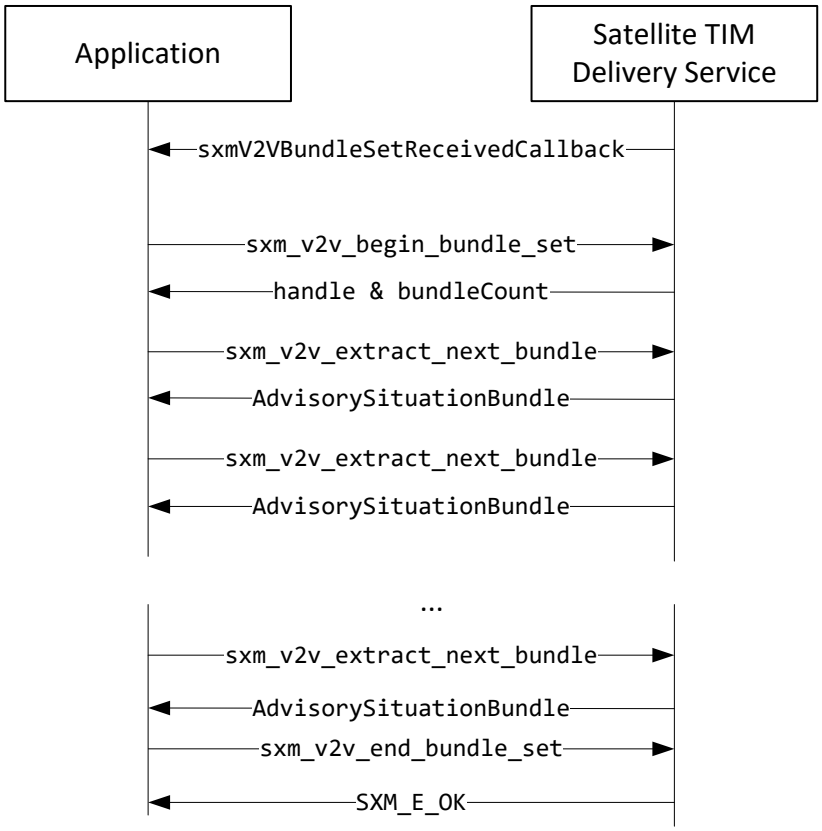


Figure 5-41. Sequence Diagram: Application receives Data from the Satellite TIM Delivery Service. Source: SiriusXM

5.24.1.4 Messages

SEMI_ASN.1 Structure_2.1.txt contains the AdvisorySituationDataBundle in which Traveler Information Messages are bundled. Traveler Information Message is defined in SAE J2735 MAR2016, Section 5.16.

The messages used in these APIs are all proprietary API calls except the AdvisorySituationBundle returned by the sxm_v2v_extract_next_bundle request.

Each AdvisorySituationBundle contains a sequence of up to 10 AdvisoryBroadcast frames. Each AdvisoryBroadcast frame contains an advisoryMessage that is encoded as an OCTET STRING. The AdvisorySituationBundle and AdvisoryBroadcast frames are both defined in the USDOT SDX Clearing House Dialogs and related SEMI v2.3.0 ASN.1 definitions.

The advisoryMessage is an OER-encoded Ieee1609Dot2Data frame.

The content field of the Ieee1609Dot2Data frame can be either

- An unsigned UPER-encoded SAE J2735 MessageFrame containing a TIM (Ieee1609Dot2Data -> unsecuredData), or
- A signed UPER-encoded SAE J2735 MessageFrame containing a TIM (Ieee1609Dot2Data -> signedData)

5.24.1.5 Data Elements

- The ITIS codes and content of TIMs varies by type of notification. See **Table 7-2. Traveler Information Message (TIM) Fields.** which shows which fields are used for each different notification type. For the list of ITIS codes used, see Section: **7.4**.

5.24.1.6 Requirement Traceability

- HP-REQ-6 Receive TIM over Satellite
- MV-REQ-5 Receive TIM over Satellite
- IT-REQ-2 Receive TIM over Satellite
- RFV-REQ-2 Receive TIM over Satellite
- VS-REQ-2 Receive TIM
- VS-REQ-2.2 Receive TIM through Satellite

5.24.2 Delivery of Latest Certificate Revocation List to Vehicles

This section provides the information flows that show the delivery of the most recently made available Certificate Revocation List to Vehicles via a Satellite Service Provider.

The WYDOT pilot is considering using the capability to deliver Certificate Revocation Lists over satellite.

5.24.2.1 External References

- IEEE 1609.2 - WAVE Security Services

5.24.2.2 Covered Information Flows

Interop Cat Num	Shared/ Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	**Custom**	**33020**	**security credential revocations**	4-31	**Satellite Service Provider**	**Highway Patrol Vehicle**	**VE2**
					Satellite Service Provider	**Integrated Comm Vehicle**	**VE2**
					Satellite Service Provider	**Retrofit Comm Vehicle**	**VE2**
					Satellite Service Provider	**WYDOT Maintenance Vehicle**	**VE2**

5.24.2.3 Dialogs

The CRL that is delivered via satellite is delivered to OBUs (or any device) via a software library and Application Programming Interface (API) made available to vendors by the satellite service provider.

5.24.2.3.1 Dialog: Starting the Satellite CRL Delivery Service

This dialog is identical to Section: **5.24.1.3.2**.

5.24.2.3.2 Dialog: Application requests Data from the Satellite CRL Delivery Service

To receive CRL data the application must first request CRL data from the Satellite CRL Delivery Service.

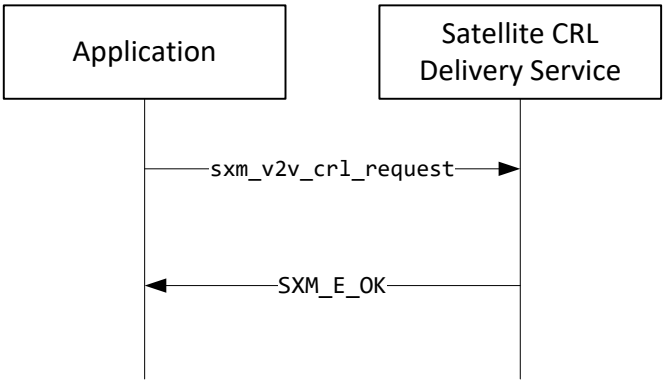


Figure 5-42. Sequence Diagram: Application requests Data from the Satellite CRL Delivery Service.
Source: SiriusXM

5.24.2.3.3 Dialog: Application receives Data from the Satellite CRL Delivery Service

When new CRL data is available, the Satellite CRL Delivery Service will notify the application and the application will then retrieve the CRL data.

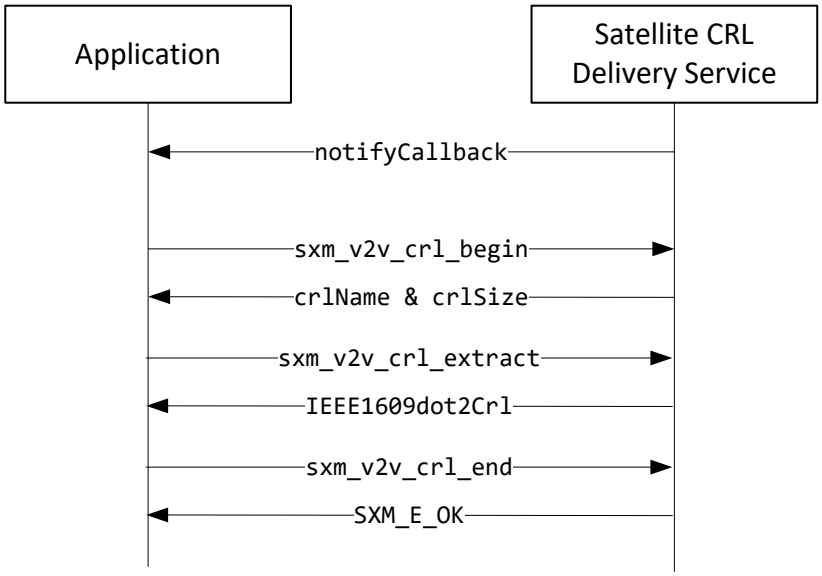


Figure 5-43. Sequence Diagram: Application receives Data from the Satellite CRL Delivery Service.
Source: SiriusXM

5.24.2.4 Messages

The messages used in these APIs are all proprietary API calls except the IEEE1609dot2Crl returned by the sxm_v2v_crl_extract request.

The IEEE1609dot2Crl data frame as specified in the IEEE 1609.2 standard.

5.24.2.5 Data Elements

There are no optional data elements for this message flow.

5.24.2.6 Requirement Traceability

The WYDOT pilot is considering using the capability to deliver Certificate Revocation Lists over satellite.

- SCMS-REQ-2 Vehicle System SCMS Use
- SCMS-REQ-2.1 SCMS Vehicle System Certificates
- SCMS-REQ-2.3 SCMS Vehicle System Certificates Revocation List (CRL)

5.25 Pikalert <-> Weather Sources

5.25.1 Weather Information Sources provide data to Pikalert

The Pikalert system uses weather data from the following sources:

- The Weather Data Environment
  - RWIS observations and QC values
- The National Weather Service
  - Multi-Sensor Multi-Radar (MRMS) radar mosaic
- Meteorological Assimilation Data Ingest System (MADIS)
  - Automated Surface Observing System (ASOS) observations
  - Automated Weather Observing System (AWOS) observations
- National Centers for Environmental Prediction (NCEP)
  - High-Resolution Rapid Refresh (HRRR) model
  - Weather Research and Forecasting (WRF) Rapid Refresh (RAP) model
  - North American Model (NAM)
  - Global Forecast System (GFS) model
  - Real-time Mesoscale Analysis (RTMA) model
- Environment Canada
  - Global Environmental Model (GEM)
- WYDOT Weather Stations
  - WYDOT RWIS Stations

5.25.1.1 External References

All of the above weather data sources are pre-existing and are not being modified for the WYDOT CV Pilot and will therefore not be documented in further detail.

5.25.1.2 Covered Information Flows

Table 5-45. Flow: Weather Sources to Pikalert.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33014**	**weather information**	4-12	Weather Sources	WYDOT Pikalert System (PA)	WE4

5.25.1.3 Dialogs

All of the above weather data sources are pre-existing and are not being modified for the WYDOT CV Pilot and will therefore not be documented in further detail.

5.25.1.4 Messages

Existing interface will not be documented.

5.25.1.5 Data Elements

There are no optional data elements.

5.25.1.6 Requirement Traceability

- WI-REQ-1 External Data Acquisition
- WI-REQ-2 Fixed Data Acquisition
- PA-REQ-1 External Weather Data
- WCVS-REQ-3 Ingest Data for Road Weather information

5.26 Pikalert <-> TMC FTP Server

This section describes the interface between the Pikalert weather prediction application and the TMC FTP Server.

5.26.1 Pikalert Retrieves Camera Images from TMC FTP Server

This sub-section describes how the Pikalert System retrieves camera images for the areas surrounding RWIS stations. The Pikalert system will periodically retrieve images and allow users of the Pikalert website to display them. The intent is that users can perform a sanity check of the observable weather conditions around an RWIS station to see how that compares with the reported weather sensor data.

5.26.1.1 Covered Information Flows

Table 5-46. Flow: Pikalert Retrieves Camera Images for RWIS Stations from TMC FTP Server.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**Custom**	**Camera images**	**4-14**	TMC FTP Server	WYDOT Pikalert System (PA)	**WE4**

5.26.1.2 Dialogs

5.26.1.2.1 Dialog: Pikalert Retrieves Camera Images for RWIS Stations from TMC FTP Server.

A file naming convention associates the image file names with the RWIS station identifiers. The Pikalert system simply requests images for RWIS stations by name.

Figure 5-44. Sequence Diagram: Pikalert Retrieves Camera Images for RWIS Stations from TMC FTP Server.
Source: WYDOT

5.26.1.3 Requirement Traceability

- PA-REQ-2 Wyoming CV Sub-Systems Data
- PA-REQ-2.2 TMC Data
- WI-REQ-2 Fixed Data Acquisition

5.27 Pikalert <-> WYDOT Data Broker

This section describes the interface between the Pikalert weather prediction application and the WYDOT Data Broker.

5.27.1 WYDOT DB Retrieves Road Weather Alerts from Pikalert

This sub-section describes how the WYDOT Data Broker periodically retrieves road weather alerts from a REST end-point on the Pikalert server. The Pikalert system's Road Weather Hazard (RWH) module produces advisories and alerts of hazardous weather conditions in JSON format. The JSON includes the alert type, severity, and associated message (e.g., Icy Roads, Warning, Use Slower Speed).

The Pikalert system's Road Weather Hazard (RWH) module produces advisories and alerts of hazardous weather conditions by assessing a combination of observations from connected vehicles and other weather observations such as radar and RWIS station reports. Currently, these include precipitation, pavement condition, and visibility assessments. A vehicle blow-over algorithm will be developed as part of this project. The Road Weather Forecast System (RWFS) produces forecasts of road weather conditions using a combination of an optimized blending of Numerical Weather Prediction (NWP) forecasts and connected vehicle observations to correct the forecast. These forecasts are categorized into road weather advisories and alerts by the RWH module.

The RWH module produces output in netCDF format which is converted into JSON and then made available on a REST end-point.

5.27.1.1 External References

- IETF RFC 7230: Hypertext Transfer Protocol (HTTP/1.1)

5.27.1.2 Covered Information Flows

Table 5-47. Flow: WYDOT DB Retrieves road weather alerts from Pikalert.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33022**	**road weather advisories & alerts**	4-12	WYDOT Pikalert System (PA)	WYDOT Data Broker (DB)	WI1

5.27.1.3 Dialogs

5.27.1.3.1 Dialog: WYDOT DB Retrieves road weather alerts from Pikalert.

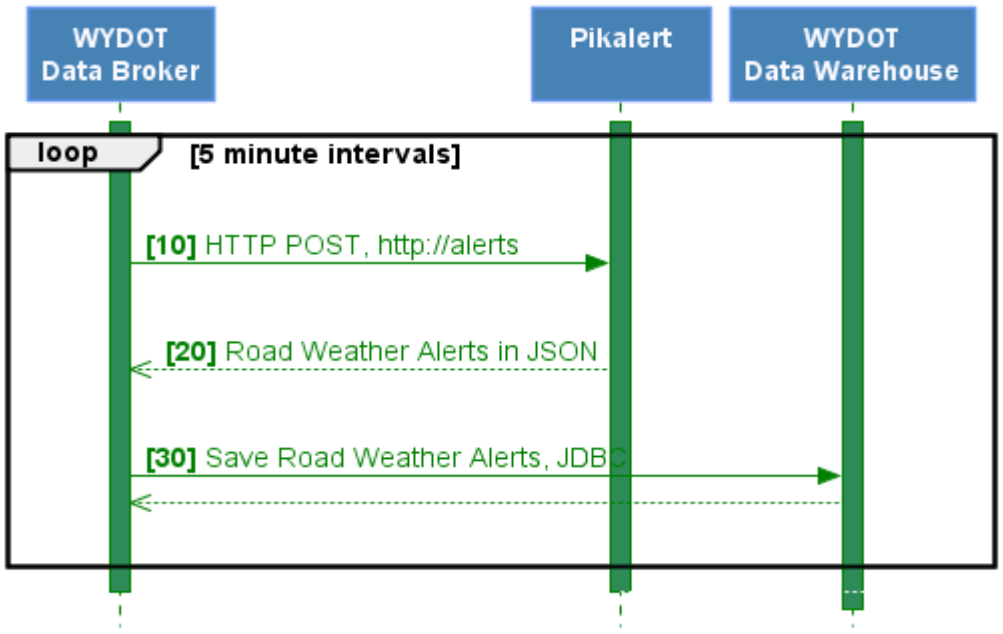


Figure 5-45. Sequence Diagram: WYDOT DB Retrieves road weather alerts from Pikalert. Source: WYDOT

5.27.1.4 Messages

- Pikalert System weather alert JSON strings are described in Section: **7.8**.

5.27.1.5 Data Elements

There are no optional data elements in this data structure.

5.27.1.6 Requirement Traceability

- TRAC-REQ-1.2.2 Segment Alerts-Pikalert
- WCVS-REQ-4 Contents of Alerts and Advisories
- WCVS-REQ-4.1 Precipitation Hazard
- WCVS-REQ-4.2 Road Condition Hazard
- WCVS-REQ-4.3 Visibility Hazard
- WCVS-REQ-8 Internal Brokerage
- PA-REQ-4 Distribute Alerts/Advisories and Forecasts
- PA-REQ-4.1 Distribute to DB
- DB-REQ-4 Receive from Pikalert
- DB-REQ-4.1 Receive Alerts and Advisories

5.27.2 WYDOT DB Retrieves Road Weather Forecasts from Pikalert

This sub-section describes how the WYDOT Data Broker periodically retrieves road weather forecasts from the Pikalert server. The Pikalert System generates a new forecast for major road ways across the entire state of Wyoming once an hour. A forecast consists of hourly forecasts for each road segment extending out to 72 hours. The Pikalert forecast data includes surface condition forecast data as well as weather forecast data. The DB will be configured to retrieve each of these hourly Pikalert forecasts and save them to the WYDOT Data Warehouse. Other WYDOT applications will retrieve weather forecast data from the Data Warehouse, only the Data Broker will retrieve forecast data directly from Pikalert.

5.27.2.1 External References

- IETF RFC 7230: Hypertext Transfer Protocol (HTTP/1.1)
- netCDF

5.27.2.2 Covered Information Flows

Table 5-48. Flow: WYDOT DB Retrieves road weather forecasts from Pikalert.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**30023, 33011**	**road weather forecasts**	4-4	WYDOT Pikalert System (PA)	WYDOT Data Broker (DB)	WI1

5.27.2.3 Dialogs

5.27.2.3.1 Dialog: WYDOT DB Retrieves road weather forecasts from Pikalert.

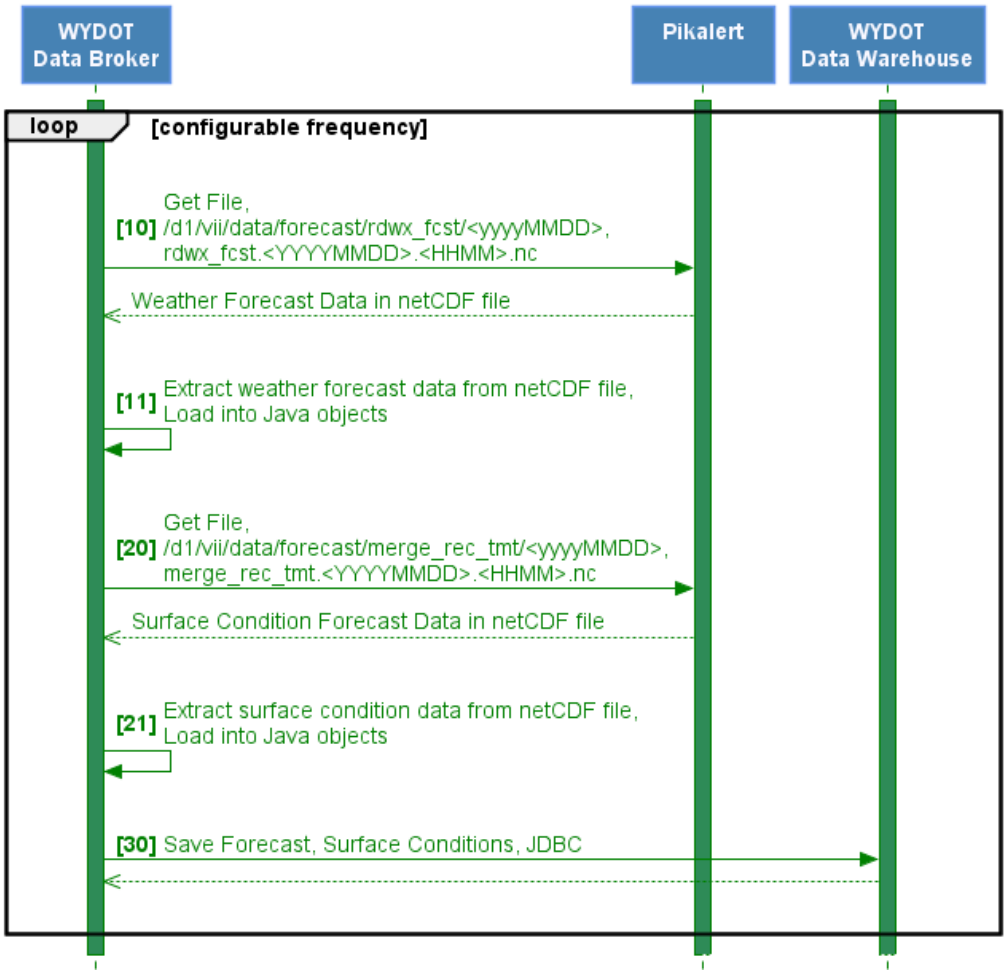


Figure 5-46. Sequence Diagram: WYDOT DB Retrieves road weather forecasts from Pikalert. Source: WYDOT

[10-11] WYDOT Data Broker Copies Weather Forecast data file from Pikalert

The DB will retrieve the latest weather forecast file from the Pikalert server.

[20-21] WYDOT Data Broker Copies Surface Condition Forecast data file from Pikalert

The DB will retrieve the latest surface condition forecast date file from the Pikalert server.

[30] WYDOT Data Broker Archives Forecast Data to Data Warehouse

The Data Broker will save the forecast data from Pikalert to the Data Warehouse.

5.27.2.4 Messages

- Pikalert Weather Forecast Data is defined by the netCDF schemas shown in Section: **7.8.2.1**.

- Pikalert Surface Condition Forecast Data is defined by the netCDF schemas shown in Section: **7.8.2.2**.
- The Oracle schema for the forecast data is shown in Section: **7.8.3**.

5.27.2.5 Data Elements

- There are no optional data elements in this data structure.

5.27.2.6 Requirement Traceability

- WCVS-REQ-5 Forecast Conditions
- WCVS-REQ-5.1 Atmospheric Forecasts
- WCVS-REQ-5.2 Road Weather Forecasts
- WCVS-REQ-6 Associate Alerts and Forecast to Segments
- WCVS-REQ-8 Internal Brokerage
- PA-REQ-4 Distribute Alerts/Advisories and Forecasts
- PA-REQ-4.1 Distribute to DB
- DB-REQ-4 Receive from Pikalert
- DB-REQ-4.2 Receive Forecast

5.28 WYDOT DB <-> WYDOT TRAC

This section describes the interface between the WYDOT Data Broker and the WYDOT TRAC System.

5.28.1 DB Sends Emergency Notification to TRAC

This sub-section describes how Distress Notifications (DNMs) are communicated from the WYDOT DB to the WYDOT Transportation Reports and Action Console (TRAC) system so that emergency response personnel can be notified.

5.28.1.1 External References

- Distress Notification: SAE J3067, SAE J2735, SAE J2540-2

5.28.1.2 Covered Information Flows

Table 5-49. Flow: DB Sends Emergency Notification to TRAC System.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
1	**Shared**	**30007**	**emergency notification**	4-10	WYDOT Data Broker (DB)	WYDOT Transportation Reports and Action Console (TRAC)	WE11

5.28.1.3 Dialogs

5.28.1.3.1 Dialog: DB Sends Emergency Notification to TRAC System.

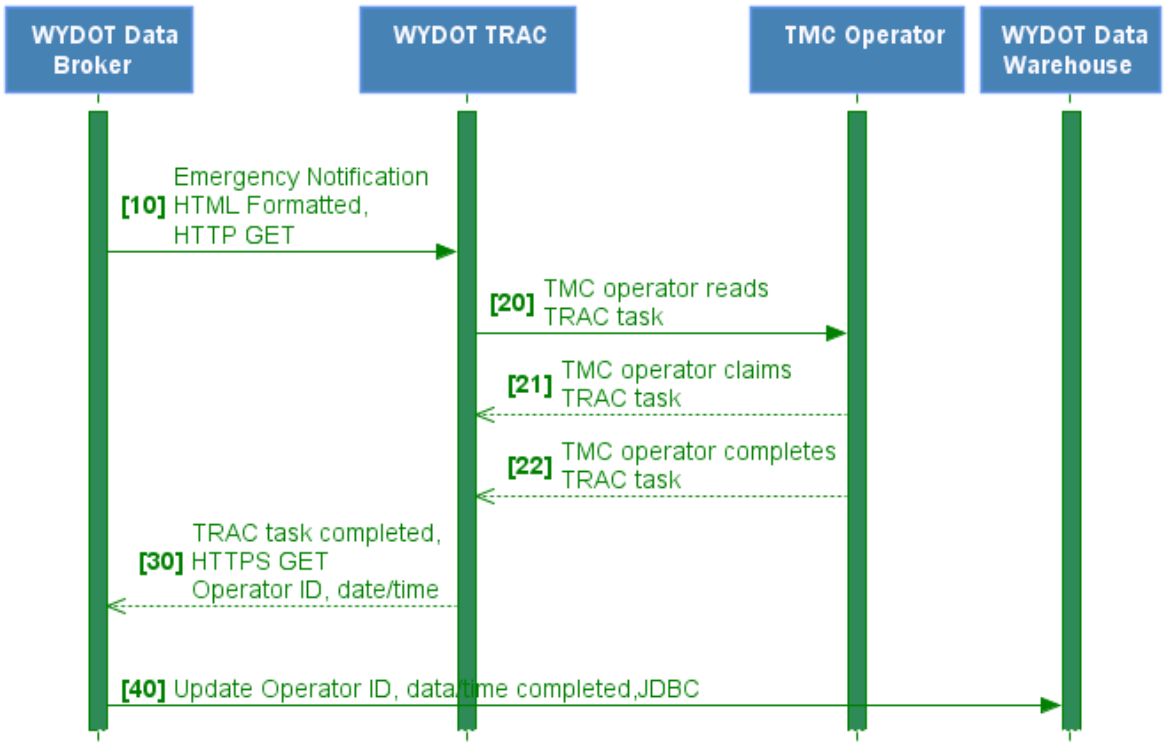


Figure 5-47. Sequence Diagram: DB Sends Emergency Notification to TRAC System. Source: WYDOT

[10] WYDOT Data Broker Sends Emergency Notification Task to TRAC system

The Data Broker performs an HTTP GET with request data containing HTML formatted description of a DNM. The request data also includes a URL which the TRAC system will use to notify the DB when the task is completed.

[20-22] TMC Operator Reads the New Task

The TMC operator reads the new task from the TRAC console. The operator marks the task claimed which associates the task to the operator's ID. The operator then marks the task complete.

[30-40] Data Broker Records the Task Status in Data Warehouse

The Data Broker will save changed status of the Emergency Notification to the Data Warehouse.

5.28.1.4 Messages

- TRAC Message: HTTP GET message containing human readable HTML with query strings: message, source ID, district number, and a callback URL, which is a WYDOT DB REST URL.

5.28.1.5 Data Elements

- There are no optional data elements for this message flow.

5.28.1.6 Requirement Traceability

- TRAC-REQ-1 TRAC Updates
- TRAC-REQ-1.1 Distress Notification
- TRAC-REQ-1.1.1 Transmission Time
- WCVS-REQ-7 External Brokerage
- WCVS-REQ-7.2 Distribute to External Interfaces
- DB-REQ-2 Distribute to External Interfaces

5.28.2 DB Sends Road Weather Alert from Pikalert to TRAC

This existing interface is not being modified.

5.28.2.1 External References

- IETF RFC 7230: Hypertext Transfer Protocol (HTTP/1.1)

5.28.2.2 Covered Information Flows

Table 5-50. Flow: DB sends Road Weather Alerts from Pikalert to TRAC.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33004**	**segment alerts**	4-14	WYDOT Data Broker (DB)	WYDOT Transportation Reports and Action Console (TRAC)	WE11

5.28.2.3 Dialogs

5.28.2.3.1 Dialog: DB sends Road Weather Alerts from Pikalert to TRAC.

The message flows for this interaction are virtually identical to those for DNM notifications in Section: **5.28.1**.

5.28.2.4 Messages

- TRAC Message: HTTP GET message containing human readable HTML with query strings: message, source ID, district number, and a callback URL, which is a WYDOT DB REST URL.

5.28.2.5 Data Elements

- There are no optional data elements.

5.28.2.6 Requirement Traceability

- TRAC-REQ-1 TRAC Updates
- TRAC-REQ-1.2 Segment Alerts
- TRAC-REQ-1.2.1 Transmission Time
- TRAC-REQ-1.2.2 Segment Alerts-Pikalert
- WCVS-REQ-4 Contents of Alerts and Advisories
- WCVS-REQ-4.1 Precipitation Hazard
- WCVS-REQ-4.2 Road Condition Hazard
- WCVS-REQ-4.3 Visibility Hazard
- WCVS-REQ-6 Associate Alerts and Forecast to Segments
- WCVS-REQ-7 External Brokerage
- WCVS-REQ-7.2 Distribute to External Interfaces
- DB-REQ-2 Distribute to External Interfaces

5.29 WYDOT DB <-> WYDOT CVOP

5.29.1 DB sends segment advisories and alerts to CVOP

This existing interface is not being modified.

5.29.1.1 Covered Information Flows

Table 5-51. Flow: WYDOT DB sends advisories to CVOP.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33011**	**segment advisories & alerts**	4-14	WYDOT Data Broker (DB)	WYDOT Commercial Vehicle Operator Portal (CVOP)	WE12

5.29.1.2 Requirement Traceability

- CVOP-REQ-1 CVOP Inputs
- CVOP-REQ-1.1 Current Segment Alerts.
- CVOP-REQ-1.1.1 Transmission Time
- WCVS-REQ-4 Contents of Alerts and Advisories
- WCVS-REQ-4.1 Precipitation Hazard
- WCVS-REQ-4.2 Road Condition Hazard
- WCVS-REQ-4.3 Visibility Hazard
- WCVS-REQ-4.4 Work Zone Hazard
- WCVS-REQ-4.5 Incident Hazard
- WCVS-REQ-4.6 Parking
- WCVS-REQ-6 Associate Alerts and Forecast to Segments
- WCVS-REQ-7 External Brokerage
- WCVS-REQ-7.2 Distribute to External Interfaces
- DB-REQ-2 Distribute to External Interfaces

5.29.2 CVOP Manages Road Weather Forecast Data Using DB

This sub-section describes how the CVOP Desktop application manages road weather forecast data using the WYDOT Data Broker.

A WYDOT meteorologist will use the CVOP desktop application to create published weather forecasts. The CVOP desktop application interfaces with the Data Broker to:

- retrieve Pikalert forecast data (to initialize new pre-published forecast, to view when updating published forecast)
- retrieve published forecast (to view published forecast)
- save published forecast (new or revised published forecast)

5.29.2.1 External References

- IETF RFC 7230: Hypertext Transfer Protocol (HTTP/1.1)

5.29.2.2 Covered Information Flows

Table 5-52. Flow: CVOP Manages Road Weather Forecast Data Using DB.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	**Custom**	**30023, 33011**	**road weather forecasts**	4-4	WYDOT Data Broker (DB)	Commercial Vehicle Operator Portal (CVOP)	WE12
					Commercial Vehicle Operator Portal (CVOP)	WYDOT Data Broker (DB)	WE12

5.29.2.3 Dialogs

5.29.2.3.1 Dialog: CVOP Retrieves the Latest Pikalert Forecast Data from DB.

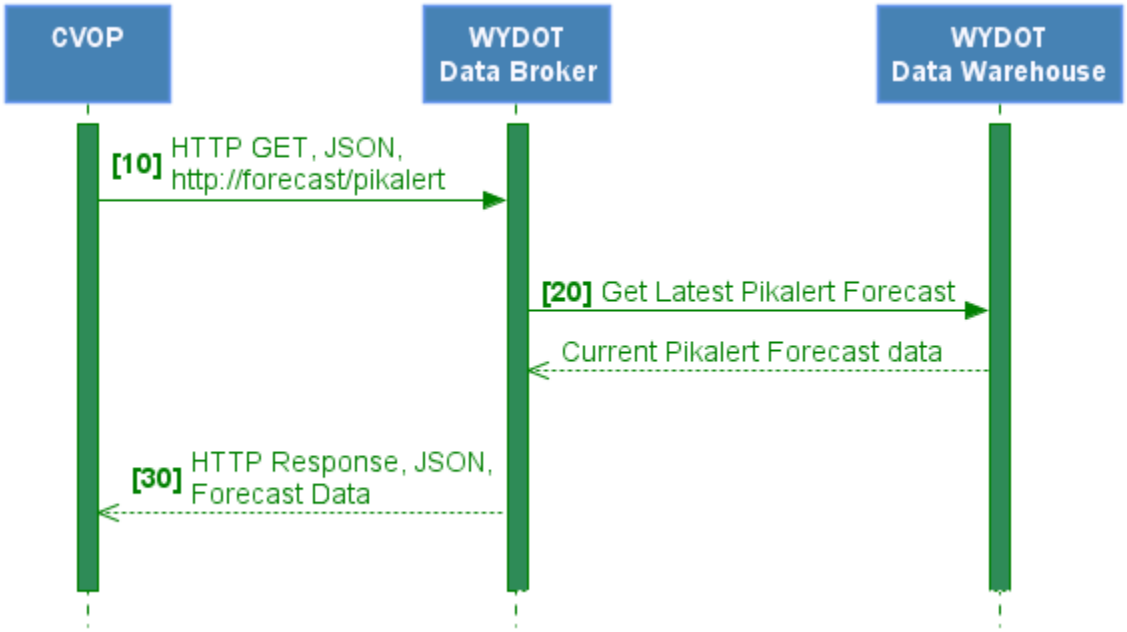


Figure 5-48. Sequence Diagram: CVOP Retrieves the Latest Pikalert Forecast Data from DB. Source: WYDOT

[10] CVOP requests latest Pikalert forecast from DB

The CVOP desktop application requests the latest Pikalert forecast data from DB REST end-point.

[20] The DB retrieves Pikalert forecast data from DW

The DB retrieves the data from the Data Warehouse and formats it into JSON.

[30] WYDOT DB returns forecast data in JSON format

The CVOP receives the HTTP Response containing JSON Forecast data.

5.29.2.3.2 Dialog: CVOP Retrieves the Published Forecast Data from DB.

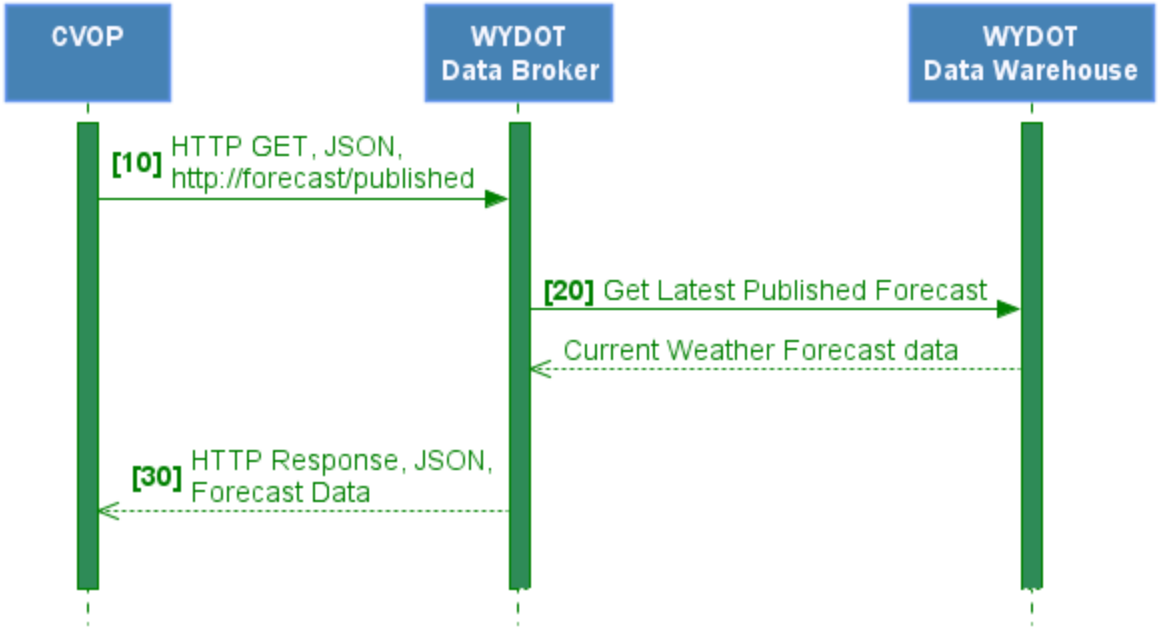


Figure 5-49. Sequence Diagram: CVOP Retrieves the Current, Published Forecast Data from DB. Source: WYDOT

[10] CVOP requests current Published forecast from DB

The CVOP desktop application requests the current Published forecast data from DB REST end-point.

[20] The DB retrieves latest Published forecast data from DW

The DB retrieves the data from the Data Warehouse and formats it into JSON.

[30] WYDOT DB returns forecast data in JSON format

The CVOP receives the HTTP Response containing JSON Forecast data.

5.29.2.3.3 Dialog: CVOP Archives Published Forecast to DW via DB.

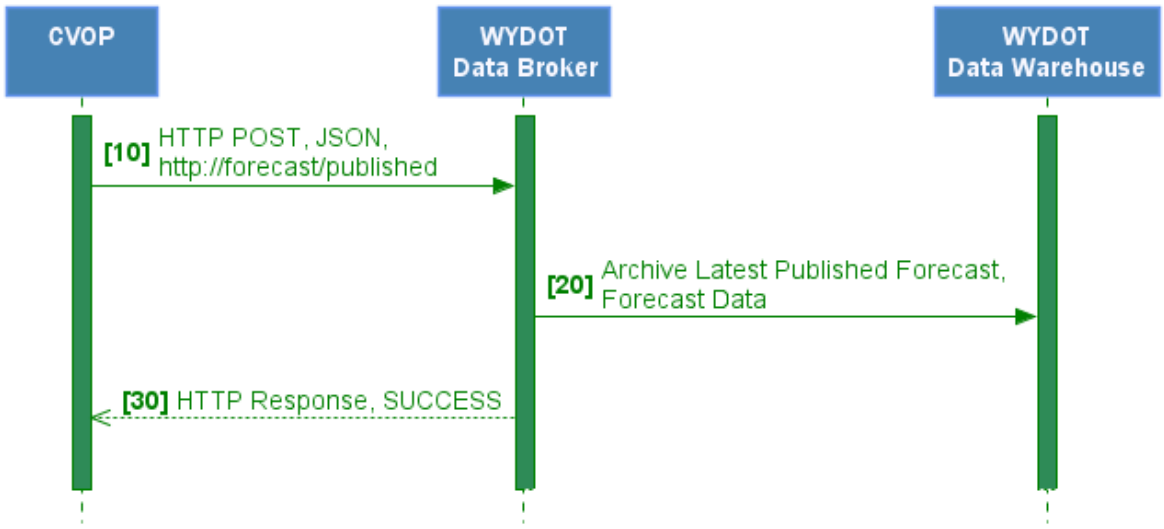


Figure 5-50. Sequence Diagram: CVOP Archives Published Forecast to DW via DB. Source: WYDOT

[10] CVOP sends Published Forecast to DB for archiving

The CVOP desktop application sends the most recent Published forecast to the DB REST end-point.

[20] The DB archives the Published forecast data to the DW

The DB archives the published forecast data to the Data Warehouse.

[30] HTTP success response returned

The CVOP receives successful HTTP Response.

5.29.2.4 Messages

- There are no new message elements.

5.29.2.5 Data Elements

- There are no optional data elements.

5.29.2.6 Requirement Traceability

- CVOP-REQ-1.2 Forecast Segment Alerts
- CVOP-REQ-1.2.1 Forecast Time
- CVOP-REQ-1.2.2 Forecast Update
- WCVS-REQ-7 External Brokerage with WYDOT Interfaces
- WCVS-REQ-7.2 Distribute to WYDOT External Interfaces
- DB-REQ-2 Distribute to External Interfaces

5.30 WYDOT DB <-> WYDOT ITS Maintenance

This section describes the interface between the WYDOT Data Broker and WYDOT ITS Maintenance dispatch.

5.30.1 DB reports malfunctioning RSU to WYDOT ITS

This sub-section describes how the DB sends email notification to ITS Maintenance staff to report a problem with an RSU. Software running on the ODE server will continuously monitor the status of WYDOT RSUs. If the monitoring application is unable to communicate with an RSU or the RSU is malfunctioning, then monitoring application notifies the DB. The DB logs the problem and then sends an email notification to ITS Maintenance Personnel.

5.30.1.1 External References

- SMTP: IETF RFC 5321

5.30.1.2 Covered Information Flows

Table 5-53. Flow: DB reports malfunctioning RSU to ITS Maintenance.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33012**	**system oper status**	4-14	WYDOT Data Broker (DB)	WYDOT ITS Maint	WE13

5.30.1.3 Dialogs

5.30.1.3.1 Dialog: DB Reports Malfunctioning RSU to ITS Maintenance.

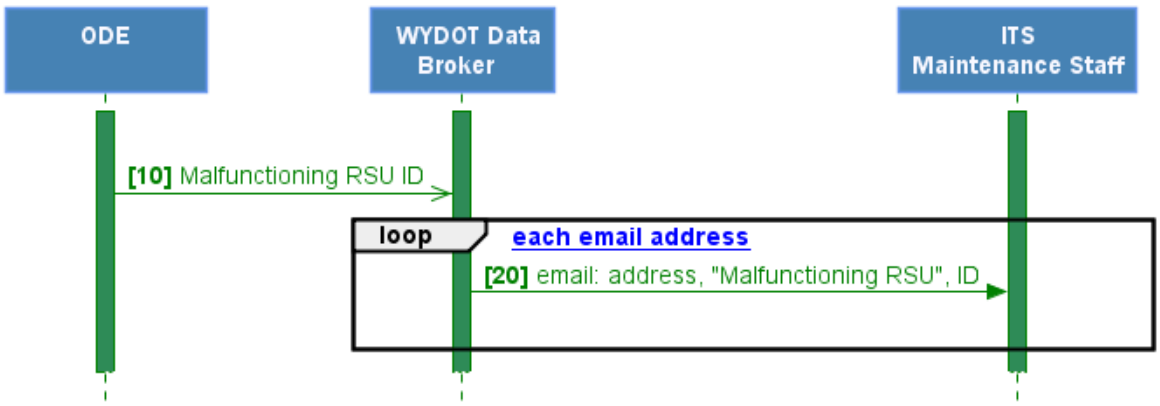


Figure 5-51. Sequence Diagram: DB Reports Malfunctioning RSU to ITS Maintenance. Source: WYDOT

5.30.1.4 Messages

The message in this interface is an email message containing the serial number of a WYDOT RSU.

5.30.1.5 Data Elements

- There are no optional data elements.

5.30.1.6 Requirement Traceability

- ITSM-REQ-1 WYDOT ITS Alerts
- WCVS-REQ-7 External Brokerage
- WCVS-REQ-7.2 Distribute to External Interfaces
- WCVS-REQ-15 Notifications
- DB-REQ-2 Distribute to External Interfaces

5.31 WYDOT DB <-> WYDOT Incident Console IC

This section describes the interface between the WYDOT Data Broker and the WYDOT Incident Console.

5.31.1 WYDOT Incident to the WYDOT DB

Note, this existing interface is not being changed for the WYDOT Pilot. This interface is described to provide context for the new DB behavior where the DB generates TIM messages for some incidents.

This sub-section describes how the WYDOT Incident Console sends incident reports to the DB so they can be translated into TIM messages and be delivered to Connected Vehicles. When new incidents arrive at the WYDOT Traffic Management Center, operators create new incident reports at the Incident Console (IC). Each incident is assigned a unique ID and each incident is stored in the WYDOT Data Warehouse. The IC makes an HTTP POST to the WYDOT Data Broker with the new incident ID, to trigger the DB to generate a TIM. Once the DB generates the TIM it sends the TIM to the ODE, then the ODE is responsible for disseminating the TIM to the WYDOT CV Pilot vehicles via WYDOT RSUs and satellite.

5.31.1.1 External References

- IETF RFC 7230: Hypertext Transfer Protocol (HTTP/1.1)
- REST Service Standards used by WYDOT are described in Section: **6.2.5**.

5.31.1.2 Covered Information Flows

Table 5-54. Flow: WYDOT IC Sends new Incident to WYDOT DB.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
7	**Custom**	**33019**	**incident information**	4-14	WYDOT Incident Console (IC)	WYDOT Data Broker (DB)	WE7

5.31.1.3 Dialogs

There are no additional dialogs specific to the Connected Vehicle project.

5.31.1.4 Messages

There are no additional messages specific to the Connected Vehicle project.

5.31.1.5 Data Elements

There are no additional data elements specific to the Connected Vehicle project.

5.31.1.6 Requirement Traceability

- IC-REQ-1 IC Data Sharing
- IC-REQ-2 Protocol
- IC-REQ-3 Schema
- IC-REQ-4 Transmission
- WCVS-REQ-7 External Brokerage
- WCVS-REQ-7.1 Receive from External Interfaces
- DB-REQ-1 Receive from External Interfaces

5.32 WYDOT DB <-> WYDOT Construction Administration

This section describes the interface between the WYDOT Data Broker and the WYDOT Incident Console.

5.32.1 WYDOT CA sends new construction project to the DB

This sub-section describes how the WYDOT Construction Administration Console reports new construction projects (and project updates) to the DB so they can be translated into TIM messages and be delivered to Connected Vehicles.

WYDOT Traffic Management Center operators enter new construction projects at the WYDOT Construction Administrator Console (ConAdmin). Each construction project is assigned a unique ID and is stored in the WYDOT Data Warehouse. Then ConAdmin HTTP POSTs the construction project's ID to the DB to trigger the DB to generate a TIM which is ultimately delivered to Connected Vehicles.

5.32.1.1 External References

- IETF RFC 7230: Hypertext Transfer Protocol (HTTP/1.1)
- REST Service Standards used by WYDOT are described in Section: **6.2.5**.

5.32.1.2 Covered Information Flows

Table 5-55. Flow: WYDOT CA Sends new Construction Project to DB.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33015**	**Work Zone Field Information**	4-17	WYDOT Construction Administration (CA)	WYDOT Data Broker (DB)	WE8

5.32.1.3 Dialogs

5.32.1.3.1 Dialog: WYDOT CA Creates a new Construction Project.

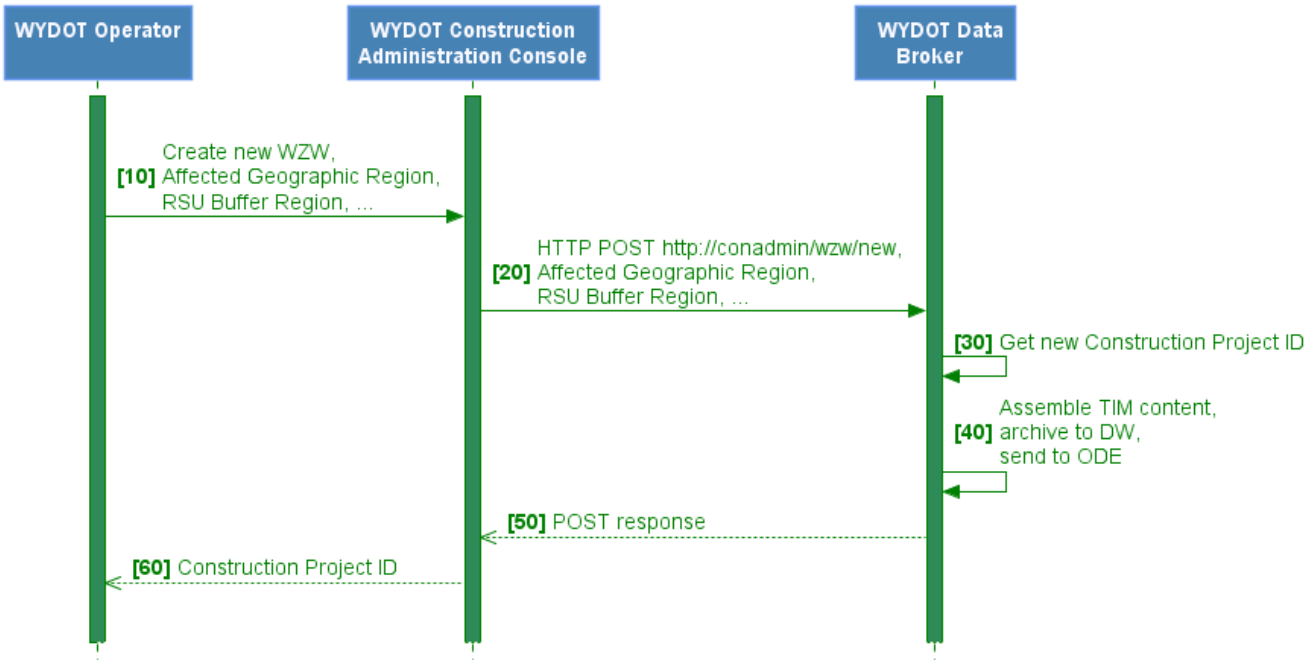


Figure 5-52. Sequence Diagram: WYDOT CA Creates a new Construction Project.
Source: WYDOT

[10-20] Operator Creates a new Construction Project

Operator specifies required fields for a new Construction Project. The application sends a request to DB's REST end point to create the new construction project.

[30-40] Data Broker Creates a new Construction Project and Associated TIM

The Data Broker create a new Construction project, save the details in the Data Warehouse and then trigger the ODE to create a new TIM message which will be sent to RSUs.

5.32.1.4 Messages

- WYDOT Construction Project Fields are defined by their Oracle Table Structure as shown in Section: **7.10.1**. The affected geographic region is defined in the TIM data structure shown in **Table 7-2. Traveler Information Message (TIM) Fields.**

5.32.1.5 Data Elements

- There are no optional data elements for this message flow.

5.32.1.6 Requirement Traceability

- CA-REQ-1 CA Data Sharing

- CA-REQ-2 Protocol
- CA-REQ-3 Schema
- CA-REQ-4 Transmission
- WCVS-REQ-7 External Brokerage
- WCVS-REQ-7.1 Receive from External Interfaces
- DB-REQ-1 Receive from External Interfaces

5.33 WYDOT DB <-> WYDOT RCRS

5.33.1 Plow-Operator Sourced Road Condition and VSL Recommendation Updates to WYDOT Data Broker

Note: There is no change to this existing interface for the WYDOT CV Pilot.

5.33.1.1 External References

The RCRS communicates with the Data Broker using an XML wrapped CSV format via a REST interface over HTTPS with Basic Authentication. The Data Broker sends notifications to RCRS using a TCP socket connection.

The format of the REST messages is described in the WYDOT Data Broker documentation:

- WTI Data Broker REST Services Definition, Version 1, October 10, 2016
- WTIDB RWIS REST Services, Version 1, September 7, 2016

5.33.1.2 Covered Information Flows

Table 5-56. Flow: RCRS to WYDOT DB.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33009**	**plow-operator-sourced updates**	4-14	WYDOT Road Condition Report System (RCRS)	WYDOT Data Broker (DB)	WE6

5.33.1.3 Dialogs

There are no additional dialogs specific to the Connected Vehicle project.

5.33.1.4 Messages

There are no additional messages specific to the Connected Vehicle project.

5.33.1.5 Data Elements

There are no additional data elements specific to the Connected Vehicle project.

5.33.1.6 Requirement Traceability

- RCRS-REQ-1 RCRS Data Sharing
- RCRS-REQ-1.1 Road Condition
- RCRS-REQ-1.2 Weather
- RCRS-REQ-1.3 Other Road Condition
- RCRS-REQ-1.4 Report Time
- RCRS-REQ-1.5 Location
- RCRS-REQ-1.6 Transmit Time
- WCVS-REQ-7 External Brokerage
- WCVS-REQ-7.1 Receive from External Interfaces
- DB-REQ-1 Receive from External Interfaces

5.34 WYDOT DB <-> WYDOT WTI

5.34.1 WYDOT DB Sends Road Weather Advisories and Alerts to WYDOT Traveler Information System

Note: There is no change to this existing interface for the WYDOT CV Pilot. No additional design is being done on this interface.

5.34.1.1 Covered Information Flows

Table 5-57. Flow: WYDOT DB to WTI.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33003**	**advisories & alerts**	4-14	WYDOT Data Broker (DB)	WYDOT Traveler Information System (WTI)	WE9

5.34.1.2 Dialogs

There are no additional dialogs specific to the Connected Vehicle project.

5.34.1.3 Messages

There are no additional messages specific to the Connected Vehicle project.

5.34.1.4 Data Elements

There are no additional data elements specific to the Connected Vehicle project.

5.34.1.5 Requirement Traceability

- WTI-REQ-1 WTI Inputs
- WTI-REQ-1.1 Current Segment Alerts

- WTI-REQ-1.1.1 Transmission Time
- WTI-REQ-1.2 Forecast Segment Alerts
- WTI-REQ-1.2.1 Forecast Time
- WTI-REQ-1.2.2 Forecast Update
- WCVS-REQ-4 Contents of Alerts and Advisories
- WCVS-REQ-4.1 Precipitation Hazard
- WCVS-REQ-4.2 Road Condition Hazard
- WCVS-REQ-4.3 Visibility Hazard
- WCVS-REQ-5 Forecast Conditions
- WCVS-REQ-5.1 Atmospheric Forecasts
- WCVS-REQ-5.2 Road Weather Forecasts
- WCVS-REQ-7 External Brokerage
- WCVS-REQ-7.2 Distribute to External Interfaces
- DB-REQ-2 Distribute to External Interfaces

5.34.2 WTI sends posted speeds, restrictions and closures to WYDOT DB

Note: There is no change to this existing interface for the WYDOT CV Pilot.

5.34.2.1 External References

The WTI is an existing desktop application developed at WYDOT that is used to send road condition information to the WYDOT Data Broker. It communicates with the data broker using XML via a REST interface over HTTPS with Basic Authentication. The Data Broker sends notifications to the WTI using a TCP socket connection.

The format of the REST messages is described in the WYDOT Data Broker documentation:

- WTI Data Broker REST Services Definition, Version 1, October 10, 2016
- WTIDB RWIS REST Services, Version 1, September 7, 2016

5.34.2.2 Covered Information Flows

Table 5-58. Flow: WTI to WYDOT DB.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**33010**	**posted speed, restrictions, closures**	4-14	WYDOT Traveler Information System (WTI)	WYDOT Data Broker (DB)	WE9

5.34.2.3 Dialogs

There are no additional dialogs specific to the Connected Vehicle project.

5.34.2.4 Messages

There are no additional messages specific to the Connected Vehicle project. The messages needs to be built as per section 7.2.1.

5.34.2.5 Data Elements

There are no additional data elements specific to the Connected Vehicle project.

5.34.2.6 Requirement Traceability

- WTI-REQ-2 WTI Outputs
- WTI-REQ-2.1 Posted Speed
- WTI-REQ-2.2 Vehicle Restrictions
- WTI-REQ-2.2.1 Restriction Information
- WTI-REQ-2.2.2 Restriction Start Time
- WTI-REQ-2.3 Posted Messages
- WTI-REQ-2.3.1 Message Information
- WTI-REQ-2.4 Posted Closures
- WTI-REQ-2.4.1 Closure Beginning
- WTI-REQ-2.4.2 Closure End
- WTI-REQ-2.4.3 Closure Start Time
- WCVS-REQ-7 External Brokerage
- WCVS-REQ-7.1 Receive from External Interfaces
- DB-REQ-1 Receive from External Interfaces

5.35 WYDOT Data Broker <-> WYDOT Data Warehouse

This section describes the interface between the WYDOT Data Broker and the WYDOT Data Warehouse.

5.35.1 WYDOT DB Archives TIMs to the WYDOT DW

This sub-section describes how the WYDOT Data Broker (DB) archives newly created TIM messages to the WYDOT Data Warehouse.

The WYDOT Data Broker must archive all TIMs it generates. The DB will generate TIMs in the following situations:

- TRAC system calls for a road weather based alert based on an alert from Pikalert
- Construction Administration Console reports a construction project
- Incident Console (IC) reports a new incident
- WYDOT Traffic Management Center (WTI) issues any of the following
    - a variable speed limit
    - a restriction such as chain requirement
    - a closure such as for high profile vehicles in high wind conditions

5.35.1.1 External References

- Traveler Information Message: SAE J2735, SAE J2540-2
- Java Database Connectivity (JDBC) API: See Section: **6.2.1**.

5.35.1.2 Covered Information Flows

Table 5-59. Flow: WYDOT DB Archives TIMs to WYDOT DW.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30023**	**I2V Situational Awareness TIM (C2C and C2I)**	4-13	WYDOT Data Broker (DB)	WYDOT Data Warehouse (DW)	WI3

5.35.1.3 Dialogs

5.35.1.3.1 Dialog: WYDOT DB Archives TIMs to WYDOT DW.

Data Broker saves a TIM data structure in the Data Warehouse. The TIM is represented by a graph of Java objects and is saved to the table structure in the DW using JDBC.

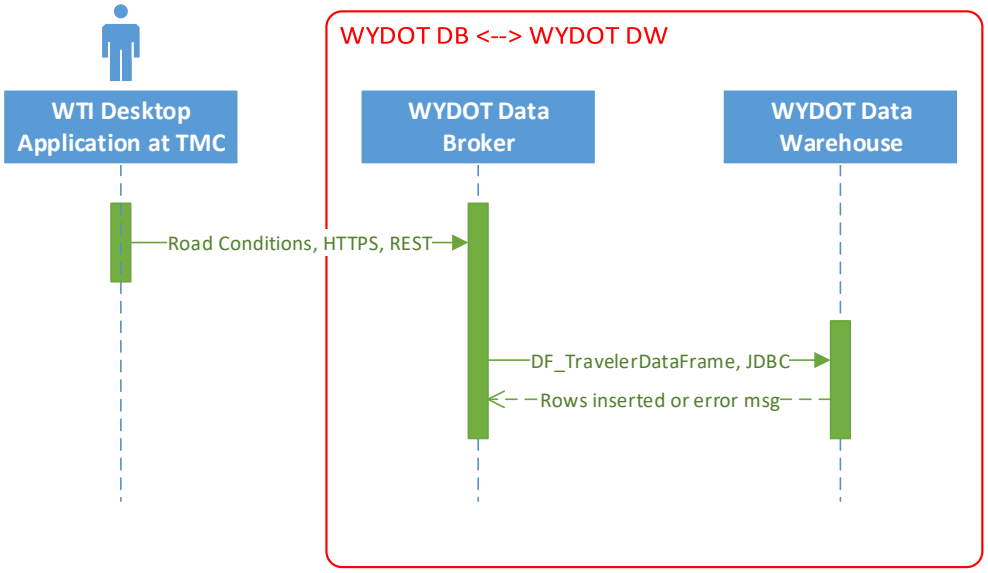


Figure 5-53. Sequence Diagram: WYDOT DB Archives TIMs to WYDOT DW.
Source: WYDOT

5.35.1.4 Messages

- Traveler Information Message: described in Section: **7.2**.
- WYDOT Oracle Tables for TIM message are described in Section: **7.2.2**.

5.35.1.5 Data Elements

- The ITIS codes and content of TIMs varies by type of notification. See **Table 7-2. Traveler Information Message (TIM) Fields**. which shows which fields are used for each different notification type. For the list of ITIS codes used, see Section: **7.4**.

5.35.1.6 Requirement Traceability

- WCVS-REQ-8 Internal Brokerage
- WCVS-REQ-12 Store Generated Alerts/Advisories
- WCVS-REQ-13 Store TIM
- DB-REQ-7 Distribute to Data Warehouse
- DB-REQ-8 Receive Data from DW
- DW-REQ-1 Store Data
- DW-REQ-1.1 Store Alerts/Advisories and Forecasts
- DW-REQ-1.1.1 Store Alerts/Advisories-Precipitation Hazard
- DW-REQ-1.1.2 Store Alerts/Advisories- Road Condition Hazard
- DW-REQ-1.1.3 Store Alerts/Advisories-Visibility Hazard
- DW-REQ-1.1.4 Store Alerts/Advisories-Work Zone Hazard
- DW-REQ-1.1.5 Store Alerts/Advisories-Incident Hazard
- DW-REQ-1.1.6 Store Alerts/Advisories-Parking
- DW-REQ-1.3 Store TIM
- DW-REQ-2.4 Share Data with DB
- DW-REQ-4 Receive Data

5.35.2 WYDOT DB Stores and Retrieves Road Weather Forecasts from WYDOT DW

This sub-section describes how the WYDOT Data Broker stores and retrieves road weather forecasts from the WYDOT DB. Note, these operations occur in response to interactions with Pikalert which are described in Section: 5.27.

5.35.2.1 External References

- IETF RFC 6455
- Java Database Connectivity (JDBC) API: See Section: **6.2.1**.

5.35.2.2 Covered Information Flows

Table 5-60. Flow: WYDOT DB Stores and Retrieves road weather forecasts from Pikalert.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
5	**Custom**	**30023, 33011**	**road weather forecasts**	4-4	WYDOT Data Broker (DB)	WYDOT Data Warehouse (DW)	WI3
					WYDOT Data Warehouse (DW)	WYDOT Data Broker (DB)	WI3

5.35.2.3 Dialogs

Existing interface will not be documented.

5.35.2.4 Messages

Existing interface will not be documented.

5.35.2.5 Data Elements

- There are no optional data elements in this data structure.

5.35.2.6 Requirement Traceability

- WCVS-REQ-5 Forecast Conditions
- WCVS-REQ-5.1 Atmospheric Forecasts
- WCVS-REQ-5.2 Road Weather Forecasts
- WCVS-REQ-5.3 Forecast Time
- WCVS-REQ-5.4 Forecast Update
- WCVS-REQ-8 Internal Brokerage
- DB-REQ-7 Distribute to Data Warehouse
- DB-REQ-8 Receive Data from DW

5.36 WYDOT DW <-> Third Party Interface (TPI)

This section describes the WYDOT Third Party Interface which is a REST service that provides standardized information to third parties regarding WYDOT road conditions, construction projects, incidents, restrictions, variable speed limits, and more.

5.36.1 Third Party retrieves WYDOT traffic and road conditions

The WYDOT Third Party Interface is a password protected REST Service which provides Wyoming traveler information following the TMDD V3.03c standard. This interface draws from information collected by the WYDOT Data Broker, WYDOT Traffic Management Center Incidents Console, WYDOT Traffic Management Center, WYDOT Construction Console and WYDOT Restrictions database. User authentication is based on existing Commercial Vehicle Operator Portal user accounts stored in DW.

5.36.1.1 External References

- Traveler Information Message: SAE J2735, SAE J2540-2.
- TMDD Vol1 v03.03c
- TMDD Vol2 v03.03c
- JSON representation of TMDD data: See Section: **6.3.1**.
- WYDOT REST Services Standards: See Section: **6.2.5**.

5.36.1.2 Covered Information Flows

Table 5-61. Flow: TPI retrieves WYDOT traffic and road conditions from DW.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Number
2	**Shared**	**30034**	**traffic conditions**	4-14	WYDOT Data Warehouse (DW)	WYDOT Third Party Interface (TPI)	WE10

5.36.1.3 Dialogs

5.36.1.3.1 Dialog: WYDOT DW Exports Road & Traffic Conditions.

The WYDOT Data Warehouse exports TMDD data to the TPI every 5 minutes.

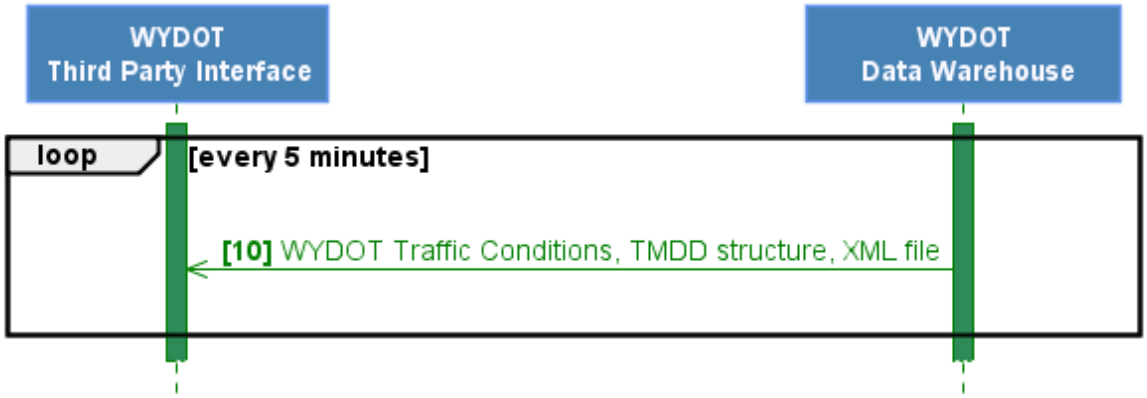


Figure 5-54: Sequence Diagram: WYDOT DW Exports Road & Traffic Conditions.
Source: WYDOT

A stored Oracle procedure is launched to scan for four different data types found in WYDOT's data sources: road conditions, construction projects, incidents and restrictions. Each WYDOT data record is then formatted into XML as a FullEventUpdate data representation as defined in the TMDDv3.03c-Vol2 specification. The complete set of FullEventUpdate data records are then formatted into a single XML elements of type fEUMsg as is defined in the TMDD. The complete XML data stream is then saved as a text file in a fixed location known to the TPI REST end-point. The stored Oracle procedure will run again after a 5-minute pause.

5.36.1.3.2 Dialog: TPI Serves Road & Traffic Conditions.

Third parties request WYDOT TMDD data in Javascript Object Notation (JSON) format by issuing an HTTP GET request to the TPI REST end-point '/tmdd/all'. The diagram below shows the sequence of events. Following the diagram is a detailed description of each of the numbered interactions on the diagram.

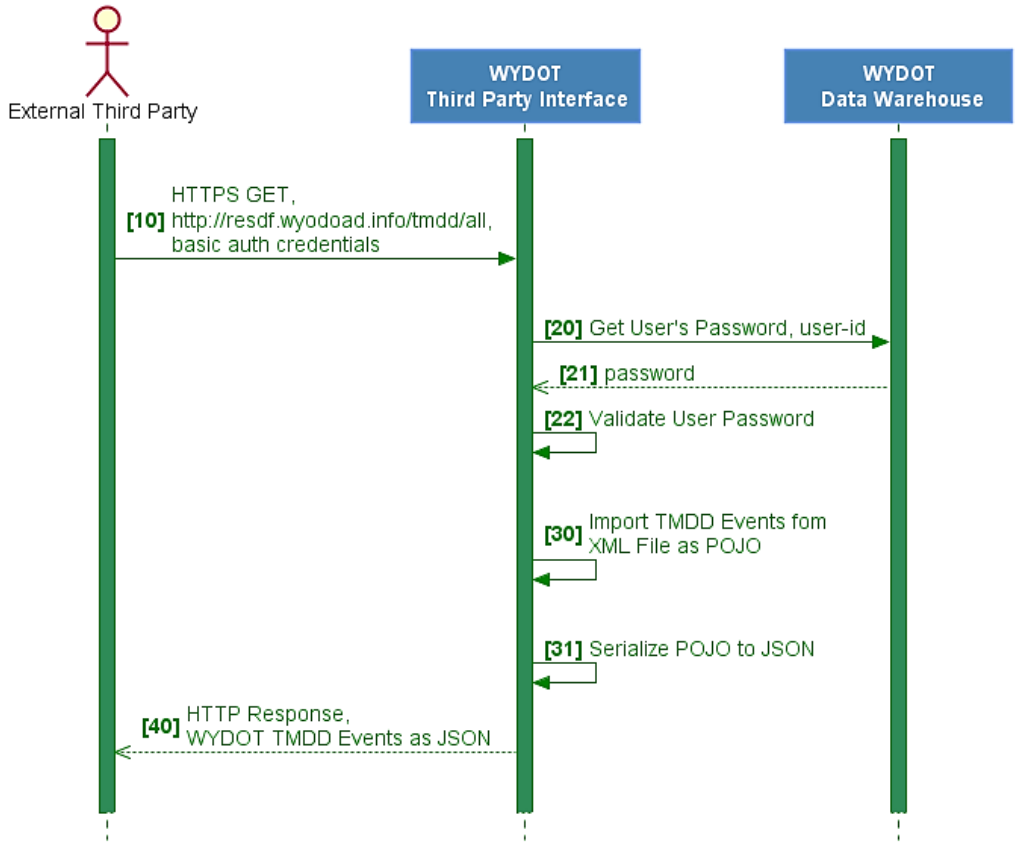


Figure 5-55. Sequence Diagram: TPI Serves Road & Traffic Conditions. Source: WYDOT

[10] Third Party sends HTTP GET request for WYDOT event data

The REST end-point requires Basic Authentication (BA) credentials to retrieve WYDOT TMDD data. Authentication required to access this service leverages existing WYDOT standard for external access. HTTPS (HTTP over SSL) is required to protect the user's authentication credentials. Apache provides base level support for SSL and then uses reverse proxy to invoke the Tomcat Java-Servlet platform which finally launches WYDOT's TPI REST Service.

[20-22] Retrieve password from WYDOT DW

The Tomcat Java-Servlet platform handles the Basic Authentication for the TPI. The Tomcat is configured to access the WYDOT DW as the DataSource for retrieving user credentials.

[30-31] Convert the TMDD fEUMsg from XML into JSON

The TPI calls a standard Java library to convert the fEUMsg XML representation into JSON. The translation from XML to JSON is in accord with the Draft White Paper TMDD JSON-REST v0.4.

[40] HTTP GET Response

If the user was successfully authenticated the HTTP GET response contains a JSON string containing the complete set of WYDOT events.

5.36.1.4 Messages

- TMDD Full Event Update Message Structure: **Table 7-3**.
- Message structure of Conditions & Closures is defined in Section **7.9.1, Oracle Table Structure for Conditions/Closures**
- ITIS codes for Conditions & Closures are defined in Section **7.9.2**,
- Message structure of Construction Projects is defined in Section **7.10.1, Oracle Table Structure for Construction Projects**
- Message structure of Incidents is defined in Section **7.11.1, Oracle Table Structure for Incidents**
- ITIS codes for Incidents defined in Sections **7.11.2, 7.11.3, 7.11.4**
- Message structure of Restrictions is defined in Section **7.12.1, Oracle Table Structure for Restrictions**

5.36.1.5 Data Elements

- The ITIS codes and content of TIMs varies by type of notification. See **Table 7-2. Traveler Information Message (TIM) Fields.** which shows which fields are used for each different notification type. For the list of ITIS codes used, see Section: **7.4**.

5.36.1.6 Requirement Traceability

- WCVS-REQ-7 External Brokerage
- WCVS-REQ-7.2 Distribute to External Interfaces
- TPI-REQ-1 TPI Data
- DW-REQ-2 Share Data
- DW-REQ-2.1 Share Data with TPI

5.37 ODE <-> SDC

This section describes the interface between the ODE and the SDC. This is a WYDOT external interface which operates over the internet. SDC is the external repository of the data for the Independent Evaluators. PII data will be shared from the ODE to the SDC.

5.37.1 ODE publishes CV data containing PII to SDC

This sub-section describes how the ODE interacts with the SDC to publish data such as BSMs, TIMs, and DNM data it receives from Connected Vehicles and RSUs. For the purposes of the ODE, the SDC system is an Amazon S3 cloud storage bucket that is used to store the ingested data. The ODE publishes highly structured data to the SDC using a unique destination bucket for each type of data being uploaded.

A complete list of Amazon S3 ingest folders and data types can be found in Section: **7.14.2**.

Each data type has a well-defined record structure and file format. The interface for uploading data to S3 buckets copies data files from the ODE to a specified bucket beneath the root level ingest folder for SDC.

Amazon provides an SDK for uploading data (files) to S3 buckets. The Amazon SDK implements security and privacy for the upload. Security credentials used by the SDK derive from an Amazon Web Service (AWS) account. The owner of the AWS account manages delegation of security credentials for applications which read or write to the S3 buckets.

The ODE will upload data to the SDC which was obtained from the following sources:

- As vehicles participating in the CV Pilot broadcast BSMs these messages will be captured by nearby RSUs. The RSUs are configured to collect received BSMs into log files and copy them to the ODE server. For more details on this OBU-RSU activity see Section: **5.9.1**.
- Connected Vehicles maintain a rolling log of their own BSMs. These logs are copied up to the ODE as the vehicles pass by. For more details on this OBU-ODE activity see Section: **5.16.1**.
- Connected Vehicles copy logs for received DNMs to the ODE. For more details on OBU-ODE activity see Section: **5.16.1**.
- Vehicle environment sensor data collected by WYDOT Maintenance Vehicles. Logs are copied up to ODE and then to Pikalert. See Section: **5.19.2**.

5.37.1.1 External References

- Amazon S3 cloud storage bucket
- Amazon Security Credentials
- Basic Safety Message: SAE J2735
- Traveler Information Message: SAE J2735, SAE J2540-2
- Distress Notification: SAE J3067, SAE J2735, SAE J2540-2

5.37.1.2 Covered Information Flows

Table 5-62. Flow: ODE Uploads Data File Containing PII to SDC.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	Custom	33013	**Automated upload data containing PII**	4-14	WYDOT ODE	SDC	WE18

5.37.1.3 Dialogs

5.37.1.3.1 Dialog: ODE Uploads Data File Containing PII to SDC.

There is a unique AWS S3 destination bucket for each data type. The upload mechanism for each of these data types is the same except for the source data file name and the destination bucket. The

following sequence diagram shows how the AWS SDK is invoked to upload a data file to an S3 bucket. For a list of the distinct data files and their associated destination S3 buckets see Section: **7.14.2**.

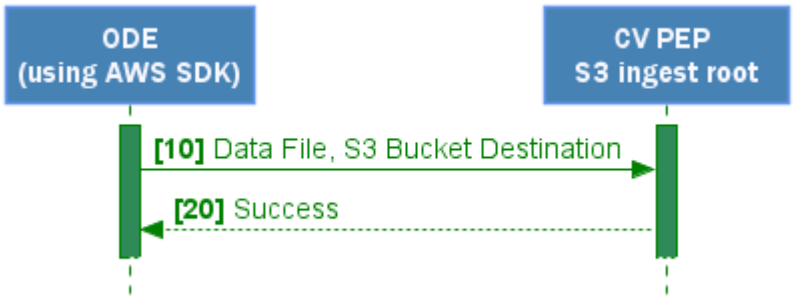


Figure 5-56. Sequence Diagram: ODE Uploads Data File Containing PII to SDC.
Source: WYDOT

The ODE Server writes to the SDC using the S3 Depositor, which is documented here: Uploading Objects, Upload Using Java.

5.37.1.4 Messages

A complete list of Amazon S3 ingest folders and data types can be found in Section: **7.14.2**.

5.37.1.5 Data Elements

- There are no optional data elements for this message flow.

5.37.1.6 Requirement Traceability

- WCVS-REQ-8 Internal Brokerage
- ODE-REQ-3 Distribute Data
- ODE-REQ-3.6 Distribute to SDC
- SDC-REQ-1 Data Provided to the SDC

5.38 WYDOT DW <-> SDC

This section describes the interface between the WYDOT DW and the SDC. This is a WYDOT external interface which operates over the internet. SDC is the external repository of the data for the Independent Evaluators. PII data will be shared from the DW to the SDC.

5.38.1 WYDOT DW publishes CV data containing PII to SDC

This sub-section describes how the WYDOT DW interacts with the SDC to publish data such as Vehicle Speed Data from VSL zones, WYDOT weather forecasts and PIKALERT forecasts. For the purposes of the DW, the SDC system is an Amazon S3 cloud storage bucket that is used to store the ingested data. The DW publishes highly structured data to the SDC using a unique destination bucket for each type of data being uploaded.

A complete list of Amazon S3 ingest folders and data types can be found in Section: **7.14.2**.

Each data type has a defined record structure and file format. The interface for uploading data to S3 buckets copies data files from the DW to a specified bucket beneath the root level ingest folder for SDC.

Amazon provides an SDK for uploading data (files) to S3 buckets. The Amazon SDK implements security and privacy for the upload process. Security credentials used by the SDK derive from an Amazon Web Service (AWS) account. The owner of the AWS account manages delegation of security credentials for applications which read or write to the S3 buckets.

The following sources contribute the data which the DW will be uploading:

- Vehicle speeds logged in VSL zones.
- Weather forecast data from WYDOT meteorologists.
- Weather forecast data from Pikalert.
- Observed weather conditions from RWIS stations and as reported by drivers of WYDOT maintenance vehicles.

5.38.1.1 External References

- Amazon S3 cloud storage bucket
- Amazon Security Credentials

5.38.1.2 Covered Information Flows

Table 5-63. Flow: DW Uploads Data File Containing PII to SDC.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	Custom	33013	**Automated upload data containing PII**	4-14	WYDOT Data Warehouse (DW)	SDC	WE14

5.38.1.3 Dialogs

5.38.1.3.1 Dialog: DW Uploads Data File Containing PII to SDC.

There is a unique AWS S3 destination bucket for each data type. The upload mechanism for each of these data types is the same except for the source data file name and the destination bucket. The following sequence diagram shows how the AWS SDK is invoked to upload a data file to an S3 bucket. For a list of the distinct data files and their associated destination S3 buckets see Section: **7.14.2**.

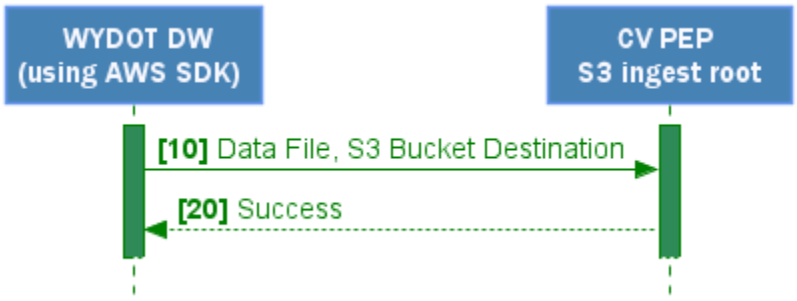


Figure 5-57. Sequence Diagram: DW Uploads Data File Containing PII to SDC.
Source: WYDOT

The WYDOT DW writes to the SDC using the S3 Depositor, which is documented here: Uploading Objects, Upload Using Java.

5.38.1.4 Messages

A complete list of Amazon S3 ingest folders and data types can be found in Section: **7.14.2**.

5.38.1.5 Data Elements

- There are no optional data elements for this message flow.

5.38.1.6 Requirement Traceability

- SDC-REQ-1 Data Provided to the SDC
- DW-REQ-2 Share Data
- DW-REQ-2.2 Share Data with SDC

5.39 WYDOT DB <-> SDC

This section describes the interface between the WYDOT DB and the SDC. This is a WYDOT external interface which operates over the internet. SDC is the external repository of data for Independent Evaluators. The WYDOT DB will occasionally have data relevant to the SDC which is not structured for automated or systematic uploading. PII data will be shared from the DB to the SDC.

5.39.1 WYDOT DB Manually Uploads data to SDC

This sub-section describes how the WYDOT DB interacts with the SDC to upload data such as accident report statistics. For the purposes of this interface, the SDC is an Amazon S3 cloud storage bucket that is used to store the ingested data. The DB manually publishes non-structured data to the SDC either in situations where the data is infrequently published or when the data cannot efficiently be structured.

Manually uploaded data is classified as data that will be uploaded by individuals at the pilot site. This data may not be well structured or have a consistent file format. Some of this data may be in complex file formats that are difficult to process by means of simple ETL logic systems. These manual uploads also may be prone to errors such as incorrect upload location, incomplete time stamp information, etc.

A list of currently known data which will be manually uploaded to the SDC is shown in Section: ***7.14.3***.

The following sources contribute the data which the DB will upload:

- crash data
- Observed weather conditions from RWIS stations and as reported by drivers of WYDOT maintenance vehicles.
- variable speed data
- surveys
- interviews

5.39.1.1 External References

- Amazon S3 cloud storage bucket
- Amazon Security Credentials

5.39.1.2 Covered Information Flows

Table 5-64. Flow: WYDOT DB Manually Uploads Data Containing PII to SDC.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	**Custom**	**33013**	**Manual upload data containing PII**	4-14	WYDOT Data Broker (DB)	SDC	WE21

5.39.1.3 Dialogs

5.39.1.3.1 Dialog: WYDOT DB Manually Uploads Data Containing PII to SDC.

Data to be uploaded will be copied to a monitored directory. When data files are detected, the monitoring application will upload the files to the AWS S3 bucket.

There is a unique AWS S3 destination bucket for each data type. The upload mechanism for each of these data types is the same except for the source data file name and the destination bucket. The following sequence diagram shows how the AWS SDK is invoked to upload a data file to one an S3 buckets. For a list of the distinct data files and their associated destination S3 buckets see Section: ***7.14.3***.

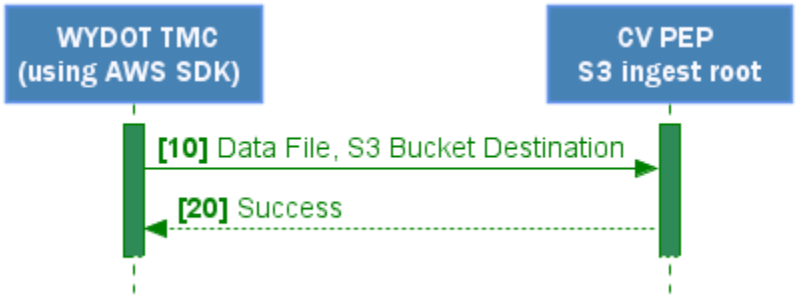


Figure 5-58. Sequence Diagram: WYDOT DB Manually Uploads Data Containing PII to SDC. Source: WYDOT

The WYDOT DB writes to the SDC using the S3 Depositor, which is documented here: Uploading Objects, Upload Using Java.

5.39.1.4 Messages

A list of currently known data which will be manually uploaded to the SDC is shown in Section: ***7.14.3***.

5.39.1.5 Data Elements

- There are no optional data elements for this message flow.

5.39.1.6 Requirement Traceability

- SDC-REQ-1 Data Provided to the SDC
- DB-REQ-9 Distribute to SDC

5.40 ODE <-> Research Data Exchange (RDE)

This section describes the interface between the ODE and the Research Data Exchange (RDE). This is a WYDOT external interface which operates over the internet. RDE is the external repository of the data for the public research community. No PII data will be uploaded to the RDE.

5.40.1 ODE Publishes CV data without PII to RDE

This sub-section describes how the ODE interacts with the RDE to publish data such as BSMs, TIMs, and DNM data it receives from Connected Vehicles and RSUs. All data uploaded to the RDE will be scrubbed of any PII. For the purposes of the ODE, the RDE system is an Amazon S3 cloud storage bucket that is used to store the ingested data. The ODE publishes highly structured data to the RDE using a unique destination bucket for each type of data being uploaded.

A complete list of Amazon S3 ingest folders and data types can be found in Section: **7.15.2**.

Each data type has a defined record structure and file format. The interface for uploading data to S3 buckets copies data files from the ODE server to a specified bucket beneath the root level ingest folder for RDE. Amazon provides an SDK for uploading data (files) to S3 buckets. The Amazon SDK implements security and privacy for the upload process. Security credentials used by the SDK derive from an Amazon Web Service (AWS) account. The owner of the AWS account manages delegation of security credentials for applications which read or write to the S3 buckets.

The following sources contribute the data which the ODE will be archiving:

- As vehicles participating in the CV Pilot broadcast BSMs these messages will be captured by nearby RSUs. The RSUs are configured to collect received BSMs into log files and copy them to the ODE server. For more details on this OBU-RSU activity see Section: **5.9.1**.

5.40.1.1 External References

- Amazon S3 cloud storage bucket
- Amazon Security Credentials
- Basic Safety Message: SAE J2735
- Traveler Information Message: SAE J2735, SAE J2540-2
- Distress Notification: SAE J3067, SAE J2735, SAE J2540-2

5.40.1.2 Covered Information Flows

Table 5-65. Flow: ODE Publishes non-PII Data to RD.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	**Custom**	**33013**	**Automated upload data without PII**	4-14	WYDOT ODE	RDE	WE19

5.40.1.3 Dialogs

5.40.1.3.1 Dialog: ODE Publishes non-PII Data to RDE.

There is a unique AWS S3 destination bucket for each data type. Non-PII data is defined in the Security Management Operating Concept document section 7.4.1. The upload mechanism for each of these data

types is the same except for the source data file name and the destination bucket. The following sequence diagram shows how the AWS SDK is invoked to upload a data file to one an S3 buckets. For a list of the distinct data files and their associated destination S3 buckets see Section: **7.15.2**.

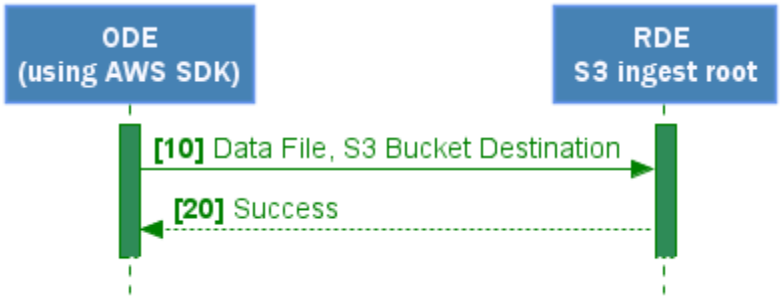


Figure 5-59. Sequence Diagram: ODE Publishes non-PII Data to RDE.
Source: WYDOT

The ODE Server writes to the RDE using the S3 Depositor, which is documented here: Uploading Objects, Upload Using Java.

5.40.1.4 Messages

A complete list of Amazon S3 ingest folders and data types are show in Section: **7.15.2**.

5.40.1.5 Data Elements

There are no optional data elements for this message flow defined in section 5.40.1.3.1.

5.40.1.6 Requirement Traceability

- RDE-REQ-1 Data Provided to the RDE
- ODE-REQ-3 Distribute Data
- ODE-REQ-3.7 Distribute to RDE

5.41 WYDOT DW <-> Research Data Exchange (RDE)

This section describes the interface between the WYDOT DW and the RDE. This is a WYDOT external interface which operates over the internet. RDE is the external repository of the data for public research community. No PII data will be uploaded to the RDE.

5.41.1 WYDOT DW publishes CV data without PII to RDE

This sub-section describes how the WYDOT DW interacts with the RDE to publish data such as Vehicle Speed Data from VSL zones, WYDOT weather forecasts and PIKALERT forecasts. All data uploaded to the RDE will be scrubbed of any PII. For the purposes of the DW, the RDE system is an Amazon S3 cloud storage bucket that is used to store the ingested data. The DW publishes highly structured data to the RDE using a unique destination bucket for each type of data being uploaded.

A complete list of Amazon S3 ingest folders and data types can be found in Section: **7.15.2**.

Each data type has a defined record structure and file format. The interface for uploading data to S3 buckets copies data files from the DW to a specified bucket beneath the root level ingest folder for RDE.

Amazon provides an SDK for uploading data (files) to S3 buckets. The Amazon SDK implements security and privacy for the upload process. Security credentials used by the SDK derive from an Amazon Web Service (AWS) account. The owner of the AWS account manages delegation of security credentials for applications which read or write to the S3 buckets.

The following sources contribute the data which the DW will be archiving:

- Vehicle speeds logged in VSL zones.
- Weather forecast data from WYDOT meteorologists.
- Weather forecast data from Pikalert.
- Observed weather conditions from RWIS stations and as reported by drivers of WYDOT maintenance vehicles.

5.41.1.1 External References

- Amazon S3 cloud storage bucket
- Amazon Security Credentials

5.41.1.2 Covered Information Flows

Table 5-66. Flow: DW Publishes non-PII Data to RDE.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	**Custom**	**33013**	**Automated upload data without PII**	4-14	WYDOT Data Warehouse (DW)	RDE	WE20

5.41.1.3 Dialogs

5.41.1.3.1 Dialog: DW Publishes non-PII Data to RDE.

There is a unique AWS S3 destination bucket for each data type. Non-PII data is defined in the Security Management Operating Concept document section 7.4.1. The upload mechanism for each of these data types is the same except for the source data file name and the destination bucket. The following sequence diagram shows how the AWS SDK is invoked to upload a data file to one an S3 buckets. For a list of the distinct data files and their associated destination S3 buckets see Section: **7.15.2**.

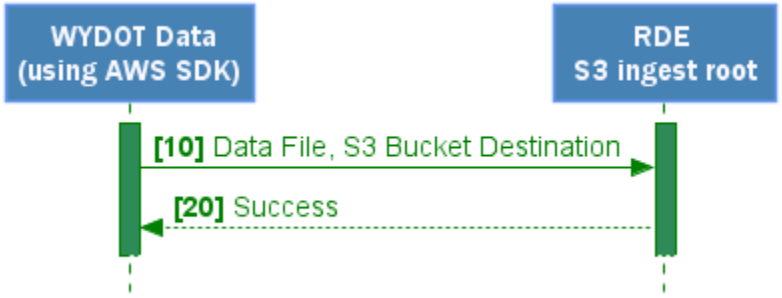


Figure 5-60. Sequence Diagram: DW Publishes non-PII Data to RDE.
Source: WYDOT

The DW writes to the RDE using the S3 Depositor, which is documented here: Uploading Objects, Upload Using Java.

5.41.1.4 Messages

A complete list of Amazon S3 ingest folders and data types can be found in Section: **7.15.2**.

5.41.1.5 Data Elements

- There are no optional data elements for this message flow defined in section **5.41.1.3.1** of this document.

5.41.1.6 Requirement Traceability

- RDE-REQ-1 Data Provided to the RDE
- DW-REQ-2 Share Data
- DW-REQ-2.3 Share Data with RDE

5.42 WYDOT DB <-> RDE

This section describes the interface between the WYDOT DB and the Research Data Exchange (RDE). This is a WYDOT external interface which operates over the internet. The RDE is the external repository of the data for the public research community. The WYDOT DB will occasionally have data relevant to the RDE which is not structured for automated or systematic uploading. No PII data will be shared from the DB to the RDE.

5.42.1 WYDOT DB Manually Publishes data to RDE

This sub-section describes how the WYDOT DB interacts with the RDE to upload data such as variable speed statistics. For the purposes of this interface, the RDE is an Amazon S3 cloud storage bucket that is used to store the ingested data. The DB manually publishes non-structured data to the RDE either in situations where the data is infrequently published or when the data cannot efficiently be structured.

Manually uploaded data is classified as data that will be uploaded by individuals at the pilot site. This data may not be well structured or have a consistent file format. Some of this data may be in complex file formats that are difficult to process by means of simple ETL logic systems. These manual uploads also may be prone to errors such as incorrect upload location, incomplete time stamp information, etc.

A list of currently known data which will be manually uploaded to the RDE is shown in Section: ***7.15.3***.

5.42.1.1 External References

- Amazon S3 cloud storage bucket
- Amazon Security Credentials

5.42.1.2 Covered Information Flows

Table 5-67. Flow: WYDOT DB Manually Publishes non-PII Data to RDE.

Interop Cat Num	Shared / Custom	Instance ID	Flow Name	Fig. Num	Source Element	Destination Element	WYDOT Interface Num
5	**Custom**	**33013**	**Manual upload data without PII**	4-14	WYDOT Data Broker (DB)	RDE	WE22

5.42.1.3 Dialogs

5.42.1.3.1 Dialog: WYDOT DB Manually Publishes non-PII Data to RDE.

Data to be uploaded will be copied to a monitored directory. When data files are detected, the monitoring application will upload the files to the AWS S3 bucket.

There is a unique AWS S3 destination bucket for each data type. The upload mechanism for each of these data types is the same except for the source data file name and the destination bucket. The following sequence diagram shows how the AWS SDK is invoked to upload a data file to one an S3 buckets. For a list of the distinct data files and their associated destination S3 buckets see Section: ***7.15.3***.

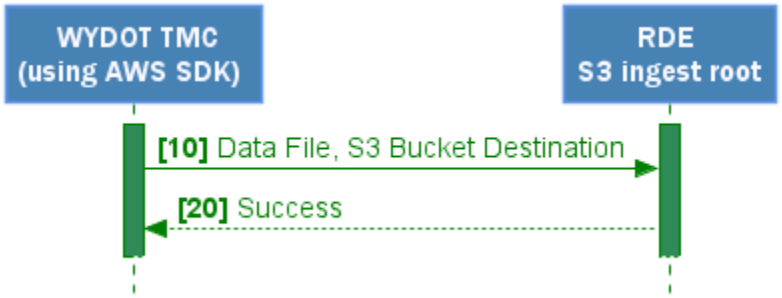


Figure 5-61. Sequence Diagram: WYDOT DB Manually Publishes non-PII Data to RDE. Source: WYDOT

The WYDOT DB writes to the RDE using the S3 Depositor, which is documented here: Uploading Objects, Upload Using Java.

5.42.1.4 Messages

A complete list of Amazon S3 ingest folders and data types are show in Section: ***7.15.3***.

5.42.1.5 Data Elements

- There are no optional data elements for this message flow.

5.42.1.6 Requirement Traceability

- RDE-REQ-1 Data Provided to the RDE

6 Standards Plan

6.1 Standards Use Summary

This section provides the high-level list of the standards used by WYDOT CV Pilot Deployment. This highlights the Connected Vehicle (CV) and Intelligent Transportation Systems (ITS) standards and any other Center to Center standards. This is displayed in a table that lists the Section 5.X Interfaces in one column and the standards used by that interface in a separate column.

Table 6-1. Standards Used.

Section	Flow & Data	Standards
5.1.1	OBU<->OBU, broadcast & receive BSMs	SAE J2735 SAE J3067 ISO 11898-1 ISO 15628 SAE J2945/1 IEEE 802.11p IEEE 1609.3 IEEE 1609.2
5.1.2	OBU<->OBU, broadcast and receive DNM	EEE 1609.2 ISO 15628 SAE J2735 SAE J2945/1 SAE J3067 IEEE 802.11p IEEE 1609.3 SAE J2540-2 ISO 11898-1
5.2.1	Vehicle Driver<->OBU, input non-DN	SAE J2735 ISO/TC 145 SAE J2831 ISO 15006 Protobuf2
5.2.2	Vehicle Driver<->OBU, Drive declares Distress Situation	SAE J3067 SAE J2735 SAE J2540-2 IEEE 1609.2 ISO/TC 145 SAE J2831 ISO 15006 Protobuf2

Section	Flow & Data	Standards
5.2.3	OBU<->Vehicle Driver, Alert Distressed Vehicle	SAE J3067 SAE J2735 SAE J2540-2 ISO/TC 145 SAE J2831 ISO 15006 Protobuf2
5.2.4	OBU<->Vehicle Driver, notify non-DN	SAE J2735 ISO/TC 145 SAE J2831 ISO 15006 Protobuf2
5.3.1	VLT<->OBU, location & time	SAE J2735SAE J2945/1
~~5.4.1~~	~~CAN bus<->OBU, trigger DN~~	~~SAE J2735~~ ~~ISO 11898-1~~ ~~SAE J3067~~ ~~SAE J2735~~ ~~SAE J2540-2~~
~~5.4.2~~	~~CAN bus<->OBU, report CAN data~~	~~SAE J2735~~ ~~ISO 11898-1~~
5.5.1	MV Environmental Sensors<->WYDOT MV, GroundTruth Android Application Function	Bluetooth 4.2
5.6.1	CMV Driver PID<->Vehicle Driver, Driver enters parking data	None
5.7.1	CMV Driver PID<->WYDOT 511, send parking data	None
5.8.1	WYDOT 511<->WYDOT DB, send parking data	None
5.9.1	OBU<->RSU, OBU broadcasts BSM	SAE J2735 IEEE 1609.2 ISO 15628 SAE J2945/1 SAE J3067 IEEE 802.11p IEEE 1609.3 RSU v4.1
5.9.2	RSU<->OBU, RSU broadcasts TIM	SAE J2735 SAE J2540-2 IEEE 1609.2 ISO 15628 SAE J2945/1 SAE J3067 IEEE 802.11p IEEE 1609.3 RSU v4.1
5.9.3	OBU<->RSU, OBU Utilizes RSU Broadcast SCMS Services	SAE J2735 IEEE 802.11p IEEE 1609.2 IEEE 1609.3 IEEE 1609.4 IETF RFC 2460 IETF RFC 793 RSU v4.1

Section	Flow & Data	Standards
5.10.1	RSU<->FLTS, location & time	RSU v4.1 SAE J2945/1
5.11.1	RSU<->NTP, NTP time	IETF RFC 5905 RSU v4.1
5.12.1	NTP<->ODE, time	IETF RFC 5905
5.13.1	SCMS<->OBU, OBU Device Enrollment	IEEE 802.11p IEEE 1609.2 IEEE 1609.3 IEEE 1609.4 IETF RFC 2460 IETF RFC 793
5.13.2	SCMS<->OBU, Pseudonym Certificate Provisioning	IEEE 802.11p IEEE 1609.2 IEEE 1609.3 IEEE 1609.4 IETF RFC 2460 IETF RFC 793
5.13.3	SCMS<->OBU, OBU Security Policy and Networking Information	IEEE 802.11p IEEE 1609.2 IEEE 1609.3 IEEE 1609.4 IETF RFC 2460 IETF RFC 793
5.13.4	SCMS<->OBU, OBU Misbehavior Reporting	IEEE 802.11p IEEE 1609.2 IEEE 1609.3 IEEE 1609.4 IETF RFC 2460 IETF RFC 793
5.13.5	SCMS<->OBU, OBU Security Credential Revocations	IEEE 802.11p IEEE 1609.2 IEEE 1609.3 IEEE 1609.4 IETF RFC 2460 IETF RFC 793
5.14.1	SCMS <->RSU, RSU Device Enrollment	IEEE 1609.2 RSU v4.1
5.14.2	SCMS<->RSU, RSU Application Certificate Provisioning	IEEE 1609.2 RSU v4.1 IETF RFC 2818 IETF RFC 7525
5.14.3	SCMS<->RSU, RSU Security Policy and Networking Information	EEE 1609.2 RSU v4.1 IETF RFC 2818 IETF RFC 7525
5.14.4	SCMS<->RSU, RSU Misbehavior Reporting	EEE 1609.2 RSU v4.1 IETF RFC 2818 IETF RFC 7525
5.14.5	SCMS<->RSU, RSU Security Credentials Revocations	EEE 1609.2 RSU v4.1 IETF RFC 2818 IETF RFC 7525

Section	Flow & Data	Standards
5.15.1	ODE<->HSM, HSM signs TIMs	
5.16.1	OBU<->ODE, Copy Logs to ODE	SAE J2735 IEEE 1609.2 ISO 15628 SAE J2945/1 SAE J3067 IEEE 802.11p IEEE 1609.3 IEEE 1609.4 RSU v4.1 IETF RFC 2460 IETF 5781 IETF 4253
5.16.2	OBU<->ODE, ODE Updates OBU Firmware OTA	SAE J2735 IEEE 1609.2 ISO 15628 SAE J2945/1 SAE J3067 IEEE 802.11p IEEE 1609.3 IEEE 1609.4 RSU v4.1 IETF RFC 2460 IETF 5781 IETF 4253
5.17.1	ODE<->WY Maintenance Vehicle, weather environmental data	IEEE 1609.2 ISO 15628 SAE J2735 SAE J2945/1 SAE J3067 IEEE 802.11p IEEE 1609.3 IEEE 1609.4 RSU v4.1 IETF RFC 2460 IETF 5781 IETF 4253
5.18.1	RSU<->ODE, RSU Sends Traffic Situation Data to the ODE	SAE J2735 SAE J3067 SAE J2945/1 IEEE 802.11p RSU v4.1 IEEE 1609.2
5.18.2	ODE<->RSU, TIM	SAE J2735 SAE J2540-2 RSU v4.1 IETF RFC 3411 IETF RFC 3418

Section	Flow & Data	Standards
5.19.1	ODE<->Pikalert System, ODE Sends Vehicle Environmental Data to Pikalert System	SAE J2735 SAE J3067 SAE J2540-2 ISO 11898-1 SAE J2945/1 IEEE 1609.4 IEEE 802.11p IEEE 1609.2 RSU v4.1
5.19.2	ODE<->Pikalert System, ODE Sends Weather Environmental Situation Data to Pikalert System	None
5.20.1	ODE<->WYDOT Data Warehouse, Traffic Situation Data	SAE J2735 SAE J2540-2 SAE J3067 IEEE 1609.2
5.20.2	ODE<->WYDOT Data Warehouse, ODE Sends Environmental Sensor Data to WYDOT DW	IETF RFC 6455
5.21.1	ODE<->WYDOT DB, DNM	SAE J2735 SAE J3067 SAE J2540-2
5.21.2	ODE<->WYDOT DB, TIM	SAE J2735 SAE J2540-2 RSU v4.1
5.22.1	ODE<->SDX, TIM	SAE J2735 SAE J2540-2 RSU v4.1 IETF RFC 6455
5.23.1	SDX<->SATELLITE, TIM	None
5.24.1	SATELLITE<->OBU, TIM	SEMI_ASN.1 SEMI v2.3.0 ASN.1 SAE J2735 SAE J2540-2 IEEE 1609.2
5.24.2	SATELLITE<->OBU, CRL	IEEE 1609.2 SAE J2945/1
5.25.1	Pikalert System<->Weather Sources, Weather Data	None
5.26.1	Pikalert <-> TMC FTP Server, Pikalert Retrieves Camera Images from	IETF RFC 959
5.27.1	Pikalert <-> WYDOT DB, Road Weather Alerts	IETF RFC 7230
5.27.2	Pikalert <-> WYDOT DB, Road Weather Forecasts	IETF RFC 7230 NetCDF
5.28.1	WYDOT DB <-> WYDOT TRAC, DNM	SAE J2735 SAE J3067 SAE J2540-2
5.28.2	WYDOT DB <-> WYDOT TRAC, Segment Alert	IETF RFC 7230
5.29.1	WYDOT DB <-> WYDOT CVOP, Segment Advisories	None
5.29.2	WYDOT DB <-> WYDOT CVOP, CVOP Manages Road Weather Forecast Data Using DB	IETF RFC 7230
5.30.1	WYDOT DB <-> WYDOT ITS Maintenance, RSU alert	IETF RFC 5321
5.31.1	WYDOT Incident Console (IC)<->WYDOT DB, Incident	IETF RFC 7230

Section	Flow & Data	Standards
5.32.1	WYDOT DB <-> WYDOT Construction Administration, New Construction	IETF RFC 7230
5.33.1	WYDOT DB <->WYDOT RCRS , RCRS report	None
5.34.1	WYDOT DB<->WYDOT WTI, WYDOT DB Sends Road Weather Advisories and Alerts to WYDOT Traveler Information System	IETF RFC 7230
5.34.2	WYDOT DB<->WYDOT WTI, WTI sends posted speeds, restrictions and closures to WYDOT DB	IETF RFC 7230
5.35.1	WYDOT DB<->WYDOT DW, TIM	SAE J2735 SAE J2540-2
5.35.2	WYDOT DB<->WYDOT DW, Weather Forecasts	IETF RFC 6455
5.36.1	WYDOT DW<->TPI, FEUMsg	SAE J2735 SAE J2540-2 TMDD Vol1 v03.03c TMDD Vol2 v03.03c
5.37.1	ODE<->SDC, ODE publishes CV data containing PII to SDC	IETF 5246 AWS S3
5.38.1	WYDOT DW<->SDC, WYDOT DW publishes CV data containing PII to SDC	IETF 5246 AWS S3
5.39.1	WYDOT DB<->SDC, WYDOT DB Manually Uploads data to SDC	IETF 5246 AWS S3
5.40.1	ODE<->RDE, ODE Publishes CV data without PII to RDE	IETF 5246 AWS S3
5.41.1	WYDOT DW<->RDE, WYDOT DW publishes CV data without PII to RDE	IETF 5246 AWS S3
5.42.1	WYDOT DB<->RDE, WYDOT DB Manually Publishes data to RDE	IETF 5246 AWS S3

6.2 WEB Services Standards

6.2.1 Java Standards

WYDOT servers write to the WYDOT Data Warehouse using the Java Database Connectivity (JDBC) API, which is documented here:
http://download.oracle.com/otndocs/jcp/jdbc-4_2-mrel2-spec/index.html

6.2.2 Web Sockets

ODE uses WebSocket interface which is a standards-based protocol defined in RFC 6455 (https://tools.ietf.org/html/rfc6455) to deposit TIMs to the SDX.

6.2.3 Single Sign-on (SSO)

SDX uses open source, single sign-on (SSO) software to authenticate users of their web applications. Here are links to the software description and download https://www.apereo.org/projects/cas and the source can be downloaded from here: https://github.com/apereo/cas.

6.2.4 Kafka Standard Usage

Kafka is a top level Apache project. The APIs and security model are documented at the following location: https://kafka.apache.org/.

6.2.5 REST Service Standards

WYDOT implements multiple web applications following the RESTful[7] model. Such web services are commonly called REST services or REST end-points. Strictly speaking representational state transfer (REST) or RESTful Web services are not based on a formal standard, rather a REST-compliant Web service is one which provides access to textual representations of Web resources using a predefined set of stateless operations.

WYDOT REST Services Documentation:

- WTI Data Broker REST Services Definition, Version 1, October 10, 2016
- WTIDB RWIS REST Services, Version 1, September 7, 2016

The following Java frameworks are used by WYDOT web applications:

- RESTEasy[8] framework.
- The RESTEasy framework runs within a Tomcat[9] Java-Servlet[10] platform.
- The Tomcat platform optionally integrates with an Apache[11] web server which serves as the front-end Web presence in the case of public internet sites.

The Java application code uses the following standard, open source libraries:

- json-20151123.jar (http://www.JSON.org/)
- log4j-api-2.5.jar (https://logging.apache.org/log4j/2.x/)
- Java Architecture for XML Binding (JAXB) (http://www.oracle.com/technetwork/articles/javase/index-140168.html)

6.3 Standards Gaps

This section highlights interfaces that should be standardized, but have no standard yet, or have standards that require additional clarity or maturation. This includes specific references to the relevant interface. It also lists the user needs or use cases that are driving the requirements and functionality for that interface.

6.3.1 JSON Representation of TMDD Messages

M. Insignares & P. Chan have written a draft white paper which describes a recommendation for translating TMDD messages from XML into JSON.

[7] https://en.wikipedia.org/wiki/Representational_state_transfer
[8] http://resteasy.jboss.org/
[9] http://tomcat.apache.org/
[10] https://jcp.org/en/jsr/detail?id=340
[11] https://httpd.apache.org/

TMDD data produced by REST Interfaces in the WYDOT CV Pilot follows the TMDD V3.03c standard and is translated into JSON per the guidance presented in the following white paper: DRAFT White Paper TMDD JSON-REST v0.4 - 2016-08-06.docx

6.3.2 Distress Notification

The use of the Distress Notification uses the TIM message from J2735 but differs in implementation. The ODE is broadcasting the TIM rather than the traditional RSU. This is built based on the J3067 Mayday request and Mayday relay.

6.4 Non-standardized Interfaces

This section lists any interfaces that are not using standards and/or interfaces that are only partially implementing a standard. Each interface in this list should explain why it is not using a standard or why it is not completely following a standard.

The WYDOT CV Pilot team is extending the use of the TIM messages to broadcast (rather than just receive) at the RSU, this interface is still using the standard TIM message.

The WYDOT CV Pilot team is using the standard ITIS codes for TMDD but presenting them through a JSON RESTful interface rather than WSDL.

6.5 Standards Development Organization (SDO) Outreach

This section outlines the WYDOT CV Pilot plans for providing feedback to the relevant SDOs and equivalent organizations. This includes SDO Working Groups engaged, time frame planned to engage them and what is planned to provide feedback. Feedback includes: recommended changes to existing user needs, requirements or design elements; new user needs and requirements; or the creation of a new standard.

The WYDOT CV Pilot plans to work with SAE to present the Distress Notification (with geo dissemination) as a consideration for extending the use of the TIM messages for OBU broadcasting in specific area of traffic incidence. This process has already begun and will continue with the publishing of this ICD and the accompanied SDD details.

The WYDOT CV Pilot is currently working with the TMDD Steering Committee on the implementation of JSON and REST for TMDD Messages and Dialogs. This includes source code for this team's implementation as well as documentation of the solution.

7 Message Spreadsheets

7.1 Basic Safety Message (BSM)

Connected V2V safety applications are built around the capability to transmit BSMs, following the Society of Automotive Engineers (SAE) J2735 standard along with additional performance requirements in SAE 2945/1. The BSM is transmitted over DSRC over a range of approximately 300 meters. In general, BSMs are broadcast frequently to provide connected vehicles with data content necessary for the different safety-oriented applications. The BSM is divided into two parts:

- Part I, transmitted approximately 10 times per second, contains the core data elements: Message Count, Temporary ID, Time (through a Second Mark), Latitude, Longitude, Elevation, Positional Accuracy, Transmission State, Speed, Heading, Steering Wheel Angle, Acceleration, Brake System Status, and Vehicle Size.
- Part II is always added to Part I

Key sub sections of SAE J2735 include:

- Section 5.2 Message: MSG_BasicSafetyMessage (BSM)
- Section 6.8 Data Frame: DF_BSMCoreData
- Section 6.128 Data Frame: DF_SpecialVehicleExtensions
- Section 6.133 Data Frame: DF_SupplementalVehicleExtensions
- Section 6.148 Data Frame: DF_VehicleSafetyExtensions

Key sub sections of SAE J2945/1 include:

- Section 6.2 Positioning and Timing Requirements (POSTIM)

7.1.1 ASN.1 Structure of Basic Safety Message (BSM)

The following table shows the fields from the J2735, Message: MSG_BasicSafetyMessage (BSM).

Heading Descriptions for Table 7-1:

1. WYDOT: Indicates if the field is used by WYDOT Pilot.
2. Field Name: Field name from SAE J2735.
3. Field Type: Field type from SAE J27365.
4. ASN.1 Structural Type: ASN.1 structural type: Ex. OPTIONAL, Sequence, Choice, etc.
5. ASN.1 Primitive Type: ASN.1 primitive data type.
6. WYDOT Comments: Comments about specific WYDOT usage of the field.

Table 7-1: BSM Message Fields

WY	Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
yes	BasicSafetyMessage	MSG_BasicSafetyMessage			
yes	coreData	BSMcoreData	SEQUENCE		
yes	msgCnt	MsgCount		INTEGER (0..127)	
yes	id	TemporaryID		OCTET STRING (SIZE (4))	
yes	secMark	DSecond		INTEGER (0..65535)	
yes	lat	Latitude		INTEGER (-900000000..900000001)	
yes	long	Longitude		INTEGER (-1799999999..1800000001)	
yes	elev	Elevation		INTEGER (-4096..61439)	
yes	accuracy	PositionalAccuracy	SEQUENCE		
yes	semiMajor	SemiMajorAxisAccuracy		INTEGER (0..255)	
yes	semiMinor	SemiMinorAxisAccuracy		INTEGER (0..255)	
yes	orientation	SemiMajorAxisOrientation		INTEGER (0..65535)	
yes/CAN	transmission	TransmissionState		ENUMERATED (0..7)	when available, based on CAN and vendor data access
yes	speed	Speed		INTEGER (0..8191)	
yes	heading	Heading		INTEGER (0..28800)	
yes/CAN	angle	SteeringWheelAngle		INTEGER (-126..127)	set to unavailable
yes	accelSet	AccelerationSet4Way	SEQUENCE		
yes	long	Acceleration		INTEGER (-2000..2001)	
yes	lat	Acceleration		INTEGER (-2000..2001)	
yes	vert	VerticalAcceleration		INTEGER (-127..127)	
yes	yaw	YawRate		INTEGER (-32767..32767)	
yes/CAN	brakes	BrakeSystemStatus	SEQUENCE		when available, based on CAN and vendor data access
yes/CAN	wheelBrakes	BrakeAppliedStatus		BIT STRING (SIZE (5))	when available, based on CAN and vendor data access
yes/CAN	traction	TractionControlStatus		ENUMERATED (0..3)	when available, based on CAN and vendor data access
yes/CAN	abs	AntiLockBrakeStatus		ENUMERATED (0..3)	when available, based on CAN and vendor data access
yes/CAN	scs	StabilityControlStatus		ENUMERATED (0..3)	when available, based on CAN and vendor data access
yes/CAN	brakeBoost	BrakeBoostApplied		ENUMERATED (0..2)	set to unavailable
yes/CAN	auxBrakes	AuxiliaryBrakeStatus		ENUMERATED (0..3)	set to unavailable
yes	Size	VehicleSize	SEQUENCE		
yes	width	VehicleWidth		INTEGER (0..1023)	
yes	length	VehicleLength		INTEGER (0..4095)	
	partII	PartIIcontent {{ BSMpartIIExtension }}	SEQUENCE (SIZE (1..8))		

WY	Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
yes	partII-Id	PartII-Id		INTEGER (0..63)	
yes	partII-Value	BSMpartIIExtension		IDENTIFIED BY partII-Id	
yes	vehicleSafetyExt	VehicleSafetyExtensions	SEQUENCE	IDENTIFIED BY partII-Id = vehicleSafetyExt	
yes	events	VehicleEventFlags		BIT STRING (SIZE (13, ...))	use imu for hard braking over .4 g's
yes	pathHistory	PathHistory	SEQUENCE		
no	initialPosition	FullPositionVector	SEQUENCE		
no	utcTime	DDateTime	SEQUENCE		
no	year	DYear			
no	month	DMonth			
no	day	DDay			
no	hour	DHour			
no	minute	DMinute			
no	second	DSecond			
no	offset	DOffset			
no	long	Longitude			
no	lat	Latitude			
no	elevation	Elevation			
no	heading	Heading		INTEGER (0..28800)	
no	speed	TransmissionAndSpeed	SEQUENCE		
no	transmission	TransmissionState		SEQUENCE	
no	speed	Velocity			
no	posAccuracy	PositionalAccuracy	SEQUENCE		
no	semiMajor	SemiMajorAxisAccuracy		SEQUENCE	
no	semiMinor	SemiMinorAxisAccuracy		INTEGER (0..255)	
no	orientation	SemiMajorAxisOrientation		INTEGER (0..65535)	
no	timeConfidence	TimeConfidence		ENUMERATED (0..39)	
no	posConfidence	PositionConfidenceSet	SEQUENCE		
no	pos	PositionConfidence		ENUMERATED (0..15)	
no	elevation	ElevationConfidence		ENUMERATED (0..15)	
no	speedConfidence	SpeedandHeadingandThrottleConfidence	SEQUENCE		
no	heading	HeadingConfidence		ENUMERATED (0..7)	
no	speed	SpeedConfidence		ENUMERATED (0..7)	
no	throttle	ThrottleConfidence		ENUMERATED (0..3)	
no	currGNSSstatus	GNSSStatus		BIT STRING (SIZE (8))	
yes	crumbData	PathHistoryPointList	SEQUENCE (SIZE (1..23))		
yes	crumbData[n]	PathHistoryPoint	SEQUENCE		
yes	latOffset	OffsetLL-B18		INTEGER (-131072..131071)	
yes	lonOffset	OffsetLL-B18		INTEGER (-131072..131071)	
yes	elevationOffset	VertOffset-B12		INTEGER (-2048..2047)	

WY	Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
yes	timeOffset	TimeOffset		INTEGER (1..65535)	
no	speed	Speed		INTEGER (0..8191)	
no	posAccuracy	PositionalAccuracy	SEQUENCE		
no	semiMajor	SemiMajorAxisAccuracy		INTEGER (0..255)	
no	semiMinor	SemiMinorAxisAccuracy		INTEGER (0..255)	
no	orientation	SemiMajorAxisOrientation		INTEGER (0..65535)	
no	heading	CoarseHeading		INTEGER (0..240)	
yes	pathPrediction	PathPrediction	SEQUENCE		
yes	radiusOfCurve	RadiusOfCurvature		INTEGER (-32767..32767)	
yes	confidence	Confidence		INTEGER (0..200)	
yes/CAN	lights	ExteriorLights		BIT STRING (SIZE (9, …))	
yes	specialVehicleExt	SpecialVehicleExtensions	SEQUENCE	IDENTIFIED BY partII-Id = specialVehicleExt	
no	vehicleAlerts	EmergencyDetails			
no	sspRights	SSPindex		INTEGER (0..31)	
no	sirenUse	SirenInUse		ENUMERATED (0..3)	
no	lightsUse	LightbarInUse		ENUMERATED (0..7)	
no	multi	MultiVehicleResponse		ENUMERATED (0..3)	
no	events	PrivilegedEvents	SEQUENCE		
no	sspRights	SSPindex		INTEGER (0..31)	
no	event	PrivilegedEventFlags		BIT STRING (SIZE (16))	
no	responseType	ResponseType		ENUMERATED (0..6)	
no	description	EventDescription	SEQUENCE		
no	typeEvent	ITIS.ITIScodes		ITIScodes	
no	description	ITIS.ITIScodes	SEQUENCE (SIZE(1..8)	ITIScodes	
no	priority	Priority		OCTET STRING (SIZE(1)	
no	heading	HeadingSlice		BIT STRING	
no	extent	Extent		ENUMERATED	
no	regional		SEQUENCE (SIZE(1..4))		
no	regional[n]	RegionalExtension {{REGION.Reg-EventDescription}}			
yes	trailers	TrailerData	SEQUENCE		
yes	sspRights	SSPindex		INTEGER (0..31)	
yes	connection	PivotPointDescription	SEQUENCE		
yes/driver	pivotOffset	Offset-B11		INTEGER (-1024..1023)	
yes/driver	pivotAngle	Angle		INTEGER (0..28800)	
yes/driver	pivots	PivotingAllowed		BOOLEAN	
yes	units	TrailerUnitDescriptionList	SEQUENCE (SIZE(1..8))		
yes	units[n]	TrailerUnitDescription	SEQUENCE		
yes/driver	isDolly	IsDolly		BOOLEAN	

WY	Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
yes/driver	width	VehicleWidth		INTEGER (0..1023)	
yes/driver	length	VehicleLength		INTEGER (0..4095)	
yes/driver	height	VehicleHeight		INTEGER (0..127)	
no	mass	TrailerMass		INTEGER (0..255)	
no	bumperHeights	BumperHeights	SEQUENCE		
no	front	BumperHeight		INTEGER (0..127)	
no	rear	BumperHeight		INTEGER (0..127)	
no	centerOfGravity	VehicleHeight		INTEGER (0..127)	
no	frontPivot	PivotPointDescription	SEQUENCE		
no	pivotOffset	Offset-B11		INTEGER (-1024..1023)	
no	pivotAngle	Angle		INTEGER (0..28800)	
no	pivots	PivotingAllowed		BOOLEAN	
no	rearPivot	PivotPointDescription	SEQUENCE		
no	pivotOffset	Offset-B11		INTEGER (-1024..1023)	
no	pivotAngle	Angle		INTEGER (0..28800)	
no	pivots	PivotingAllowed		BOOLEAN	
no	rearWheelOffset	Offset-B12		INTEGER (-2048..2047)	
no	positionOffset	Node-XY-24b	SEQUENCE		
no	x	Offset-B12		INTEGER (-2048..2047)	
no	y	Offset-B12		INTEGER (-2048..2047)	
no	elevationOffset	VertOffset-B07		INTEGER (-64..63)	
no	crumbData	TrailerHistoryPointList	SEQUENCE (SIZE (1..23))		
no	crumbData[n]	TrailerHistoryPoint			
no	pivotAngle	Angle		INTEGER (0..28800)	
no	timeOffset	TimeOffset		INTEGER (0..65535)	
no	positionOffset	Node-XY-24b	SEQUENCE		
no	x	Offset-B12		INTEGER (-2048..2047)	
no	y	Offset-B12		INTEGER (-2048..2047)	
no	elevationOffset	VertOffset-B07		INTEGER (-64..63)	
no	heading	CoarseHeading		INTEGER (0..240)	
yes	supplementalVehicleExt	SupplementalVehicleExtensions	SEQUENCE	IDENTIFIED BY partII-Id = supplementalVehicleExt	
no	classification	BasicVehicleClass		INTEGER (0..255)	HPMS
yes	classDetails	VehicleClassification			
no	keyType	BasicVehicleClass		INTEGER (0..255)	
optional	role	BasicVehicleRole		ENUMERATED (0..22)	
no	iso3883	Iso3833VehicleType		INTEGER (0..100)	
yes/driver	hpmsType	VehicleType		ENUMERATED (0..15)	
no	vehicleType	ITIS.VehicleGroupAffected		ENUMERATED (9217..9251)	

WY	Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
no	responseEquip	ITIS.IncidentResponseEquipment		ENUMERATED (9985..10113)	
no	responderType	ITIS.ResponderGroupAffected		ENUMERATED (9729..9742)	
no	fuelType	FuelType		INTEGER (0..15)	
no	regional		SEQUENCE (SIZE (1..4))		
no	regional[n]	RegionalExtension {{ REGION.Reg-VehicleClassification }}	SEQUENCE		
no	vehNumber				
yes	vehicleData	VehicleData	SEQUENCE		
yes/driver	height	VehicleHeight		INTEGER (0..127)	
no	bumpers	BumperHeights	SEQUENCE		
no	front	BumperHeight		INTEGER (0..127)	
no	rear	BumperHeight		INTEGER (0..127)	
optional/driver	mass	VehicleMass		INTEGER (0..255)	
optional/driver	trailerWeight	TrailerWeight		INTEGER (0..64255)	
no	weatherReport	WeatherReport	SEQUENCE		
no	isRaining	NTCIP.EssPrecipYesNo		ENUMERATED (1..3)	
no	rainRate	NTCIP.EssPrecipRate		INTEGER (0..65535)	
no	precipSituation	NTCIP.EssPrecipSituation		ENUMERATED (1..15)	
no	solarRadiation	NTCIP.EssSolarRadiation		INTEGER (0..65535)	
no	friction	NTCIP.EssMobileFriction		INTEGER (0..101)	
no	roadFriction	CoefficientOfFriction		INTEGER (0..50)	
no	weatherProbe	WeatherProbe	SEQUENCE		
no	airTemp	AmbientAirTemperature		INTEGER (0..191)	
no	airPressure	AmbientAirPressure		INTEGER (0..255)	
no	rainRates	WiperSet	SEQUENCE		
no	statusFront	WiperStatus		ENUMERATED (0..6)	
no	rateFront	WiperRate		INTEGER (0..127)	
no	statusRear	WiperStatus		ENUMERATED (0..6)	
no	rateRear	WiperRate		INTEGER (0..127)	
no	obstacle	ObstacleDetection	SEQUENCE		
no	obDist	ObstacleDistance		INTEGER (0..32767)	
no	obDirect	ObstacleDirection		INTEGER (0..28800)	
no	description	ITIS.ITIScodes(523..541)			
no	locationDetials	ITIS.GenericLocations			
no	dateTime	DDateTime			
no	year	DYear		INTEGER (0..4095)	
no	month	DMonth		INTEGER (0..12)	
no	day	DDay		INTEGER (0..31)	
no	hour	DHour		INTEGER (0..31)	
no	minute	DMinute		INTEGER (0..60)	

WY	Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
no	second	DSecond		INTEGER (0..65535)	
no	offset	DOffset		INTEGER (-840..840)	
no	vertEvent	VerticalAccelerationThreshold		BIT STRING (SIZE (5))	
no	status	DisabledVehicle	SEQUENCE		
no	statusDetails	ITIS.ITIScodes (523..541)			
no	locationDetails	ITIS.GenericLocations			
no	speedProfile	SpeedProfile	SEQUENCE		
no	speedReports	SpeedProfileMeasurementList	SEQUENCE (SIZE (1..20))		
no	speedReports[n]	GrossSpeed		INTEGER (0..31)	
no	theRTCM	RTCMPackage	SEQUENCE		
no	rtcmHeader	RTCMheader	SEQUENCE		
no	status	GNSSstatus		BIT STRING (SIZE (8))	
no	offsetSet	AntennaOffsetSet	SEQUENCE		
no	antOffsetX	Offset-B12		INTEGER (-2048..2047)	
no	antOffsetY	Offset-B09		INTEGER (-256..255)	
no	antOffsetZ	Offset-B10		INTEGER (-512..511)	
no	msgs	RTCMmessageList	SEQUENCE (SIZE (1..5))		
no	msgs[n]	RTCMmessage		OCTET STRING (SIZE (1..1023))	
no	regional		SEQUENCE (SIZE (1..4))		
no	regional[n]	RegionalExtension {{ REGION.Reg-SupplementalVehicleExtensions }}			
no	regional		SEQUENCE (SIZE(1..4))		
no	regional[n]	RegionalExtension {{ REGION.Reg-BasicSafetyMessage }}			

7.1.2 Oracle Tables for BSM Part I

The following shows the organization of WYDOT Data Warehouse's Oracle Database for storing BSM Part I messages.

BSM_CORE_DATA	
PK	**BSM_CORE_DATA_ID [NUMBER(10)]**
	ID [VARCHAR2(255)]
	MSGCNT [NUMBER(10)]
	SECMARK [NUMBER(10)]
	POSITION_LAT [NUMBER(38)]
	POSITION_LONG [NUMBER(38)]
	POSITION_ELEV [NUMBER(38)]
	ACCELSET_ACCELLAT [NUMBER(38)]
	ACCELSET_ACCELLONG [NUMBER(38)]
	ACCELSET_ACCELVERT [NUMBER(38)]
	ACCELSET_ACCELYAW [NUMBER(38)]
	ACCURACY_SEMIMAJOR [NUMBER(38)]
	ACCURACY_SEMIMINOR [NUMBER(38)]
	ACCURACY_ORIENTATION [NUMBER(38)]
	TRANSMISSION [VARCHAR2(20)]
	SPEED [NUMBER(38)]
	HEADING [NUMBER(38)]
	ANGLE [NUMBER(38)]
	BRAKES_WHEELBRAKES [VARCHAR2(1000)]
	BRAKES_TRACTION [VARCHAR2(255)]
	BRAKES_ABS [VARCHAR2(255)]
	BRAKES_SCS [VARCHAR2(255)]
	BRAKES_BRAKEBOOST [VARCHAR2(255)]
	BRAKES_AUXBRAKES [VARCHAR2(255)]
	SIZE_LENGTH [NUMBER(10)]
	SIZE_WIDTH [NUMBER(10)]

Figure 7-1. BSM Part I Oracle Data Table. (Source: WYDOT)

7.1.3 Oracle Tables for BSM Part II

The following shows the organization of WYDOT Data Warehouse's Oracle Database for storing BSM Part II messages.

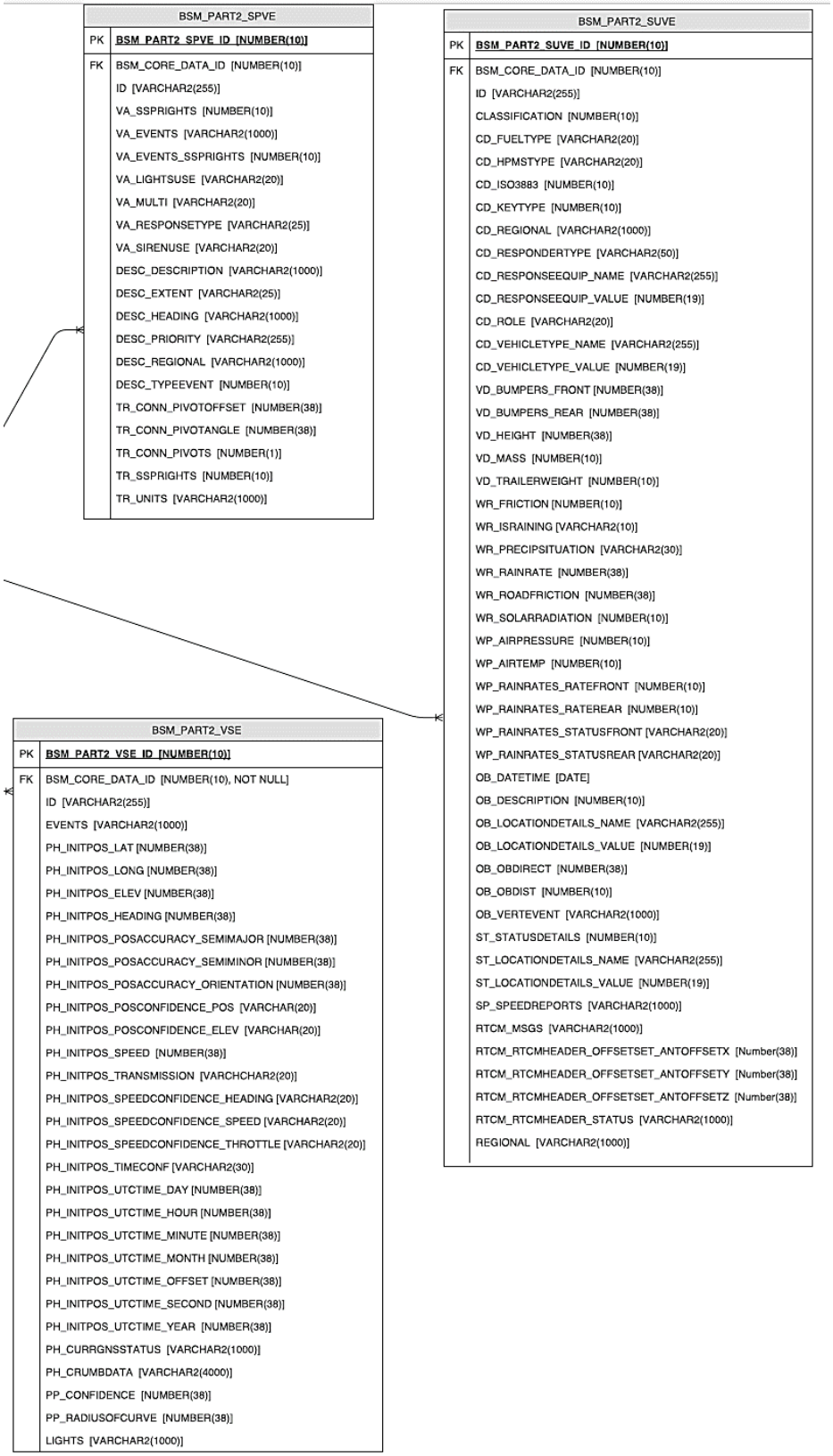


Figure 7-2. BSM Part II Oracle Data Table. (Source: WYDOT)

7.2 Traveler Information Message (TIM)

The Traveler Information message is used to send various types of information (advisory and road sign types) to equipped devices. Traveler Information Message is defined in the SAE J2735 specification. 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, like roadway geometry is defined in the MAP messages.

The primary sub-sections of J2735 which define TIMs are:

- Section 5.16 Message: MSG_TravelerInformation Message (TIM)
- Section 6.142 Data Frame: DF_TravelerDataFrame

Requirements Traceability:

- BC-REQ-1 Traveler Information Requirements
- BC-REQ-1.1 Broadcast Traveler Information
- BC-REQ-1.2 Broadcast Traveler Information - Mandatory Requirements
- BC-REQ-1.2.1 Broadcast Traveler Information - Packet Identifier
- BC-REQ-1.2.2 Broadcast Traveler Information - Message Identifier Requirements
- BC-REQ-1.2.2.1 Broadcast Traveler Advisories - Message Identifier
- BC-REQ-1.3 Broadcast Traveler Information
- BC-REQ-1.3.1 Broadcast Traveler Information - Validity Duration
- BC-REQ-1.3.2 Broadcast Traveler Information – Importance
- BC-REQ-1.3.3 Broadcast Traveler Information - Presentation Requirements
- BC-REQ-1.3.3.1 Broadcast Traveler Information - Default Anchor Point Position
- BC-REQ-1.3.3.2 Broadcast Traveler Information - Heading Slice
- BC-REQ-1.3.3.3 Broadcast Traveler Information - Circular Valid Region Requirements
- BC-REQ-1.3.3.3.1 Broadcast Traveler Information - Circular Region – Radius
- BC-REQ-1.3.3.3.2 Broadcast Traveler Information - Circular Region - Anchor Point
- BC-REQ-1.3.3.4 Broadcast Traveler Information - Polygon Valid Region Requirements
- BC-REQ-1.3.3.4.1 Broadcast Traveler Information - Polygon Region – Offsets
- BC-REQ-1.3.3.4.2 Broadcast Traveler Information - Polygon Region - Anchor Point
- BC-REQ-1.3.3.5 Broadcast Traveler Information - Valid Shape Point Set Region Requirements
- BC-REQ-1.3.3.5.1 Broadcast Traveler Information - Shape Point Set - Default Direction
- BC-REQ-1.3.3.5.2 Broadcast Traveler Information - Shape Point Set - Default Width
- BC-REQ-1.3.3.5.3 Broadcast Traveler Information - Shape Point Set – Offsets
- BC-REQ-1.3.3.5.4 Broadcast Traveler Information - Shape Point Set – Direction
- BC-REQ-1.3.3.5.5 Broadcast Traveler Information - Shape Point Set – Width
- BC-REQ-1.3.3.5.6 Broadcast Traveler Information - Shape Point Set - Node Width
- BC-REQ-1.3.3.5.7 Broadcast Traveler Information - Shape Point Set - Anchor Point
- BC-REQ-1.3.4 Broadcast Traveler Advisories – Content
- BC-REQ-1.3.5 Broadcast Road Sign – Content
- BC-REQ-1.3.6 Broadcast Traveler Information - Uniform Resource Locator
- BC-REQ-1.3.7 Broadcast Traveler Information - Valid Vehicle Type

7.2.1 ASN.1 Structure of Traveler Information Message (TIM)

The following table shows the fields of message from SAE J2735: MSG_TravelerInformation Message (TIM).

The first column, WY, indicates if the field is being utilized by the WYDOT pilot.

Heading Descriptions for Table 7-2:

1. Field usage by WYDOT Application: The sub-column headings correspond to ITIS codes. In Part III of the TIM, the **content** field is set to one of *advisory*, *workZone*, *speedLimit* or *exitService* according to the purpose of the TIM. Table 3-1 in the System Design Document shows how the sub-column headings correspond to ITIS codes and the four **content** types.
2. Field Name: Field name from SAE J2735.
3. Field Type: Field type from SAE J27365.
4. ASN.1 Structural Type: ASN.1 structural type: Ex. OPTIONAL, Sequence, Choice, etc.
5. ASN.1 Primitive Type: ASN.1 primitive data type.
6. WYDOT Comments: Comments about specific WYDOT usage of the field.

Table 7-2. Traveler Information Message (TIM) Fields.

Field usage by WYDOT Application																Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
Work Zone	VSL	Parking	Slick Spot	Snow	Rain	Fog	Closed Road	Accident	Severe Weather	Severe Winds	Ice	Chains Required	Closed to Light High Profile vehicles	Advise No Light Trailers	Distress Notification					
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	TravelerInformation	MSG_TravelerInformation Message			
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	msgCnt	MsgCount			Use of MsgCount needs to be harmonized for all 3 sites.
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	timeStamp	MinuteOfTheYear	OPTIONAL		
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	packetID	UniqueMSGID	OPTIONAL		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	urlB	URL-Base	OPTIONAL		
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	dataFrames	TravelerDataFrameList	SEQUENCE(SIZE(1..8))		
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	dataFrames[n]	TravelerDataFrame			
																-- Part I, Frame Header				
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	sspTimRights	SSPindex		INTEGER (0..31)	Index pointing to SSP 90-FF-FF-03 within Cert
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	frameType	TravelerInfoType		ENUMERATED { 0..3 }	Advisory or roadSignage
																msgId		CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	furtherInfoId	FurtherInfoID		OCTET STRING (SIZE(2))	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	roadSignID	RoadSignID			
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	position3D	Position3D			Latitude and longitude of start of signage or advisory
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	lat	Latitude		INTEGER (-900000000..900000001)	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	long	Longitude		INTEGER (-799999999..1800000001)	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	elevation	Elevation	OPTIONAL	INTEGER (-4096..61439)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-Position3D }}			
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	viewAngle	HeadingSlice		BIT STRING (SIZE(16))	180 degree wide range of angles from which a corresponding road sign would be viewable / legible to an oncoming driver
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	mutcdCode	MUTCDCode	OPTIONAL	ENUMERATED { 0..6 }	may be used if appropriate code is available
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	msgCrc	MsgCRC	OPTIONAL	OCTET STRING (SIZE(2))	Unclear how this CRC would be calculated and then later verified being in the middle of a larger UPER message
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	startYear	DYear	OPTIONAL		Use for long term signs
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	startTime	MinuteOfTheYear		INTEGER (0..527040)	Time with Advisory or Sign goes into effect
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	durationTime	MinutesDuration		INTEGER (0..32000)	Duration of validity
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	priority	SignPriority		INTEGER (0..7)	Range 0-7 with 0 being low priority. Work Zone 4, VSL 4, Parking 2, Slick Spot 5, Snow 5, Rain 4, Fog 4, Closed Road 2, Severe Weather 5, Severe Wind 5, Ice 5, Chain Restrictions 2, Advise Not light Trailers 4, Distress Notification 7
																-- Part II, Applicable Regions of Use				
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	sspLocationRights	SSPindex		INTEGER (0..31)	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	regions	GeographicalPath	SEQUENCE (SIZE(1..16))		
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	name	DescriptiveName	OPTIONAL	IA5String (SIZE(1..63))	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	id	RoadSegmentReferenceID	OPTIONAL		
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	region	RoadRegulatorID	OPTIONAL	INTEGER (0..65535)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	id	RoadSegmentID		INTEGER (0..65535)	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	anchor	Position3D	OPTIONAL		
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	lat	Latitude		INTEGER (-900000000..900000001)	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	long	Longitude		INTEGER (-799999999..1800000001)	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	elevation	Elevation	OPTIONAL	INTEGER (-4096..61439)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-Position3D }}			
Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneWidth	LaneWidth	OPTIONAL	INTEGER (0..32767)	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	directionality	DirectionOfUse	OPTIONAL	ENUMERATED { 0..3 }	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	closedPath	BOOLEAN	OPTIONAL		
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	direction	HeadingSlice	OPTIONAL	BIT STRING (SIZE(16))	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	description		OPTIONAL CHOICE		
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	path	OffsetSystem			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	scale	Zoom	OPTIONAL	INTEGER (0..15)	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	offset		CHOICE		

Field usage by WYDOT Application																Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
Work Zone	VSL	Parking	Slick Spot	Snow	Rain	Fog	Closed Road	Accident	Severe Weather	Severe Winds	Ice	Chains Required	Closed to Light High Profile vehicles	Advise No Light Trailers	Distress Notification					
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	xy	NodeListXY	CHOICE		
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	nodes	NodeSetXY	SEQUENCE (SIZE(2..63))		
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	nodes[n]	NodeXY			
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	delta	NodeOffsetPointXY	CHOICE		
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	node-XY1	Node-XY-20b			
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	x	Offset-B10		INTEGER (-512..511)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	y	Offset-B10		INTEGER (-512..511)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	node-XY2	Node-XY-22b			
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	x	Offset-B11		INTEGER (-1024..1023)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	y	Offset-B11		INTEGER (-1024..1023)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	node-XY3	Node-XY-24b			
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	x	Offset-B12		INTEGER (-2048..2047)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	y	Offset-B12		INTEGER (-2048..2047)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	node-XY4	Node-XY-26b			
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	x	Offset-B13		INTEGER (-4096..4095)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	y	Offset-B13		INTEGER (-4096..4095)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	node-XY5	Node-XY-28b			
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	x	Offset-B14		INTEGER (-8192..8192)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	y	Offset-B14		INTEGER (-8192..8192)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	node-XY6	Node-XY-32b			
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	x	Offset-B16		INTEGER (-32768..32768)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	y	Offset-B16		INTEGER (-32768..32768)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	node-LatLon	Node-LLmD-64b			
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	lon	Longitude		INTEGER (-799999999..1800000001)	
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	lat	Latitude		INTEGER (-900000000..900000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional	RegionalExtension {{ REGION.Reg-NodeOffsetPointXY }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	attributes	NodeAttributeSetXY	OPTIONAL		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	localNode	NodeAttributeXYList	OPTIONAL SEQUENCE (SIZE (1..8))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	localNode[n]	NodeAttributeXY		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	disabled	SegmentAttributeXYList	OPTIONAL SEQUENCE (SIZE (1..8))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	disabled[n]	SegmentAttributeXY		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	enabled	SegmentAttributeXYList	OPTIONAL		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	enabled[n]	SegmentAttributeXY		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	data	LaneDataAttributeList	OPTIONAL		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	data[n]	LaneDataAttribute	CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	pathEndPointAngle	DeltaAngle		INTEGER (-150..150)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneCrownPointCenter	RoadwayCrownAngle		INTEGER (-128..127)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneCrownPointLeft	RoadwayCrownAngle		INTEGER (-128..127)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneCrownPointRight	RoadwayCrownAngle		INTEGER (-128..127)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneAngle	MergeDivideNodeAngle		INTEGER (-180..180)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	speedLimits	SpeedLimitList	SEQUENCE (SIZE (1..9))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	speedLimits[n]	RegulatorySpeedLimit			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	type	SpeedLimitType		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	speed	Velocity		INTEGER (0..8191)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-LaneDataAtrribute }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	dWidth	Offset-B10	OPTIONAL	INTEGER (-512..511)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	dElevation	Offset-B10	OPTIONAL	INTEGER (-512..511)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE(SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-NodeAttributeSetXY }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	computed	ComputedLane			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	referenceLaneId	LaneID		INTEGER (0..255)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	offsetXaxis		CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	small	DrivenLineOffsetSm		INTEGER (-2047..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	large	DrivenLineOffsetLg		INTEGER (-32767..32767)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	offsetYaxis		CHOICE		

Field usage by WYDOT Application																Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
Work Zone	VSL	Parking	Slick Spot	Snow	Rain	Fog	Closed Road	Accident	Severe Weather	Severe Winds	Ice	Chains Required	Closed to Light High Profile vehicles	Advise No Light Trailers	Distress Notification					
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	small	DrivenLineOffsetSm		INTEGER (-2047..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	large	DrivenLineOffsetLg		INTEGER (-32767..32767)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	rotateXY	Angle	OPTIONAL	INTEGER (0.28800)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	scaleXaxis	Scale-B12	OPTIONAL	INTEGER (-2048..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	scaleYaxis	Scale-B12	OPTIONAL	INTEGER (-2048..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-ComputedLane }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	ll	NodeListLL	CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	nodes	NodeSetLL		SEQUENCE (SIZE (2..63))	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	nodes[n]	NodeLL			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	delta	NodeOffsetPointLL	CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-LL1	Node-LL-24B			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lon	OffsetLL-B12		INTEGER (-2048..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	OffsetLL-B12		INTEGER (-2048..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-LL2	Node-LL-28B			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lon	OffsetLL-B14		INTEGER (-8192..8191)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	OffsetLL-B14		INTEGER (-8192..8191)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-LL3	Node-LL-32B			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lon	OffsetLL-B16		INTEGER (-32768..32767)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	OffsetLL-B16		INTEGER (-32768..32767)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-LL4	Node-LL-36B			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lon	OffsetLL-B18		INTEGER (-131072..131071)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	OffsetLL-B18		INTEGER (-131072..131071)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-LL5	Node-LL-44B			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lon	OffsetLL-B22		INTEGER (-2097152..2097151)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	OffsetLL-B22		INTEGER (-2097152..2097151)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-LL6	NodeLL-48B			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lon	OffsetLL-B24		INTEGER (-8388608..8388607)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	OffsetLL-B24		INTEGER (-8388608..8388607)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-LatLon	Node-LLmD-64b			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lon	Longitude		INTEGER (-799999999..1800000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	Latitude		INTEGER (-900000000..900000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional	RegionalExtension {{ REGION.Reg-NodeOffsetPointLL }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	attributes	NodeAttributeSetLL	OPTIONAL		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	localNode	NodeAttributeLLList	OPTIONAL SEQUENCE (SIZE (1..8))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	localNode[n]	NodeAttributeLL		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	disabled	SegmentAttributeLLList	OPTIONAL SEQUENCE (SIZE(1..8))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	disabled[n]	SegmentAttributeLL		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	enabled	SegmentAttributeLLList	OPTIONAL SEQUENCE (SIZE(1..8))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	enabled[n]	SegmentAttributeLL		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	data	LaneDataAttributeList	OPTIONAL SEQUENCE (SIZE(1..8))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	data[n]	LaneDataAttribute	CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	pathEndPointAngle	DeltaAngle		INTEGER (-150..150)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneCrownPointCenter	RoadwayCrownAngle		INTEGER (-128..127)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneCrownPointLeft	RoadwayCrownAngle		INTEGER (-128..127)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneCrownPointRight	RoadwayCrownAngle		INTEGER (-128..127)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneAngle	MergeDivideNodeAngle		INTEGER (-180..180)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	speedLimits	SpeedLimitList	SEQUENCE (SIZE (1..9))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	speedLimits[n]	RegulatorySpeedLimit			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	type	SpeedLimitType		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	speed	Velocity		INTEGER (0..8191)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-LaneDataAtrribute }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	dWidth	Offset-B10	OPTIONAL	INTEGER (-512..511)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	dElevation	Offset-B10	OPTIONAL	INTEGER (-512..511)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		SEQUENCE (SIZE(1..4))		

Field usage by WYDOT Application																Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
Work Zone	VSL	Parking	Slick Spot	Snow	Rain	Fog	Closed Road	Accident	Severe Weather	Severe Winds	Ice	Chains Required	Closed to Light High Profile vehicles	Advise No Light Trailers	Distress Notification					
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-NodeAttributeSetLL }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	geometry	GeometricProjection			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	direction	HeadingSlice		BIT STRING (SIZE(16))	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	extent	Extent	OPTIONAL	ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneWidth	LaneWidth	OPTIONAL	INTEGER (0..32767)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	circle	Circle			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	center	Position3D			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	Latitude		INTEGER (-900000000..900000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	long	Longitude		INTEGER (-799999999..1800000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	elevation	Elevation	OPTIONAL	INTEGER (-4096..61439)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-Position3D }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	radius	Radius-B12		INTEGER (0..40695)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	units	DistanceUnits		ENUMERATED (0..7)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE (1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-GeometricProjection }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	oldRegion	ValidRegion			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	direction	HeadingSlice		BIT STRING (SIZE (16))	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	extent	Extent	OPTIONAL	ENUMERATED { 0..15 }	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	area		CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	shapePointSet	ShapePointSet			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	anchor	Position3D	OPTIONAL		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	Latitude		INTEGER (-900000000..900000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	long	Longitude		INTEGER (-799999999..1800000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	elevation	Elevation	OPTIONAL	INTEGER (-4096..61439)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-Position3D }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-Position3D }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneWidth	LaneWidth	OPTIONAL	INTEGER (0..32767)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	directionality	DirectionOfUse	OPTIONAL	ENUMERATED { 0..3 }	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	nodeList	NodeListXY			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	nodes	NodeSetXY	SEQUENCE (SIZE(2..63))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	nodes[n]	NodeXY			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	delta	NodeOffsetPointXY	CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-XY1	Node-XY-20b			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	x	Offset-B10		INTEGER (-512..511)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	y	Offset-B10		INTEGER (-512..511)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-XY2	Node-XY-22b			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	x	Offset-B11		INTEGER (-1024..1023)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	y	Offset-B11		INTEGER (-1024..1023)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-XY3	Node-XY-24b			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	x	Offset-B12		INTEGER (-2048..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	y	Offset-B12		INTEGER (-2048..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-XY4	Node-XY-26b			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	x	Offset-B13		INTEGER (-4096..4095)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	y	Offset-B13		INTEGER (-4096..4095)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-XY5	Node-XY-28b			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	x	Offset-B14		INTEGER (-8192..8192)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	y	Offset-B14		INTEGER (-8192..8192)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-XY6	Node-XY-32b			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	x	Offset-B16		INTEGER (-32768..32768)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	y	Offset-B16		INTEGER (-32768..32768)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	node-LatLon	Node-LLmD-64b			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lon	Longitude		INTEGER (-799999999..1800000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	Latitude		INTEGER (-900000000..900000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional	RegionalExtension {{ REGION.Reg-NodeOffsetPointXY }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	attributes	NodeAttributeSetXY	OPTIONAL		

Field usage by WYDOT Application																Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
Work Zone	VSL	Parking	Slick Spot	Snow	Rain	Fog	Closed Road	Accident	Severe Weather	Severe Winds	Ice	Chains Required	Closed to Light High Profile vehicles	Advise No Light Trailers	Distress Notification					
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	localNode	NodeAttributeXYList	OPTIONAL SEQUENCE (SIZE (1..8))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	localNode[n]	NodeAttributeXY		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	disabled	SegmentAttributeXYList	OPTIONAL SEQUENCE (SIZE (1..8))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	disabled[n]	SegmentAttributeXY		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	enabled	SegmentAttributeXYList	OPTIONAL		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	enabled[n]	SegmentAttributeXY		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	data	LaneDataAttributeList	OPTIONAL SEQUENCE (SIZE (1..8))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	data[n]	LaneDataAttribute	CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	pathEndPointAngle	DeltaAngle		INTEGER (-150..150)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneCrownPointCenter	RoadwayCrownAngle		INTEGER (-128..127)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneCrownPointLeft	RoadwayCrownAngle		INTEGER (-128..127)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneCrownPointRight	RoadwayCrownAngle		INTEGER (-128..127)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	laneAngle	MergeDivideNodeAngle		INTEGER (-180..180)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	speedLimits	SpeedLimitList	SEQUENCE (SIZE (1..9))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	speedLimits[n]	RegulatorySpeedLimit			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	type	SpeedLimitType		ENUMERATED	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	speed	Velocity		INTEGER (0..8191)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-LaneDataAtrribute }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	dWidth	Offset-B10	OPTIONAL	INTEGER (-512..511)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	dElevation	Offset-B10	OPTIONAL	INTEGER (-512..511)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE(SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-NodeAttributeSetXY }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	computed	ComputedLane			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	referenceLaneId	LaneID		INTEGER (0..255)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	offsetXaxis		CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	small	DrivenLineOffsetSm		INTEGER (-2047..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	large	DrivenLineOffsetLg		INTEGER (-32767..32767)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	offsetYaxis		CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	small	DrivenLineOffsetSm		INTEGER (-2047..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	large	DrivenLineOffsetLg		INTEGER (-32767..32767)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	rotateXY	Angle	OPTIONAL	INTEGER (0.28800)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	scaleXaxis	Scale-B12	OPTIONAL	INTEGER (-2048..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	scaleYaxis	Scale-B12	OPTIONAL	INTEGER (-2048..2047)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-ComputedLane }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	circle	Circle			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	center	Position3D			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	Latitude		INTEGER (-900000000..900000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	long	Longitude		INTEGER (-799999999..1800000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	elevation		OPTIONAL	INTEGER (-4096..61439)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-Position3D }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	radius	Radius-B12		INTEGER (0..40695)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	units	DistanceUnits		ENUMERATED (0..7)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regionPointSet	RegionPointSet			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	anchor	Position3D	OPTIONAL		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	lat	Latitude		INTEGER (-900000000..900000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	long	Longitude		INTEGER (-799999999..1800000001)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	elevation	Elevation	OPTIONAL	INTEGER (-4096..61439)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-Position3D }}			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	scale	Zoom	OPTIONAL	INTEGER (0..15)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	nodeList	RegionList	SEQUENCE (SIZE(1..64))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	nodeList[n]	RegionOffsets			
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	xOffset	OffsetLL-B16		INTEGER (-32768..32767)	

Field usage by WYDOT Application																Field Name	Field Type	ASN.1 Structural Type	ASN.1 Primitive Type	WYDOT Comments
Work Zone	VSL	Parking	Slick Spot	Snow	Rain	Fog	Closed Road	Accident	Severe Weather	Severe Winds	Ice	Chains Required	Closed to Light High Profile vehicles	Advise No Light Trailers	Distress Notification					
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	yOffset	OffsetLL-B16		INTEGER (-32768..32767)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	zOffset	OffsetLL-B16	OPTIONAL	INTEGER (-32768..32767)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional		OPTIONAL SEQUENCE (SIZE(1..4))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-GeographicalPath			
																-- Part III, Content				
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	sspMsgRights1	SSPindex		INTEGER (0..31)	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	sspMsgRights2	SSPindex		INTEGER (0..31)	
Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	content		CHOICE		
N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	advisory	ITIS.ITIScodesAndText	SEQUENCE (SIZE(1..100))		
N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	item		CHOICE		
N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	itis	ITIScodes		INTEGER (0..65535)	
N	O	N	O	O	O	O	O	O	O	O	O	O	O	O	O	text	ITIStext		IA5String (SIZE(1.500))	
Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	workZone	WorkZone	SEQUENCE (SIZE(1..16))		
Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	item		CHOICE		
Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	itis	ITIS.ITIScodes		INTEGER (0..65535)	
O	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	text	ITIStextPhrase		IA5String (SIZE(1..16))	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	genericSign	GenericSignage	SEQUENCE (SIZE(1..16))		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	item		CHOICE		
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	itis	ITIS.ITIScodes		INTEGER (0..65535)	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	text	ITIStextPhrase		IA5String (SIZE(1..16))	
Y	Y	N	O	O	O	O	O	O	O	O	O	O	O	O	N	speedLimit	SpeedLimit	SEQUENCE (SIZE(1..16))		
Y	Y	N	O	O	O	O	O	O	O	O	O	O	O	O	N	item		CHOICE		
Y	Y	N	O	O	O	O	O	O	O	O	O	O	O	O	N	itis	ITIS.ITIScodes		INTEGER (0..65535)	
O	O	N	O	O	O	O	O	O	O	O	O	O	O	O	N	text	ITIStextPhrase		IA5String (SIZE(1..16))	
N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	exitService	ExitService	SEQUENCE (SIZE(1..16))		
O	O	N	O	O	O	O	O	O	O	O	O	O	O	O	N	text	ITIStextPhrase		IA5String (SIZE(1..16))	
N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	exitService	ExitService	SEQUENCE (SIZE(1..16))		
N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	item		CHOICE		
N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	itis	ITIS.ITIScodes		INTEGER (0..65535)	
N	N	O	N	N	N	N	N	N	N	N	N	N	N	N	N	text	ITIStextPhrase		IA5String (SIZE(1..16))	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	url	URL-Short	OPTIONAL	IA5String (SIZE(1..15))	
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional				
N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	regional[n]	RegionalExtension {{ REGION.Reg-TravelerInformation }}			

7.2.2 Oracle Tables for Traveler Information Message (TIM)

The following shows the organization of WYDOT Data Warehouse's Oracle Database for storing TIMs.

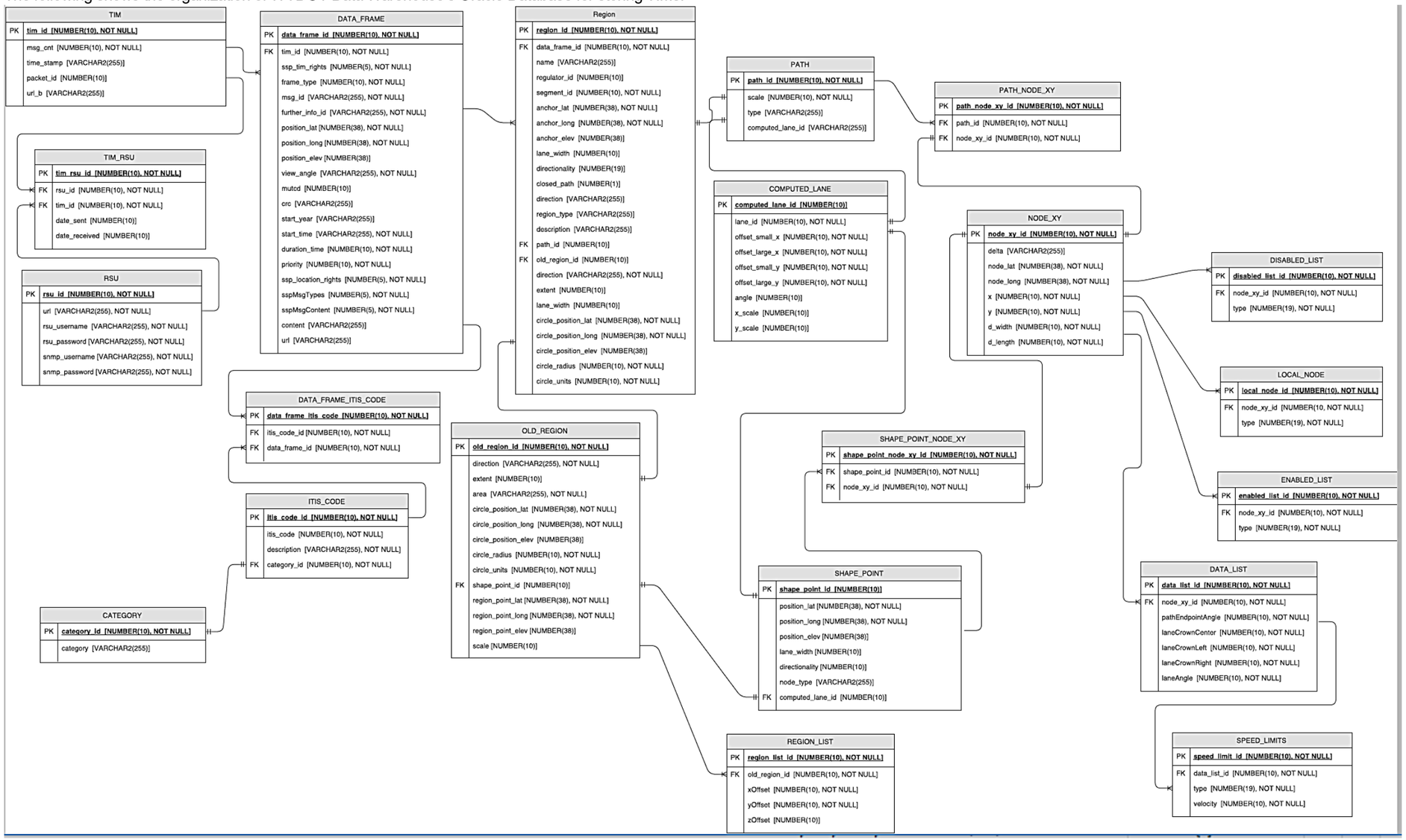


Figure 7-3. TIM Fields in Oracle Data Table.

7.3 Full Event Update Message (TMDD)

The data provided by the WYDOT Third Party Interface REST Service is defined in TMDDv3.03c-Vol2 as an ITIS data frame called ***Full Event Update*** message. The full structure could be enormous as there are sequences of optional fields which can nest very, very deeply. The fields used by WYDOT are shown in the table below.

TMDD standards references:

- TMDD Vol2 v03.03c, Section 3.2.8.4: FEUMsg ITS Message
- TMDD Vol2 v03.03c, Section 3.3.8.30: FullEventUpdate ITS Data Frame

Heading Descriptions for Table 7-3**:**

1. WYDOT Usage: Optional Field usage by WYDOT Application:
2. Field Name: Field name from SAE J2735.
3. Field Type: Field type from SAE J27365.
4. ASN.1 Structural Type: ASN.1 structural type: Ex. OPTIONAL, Sequence, Choice, etc.
5. ASN.1 Primitive Type: ASN.1 primitive data type.
6. Sample JSON Value: Example value from exported JSON.

Table 7-3: Full Event Update Message (TMDD)

WYDOT Usage	Field Name	Field Type	ASN.1 Structure Type	ASN.1 Primitive Type	Example JSON Value
Y	fEUMsg		SEQUENCE (SIZE(1..10240))		
M	fullEventUpdate	FullEventUpdate			
n	restrictions	Restrictions	OPTIONAL SEQUENCE		
M	message-header	MessageHeader			
M	organization-sending	OrganizationInformation	SEQUENCE		
M	organization-id	Organization-resource-identifier		IA5String (SIZE(1..32))	WYDOT
n	organization-name	Organization-resource-name	OPTIONAL	IA5String (SIZE(1..128))	
n	organization-location	Organization-location-fips	OPTIONAL	IA5String (SIZE(1..10))	
n	organization-function	Organization-function	OPTIONAL	IA5String (SIZE(1..128))	
n	organization-contact-details	ContactDetails	OPTIONAL SEQUENCE		
n	center-contact-list		OPTIONAL SEQUENCE (SIZE(1..1024))		
n	last-update-time	DateTimeZone	OPTIONAL		
n	organizations-receiving		OPTIONAL SEQUENCE (SIZE(1..100))		
n	organizations-responding		OPTIONAL SEQUENCE (SIZE(1..100))		
M	message-type-version	Event-message-type-version		INTEGER (0..255)	3
M	message-number	Event-message-number		INTEGER (1..4294967295)	17258439
M	message-time-stamp	DateTimeZone			
Y	date	Date		IA5String (SIZE(8))	20170622
Y	time	Time		IA5String (SIZE(6..10))	153929
Y	offset	Time-offset-utc	OPTIONAL	IA5String (SIZE(5))	-0600
Y	message-expiry-time	DateTimeZone	OPTIONAL		
Y	date	Date		IA5String (SIZE(8))	20170622
Y	time	Time		IA5String (SIZE(6..10))	153934
Y	offset	Time-offset-utc	OPTIONAL	IA5String (SIZE(5))	-0600
Y	event-reference	EventReference	OPTIONAL		
Y	event-id	Organization-resource-identifier		IA5String (SIZE(1..32))	WYDOT-17266179
Y	event-update	Event-update		INTEGER (1..65535)	1
N	response-plan-id	Organization-resource-identifier	OPTIONAL	IA5String (SIZE(1..32))	
Y	update-time	DateTimeZone			
Y	date	Date		IA5String (SIZE(8))	20170622
Y	time	Time		IA5String (SIZE(6..10))	153929
Y	offset	Time-offset-utc	OPTIONAL	IA5String (SIZE(5))	-0600
n	project-references		OPTIONAL SEQUENCE(SIZE(1..64))		
n	event-indicators		OPTIONAL SEQUENCE(SIZE(1..64))		
n	other-references		OPTIONAL SEQUENCE(SIZE(1..64))		
M	event-headline	EventHeadline			
M	headline	EventType	CHOICE		
Y	**ITIS CODE**			ITIS Code	"system-information": "travel information"
n	**transitIncident**			IA5String (SIZE(1..2048))	
n	**transitConstruction**			IA5String (SIZE(1..2048))	
n	headline-element	Event-headline-element	OPTIONAL	INTEGER (1..255)	
M	event-element-details		SEQUENCE(SIZE(1..64))		
M	event-element-detail[n]	EventElementDetail			
n	element-id	Event-element-identifier	OPTIONAL	INTEGER (1..999)	
n	schedule-element-id	Event-schedule-element-identifier	OPTIONAL	INTEGER (1..999)	
n	event-category	Event-category	OPTIONAL	ENUMERATED	
n	event-source	EventSource	OPTIONAL		
Y	event-descriptions		OPTIONAL SEQUENCE(SIZE(1..1024))		
Y	event-description[n]	EventDescription	CHOICE		
Y	**phrase**	EventType	CHOICE		
Y	**ITIS CODE**			ITIS Code	"pavement-conditions": "dry pavement"
n	**transitIncident**			IA5String (SIZE(1..2048))	
n	**transitConstruction**			IA5String (SIZE(1..2048))	
n	**cause**	EventType	CHOICE		
n	**advice**	EventQualifier	CHOICE	ENUMERATED	

WYDOT Usage	Field Name	Field Type	ASN.1 Structure Type	ASN.1 Primitive Type	Example JSON Value
n	**qualifier**	EventQuantity	CHOICE	ENUMERATED	
n	**related-landmark**	LandmarkLocation	SEQUENCE		
n	**detour**	AlternateRouteDetail	SEQUENCE		
n	**additional-text**	AdditonalText	SEQUENCE		
n	**qualifier-time**	DateTimeZone	SEQUENCE		
Y	event-locations		OPTIONAL SEQUENCE(SIZE(1..20))		
Y	event-location[n]	EventLocation	CHOICE		
n	**area-location**	AreaLocation			
Y	**location-on-link**	LinkLocation			
Y	link-ownership	Transportation-network-name	OPTIONAL	IA5String (SIZE(1..256))	WYDOT
Y	link-designator	Link-route-designator	OPTIONAL	IA5String (SIZE(1..64))	WY59
n	second-link-designator	Link-route-designator	OPTIONAL	IA5String (SIZE(1..64))	
n	link-id	Transportation-network-identifier	OPTIONAL	IA5String (SIZE(1..32))	
n	link-name	Transportation-network-name	OPTIONAL	IA5String (SIZE(1..256))	
M	primary-location	PointOnLink			
M	geo-location	LRMS.GeoLocation			
M	latitude	LRMS.Latitude	lrmsDataElements latitude(1)	INTEGER (-900000000..900000001)	44393698
M	longitude	LRMS.Longitude	lrmsDataElements longitude(1)	INTEGER (-1800000000..1800000001)	-105539006
n	horizontal-datum	LRMS.HorizontalDatum	OPTIONAL lrmsDataElements horizontalDatum(1)		
n	height	LRMS.Height	OPTIONAL		
Y	linear-reference		OPTIONAL	IA5String	119.24
n	link-name	Transportation-network-name	OPTIONAL	IA5String (SIZE(1..256))	
Y	point-name	Transportation-network-name	OPTIONAL	IA5String (SIZE(1..256))	US 14/16
n	cross-street-designator		OPTIONAL SEQUENCE (SIZE(1..8))		
n	cross-street-name		OPTIONAL SEQUENCE (SIZE(1..8))		
n	signed-destination		OPTIONAL SEQUENCE (SIZE(1..8))		
n	location-rank	Link-location-rank	OPTIONAL	INTEGER (0..10)	
n	landmark-type	Event-location-landmark-type	OPTIONAL	ENUMERATED	
n	upward-area-reference	AreaLocation	OPTIONAL SEQUENCE		
Y	secondary-location		OPTIONAL		
Y	geo-location	LRMS.GeoLocation			
Y	latitude	LRMS.Latitude	lrmsDataElements latitude(1)	INTEGER (-900000000..900000001)	45000113
Y	longitude	LRMS.Longitude	lrmsDataElements longitude(1)	INTEGER (-1800000000..1800000001)	-105371314
n	horizontal-datum	LRMS.HorizontalDatum	OPTIONAL lrmsDataElements horizontalDatum(1)		
n	height	LRMS.Height	OPTIONAL		
Y	linear-reference		OPTIONAL	IA5String	170.11
N	link-name	Transportation-network-name	OPTIONAL	IA5String (SIZE(1..256))	
Y	point-name	Transportation-network-name	OPTIONAL	IA5String (SIZE(1..256))	the Montana State Line
N	cross-street-designator		OPTIONAL SEQUENCE (SIZE(1..8))		
N	cross-street-name		OPTIONAL SEQUENCE (SIZE(1..8))		
N	signed-destination		OPTIONAL SEQUENCE (SIZE(1..8))		
N	location-rank	Link-location-rank	OPTIONAL	INTEGER (0..10)	
N	landmark-type	Event-location-landmark-type	OPTIONAL	ENUMERATED	
N	upward-area-reference	AreaLocation	OPTIONAL SEQUENCE		
Y	link-direction	Link-direction	OPTIONAL	ENUMERATED	both directions
n	link-alignment	Link-alignment	OPTIONAL	ENUMERATED	
n	linear-reference-version	Link-location-linear-reference-version	OPTIONAL	INTEGER (0..255)	
n	alternate-designations		OPTIONAL SEQUENCE (SIZE(1..8))		
n	**landmark**	LandmarkLocation			
n	**geo-location**	LRMS.GeoLocation			
M	event-times	EventTimes			
M	update-time	DateTimeZone			
M	date	Date		IA5String (SIZE(8))	20170622
M	time	Time		IA5String (SIZE(6..10))	153929
Y	offset	Time-offset-utc	OPTIONAL	IA5String (SIZE(5))	-0600
n	valid-period	ValidPeriod	OPTIONAL CHOICE		
n	schedule-element-ids		OPTIONAL SEQUENCE (SIZE(1..20))		
n	sequence-time	DateTimeZone	OPTIONAL		
n	start-time	DateTimeZone	OPTIONAL		
n	alternate-start-time	DateTimeZone	OPTIONAL		
n	alternate-end-time	DateTimeZone	OPTIONAL		
n	expected-start-time	DateTimeZone	OPTIONAL		
n	expected-end-time	DateTimeZone	OPTIONAL		
n	recurrent-times		OPTIONAL SEQUENCE (SIZE(1..64))		
n	planned-event-continuous-flag	Binary-flag	OPTIONAL	ENUMERATED { yes (1), no (2) }	
n	event-name	Organization-resource-name	OPTIONAL		
n	event-lanes		OPTIONAL SEQUENCE (SIZE(1..256))		
n	event-transit-locations		OPTIONAL SEQUENCE(SIZE(1..100))		
n	event-hazmat-details		OPTIONAL SEQUENCE(SIZE(1..100))		
n	confidence-level	Event-description-confidence-level	OPTIONAL	ENUMERATED	
n	access-level	Event-access-level	OPTIONAL	ENUMERATED	
n	event-comments	EventComments	OPTIONAL		
n	full-report-texts		OPTIONAL SEQUENCE(SIZE(1..100))		

7.4 ITIS Codes and Advisory Strings

The *ITIS Codes* and the *Advisory Strings* used in TIM messages and TMDD exported JSON data are listed in the **System Design Document, Table 3-9**.

7.5 Distress Notification Message (DNM)

Distress information is a high priority messages loosely based on the mayday broadcast defined in SAE J3067, but has the content of the TIM defined in SAE J2735. A complete definition of the TIM can be found in Section: **7.2**. Optional TIM fields which are used for DNMs are shown in: **Table 7-2. Traveler Information Message (TIM) Fields**.

Standards:

- J2735 MAR2016, Sections 5.16 & 6.142: Part III: advisory ITIS data element
- SAE J2540-2 NOV2009, Section 6.1 ITIS data elements for Accidents and Incidents
- SAE J3067 AUG2014, Section 3.5.9.2.1

TIM Part II content Data Elements (see full TIM structure in **Table 7-2)**:

- Direction HeadingSlice direction of travel for Distressed Vehicle

TIM Part III content Data Elements (see full TIM structure in **Table 7-2**):

- Content Type: Advisory
- Content Advisory ITIS code: **531 Incident**
- Content Advisory Text: ~~**Air Bag** or **Vehicle Disabled** or~~ **Driver Initiated**

7.6 Parking Availability Data

The WYDOT 511App allows users to enter parking availability information into their PID and share the data with the WYDOT CV system.

The WYDOT CV System shall receive information based on the parking schema defined by WYDOT (WYDOT Truck Parking Map – as of 07/2016).

7.6.1 Parking Data from 511App

The data transferred to the WYDOT CV system for a parking availability report is as follows:

- GPS location where report was input to PID
- Time stamp when report was input to PID
- Parking status input to PID: FULL (meaning no parking availability), Available (meaning parking is available)

7.7 Environmental Weather Sensor Data

JSON log files are created on the HMI by the Weather Cloud application. These log files are moved to the OBU and copied up the ODE server as described in Section: **5.16.1**.

7.7.1 Environmental Data Log Files

The environmental weather sensor data will be in JSON format. A sample record of data is shown below. Following this are tables which define each sensor reading in detail.

UTC, (seconds from Jan 1 1970)

```
   [{
   "time":"2017-12-07T09:56:07.533Z"
   "Humidity":"85.2",
   "Irradiance":"38832.241"
   "Pressure":"1013.123",
   "RoadPixel4":"8.0",
   "TempAmbientExterior":"8.9",
   "GPSHeading":"314.4",
   "GPSSpeed":"55.3",
   "GPSlatitude":"36.1080555",
   "GPSlongitude":"-104.9691541",
   "WiperFreq":"100.00",
   "WiperFreqReadable":"3",
   "Precipitation_density_fft":"000014-044759",
   "PrecipReadble":"1"
   }
]
```

Table 7-4. Definition of JSON Environmental Sensor Readings

JSON Tag	Description	Units	Valid Range	Sample JSON Value
time	Date and time of sample	UTC		`time:"2017-12-07T09:56:07.533Z"`
Humidity	Relative Humidity Outside the Vehicle	%	0.0 - 102.0[12] (%3.1)	`"Humidity":"85.2"`
Irradiance	Irradiance External in watts / meter^2 1 W/M^2 ~= 0.008 Lux	watts / meter^2	(%6.3)	`"Irradiance":"38832.241"`
Pressure	Atmospheric Pressure External	hectopascals	850.000 - 1100.000[13] (%4.3)	`"Pressure":"1013.100"`
RoadPixel4	Measurement of driver side road surface temperature using infrared thermistor.	degrees Fahrenheit	-99.9 - 150.0 ([-] %3.1)	`"RoadPixel4":"100.0"`
TempAmbientExterior	External Ambient Temperature	degrees Fahrenheit	-99.0 - 150.0 ([-] %3.1)	`"TempAmbientExterior":"8.9"`
GPSHeading	Vehicle heading based on GPS	degrees	-360 – 360 (%4.1)	`"GPSHeading":"314.4"`
GPSSpeed	Vehicle speed based on GPS	miles per hours	0 – 270 (%3.1)	`"GPSSpeed":"55.3"`
GPSlatitude	Latitude as Defined in WGS-84	WGS-84	(%4.7)	`"GPSlatitude":"36.1080555"`
GPSlongitude	Longitude as Defined in WGS-84	WGS-84	(%4.7)	`"GPSlongitude":"-104.9691541"`
WiperFreq	Precipitation Wiper Frequency	Hz	0.00 - 100.00 (%3.2)	`"WiperFreq":"100.00"`
WiperFreqReadable	Precipitation Wiper Frequency Human Readable	**Table 7-5**	0 - 3 (%1.0)	`"WiperFreqReadable":"3"`
Precipitation_density_fft	Precipitation Density FFT Max Bin - Return Signal Amplitude. This is a bin value and amplitude separated by a dash, and even more so an empirical sensor compared to the wiper frequency sensor.	FFT	(%06.0-06.0[14])	`"Precipitation_density_fft":"000014-044759"`

[12] Actual RH %measurements can slightly exceed 100%.

[13] Pressures can get lower during such weather phenomenon as a tornado, but we think this is a valid range to track.

[14] We are leaving off a valid value range until the measurement is better understood, honed, and indexed. It will likely be handled by the firmware in a subsequent revision, where the sensor is reporting an index such as “dry pavement” “wet dirt” etc.

JSON Tag	Description	Units	Valid Range	Sample JSON Value
PrecipReadble	Precipitation Density FFT Max Bin - Return Signal Amplitude translated into a human readable output	**Table 7-6**	0 - 3 (%1.0)	`"PrecipReadble":"1"`

Table 7-5. Lookup table for WiperFreqReadable.

Value	Wiper Frequency
0	off
1	slow
2	medium
3	fast

Table 7-6. Lookup table for PrecipReadble.

Value	Precipitation Density
0	dry
1	water/rain
2	ice/snow
3	unknown

Table 7-7. Lookup table to combine WiperFreqReadable (row lookup) and PrecipReadble (column lookup) to describe precipitation.

	0	**1**	**2**	**3**
0	none	very light wet	very light frozen	unknown
1	dry slow	light wet	light frozen	unknown slow
2	dry medium	medium wet	medium frozen	unknown medium
3	dry fast	heavy wet	heavy frozen	unknown fast

7.8 Pikalert Message Structures

7.8.1 Pikalert Weather Alert Message Structure

The Pikalert System will format weather alerts as JSON strings per the following format which the WYDOT Data Broker expects. Note, sample JSON representation of an Alert may be found in: sample_alerts.json.

```
a.  District name
   i. A string referencing the state or district in a state
b.  hr06_alert_summary_code
   i. 0 to 6 hour alert summary code string for entire district
   ii.    "missing", "clear", "warning", "alert"
c.  hr24_alert_summary_code
   i. 6 to 24 hour alert summary code string for entire district
   ii.    "missing", "clear", "warning", "alert"
d.  hr72_alert_summary_code
   i. 24 to 72 hour alert summary code string for entire district
   ii.    "missing", "clear", "warning", "alert"
e.  max_lat
   i. maximum latitude for district in degrees (northern direction)
   ii.    floating point number
f.  max_lon
   i. maximum longitude for district  in degrees(eastern direction)
   ii.    floating point number
g.  min_lat
   i. minimum latitude for district  in degrees
   ii.    floating point number
h.  min_lon
   i. minimum longitude for district  in degrees
   ii.    floating point number number
i.  obs_alert_summary_code
   i. observation alert summary code string for entire district
   ii.    "missing", "clear", "warning", "alert"
j.  Array of sites
   i. desc
      1. Description string for site
          a. For example:
          b. "LOVELAND PASS CO US CAIC"
   ii.    hr06_alert_code
      1. 0 to 6 hour alert code string for site
      2. "missing", "clear", "warning", "alert"
   iii.   hr24_alert_code
      1. 6 to 24 hour alert code string for site
      2. "missing", "clear", "warning", "alert"
   iv.    hr72_alert_code
      1. 24 to 72 hour alert code string for site
      2. "missing", "clear", "warning", "alert"
   v. is_road_cond_site
```

```
      1. true or false based on whether site is a road segment
   vi.    is_rwis_site
      1. true or false based on whether site is an RWIS station
   vii.   is_wx_obs_site
      1. true or false based on whether site is a weather obs site
      2. currently set to false
k. Each site also has time series information consisting of the following
  object(s)
   i. alert_code
      1. "missing", "clear", "warning", "alert"
   ii.    chemical
      1. none, apply chem
   iii.   pavement
      1. dry, wet, snow_covered, ice_covered, hydroplane, black_ice,
         dry_wet, dry_frozen
   iv.    plow
      1. none, plow
   v. precip
      1. none, light, moderate, heavy, road_splash
   vi.    road_temp
      1. floating point temperature in fahrenheit
   vii.   time
      1. yyyymmddhhmm string
   viii.  treatment_alert_code
      1. "missing", "clear", "warning", "alert"
   ix.    Visibility
      1. normal, low, heavy_rain, heavy_snow, blowing_snow, fog, haze,
         dust, smoke
```

7.8.2 Pikalert: Weather Forecast Message Structures

A weather forecast from Pikalert consists of two parts, each part is contained in its own netCDF file. Road surface condition forecast data is provided in one file and road weather forecast data is provided in another file. The netCDF schema definition for both files are shown below.

7.8.2.1 netCDF Schema for Weather Forecast Data

Road Weather Forecast data is generated in a file of type netCDF. A new file is generated once per hour. The Road Weather Forecast data files are located on the Pikalert Server in the following location, where the final path element is the year, month and date of creation of files in the directory:

```
/d1/vii/data/forecast/rdwx_fcst/YYYYMMDD/
```

The netCDF files are named as follows, with the date and time in the name:

```
rdwx_fcst.YYYYMMDD.HHMM.nc
```

Table 7-8. netCDF Dimensions for Weather Forecast Data File

netCDF File Dimensions
max_site_num = 6080 ;
days = 8 ;
fc_times_per_day = 24 ;
daily_time = 1 ;

Table 7-9. netCDF Variable Definitions for Weather Forecast Data File

netCDF Variable Name & Dimension	netCDF Variable Content Definition
double creation_time ;	
	creation_time:long_name = "time at which forecast file was created" ;
	creation_time:units = "seconds since 1970-1-1 00:00:00" ;
double forc_time ;	
	forc_time:long_name = "time of earliest forecast" ;
	forc_time:units = "seconds since 1970-1-1 00:00:00" ;
int num_sites ;	
	num_sites:long_name = "number of actual_sites" ;
int site_list(max_site_num) ;	
	site_list:long_name = "forecast site list" ;
	site_list:_FillValue = -99999 ;
float T(max_site_num, days, fc_times_per_day) ;	
	T:long_name = "temperature" ;
	T:units = "Celsius" ;
float max_T(max_site_num, days, daily_time) ;	
	max_T:long_name = "maximum temperature" ;
	max_T:units = "Celsius" ;
float min_T(max_site_num, days, daily_time) ;	
	min_T:long_name = "minimum temperature" ;
	min_T:units = "Celsius" ;
float dewpt(max_site_num, days, fc_times_per_day) ;	
	dewpt:long_name = "dewpoint" ;
	dewpt:units = "Celsius" ;
float cloud_cov(max_site_num, days, fc_times_per_day) ;	
	cloud_cov:long_name = "cloud cover" ;
	cloud_cov:units = "percent" ;
float prob_fog(max_site_num, days, fc_times_per_day) ;	

netCDF Variable Name & Dimension	netCDF Variable Content Definition
	prob_fog:long_name = "probability of fog" ;
	prob_fog:units = "percent" ;
float prob_thunder(max_site_num, days, fc_times_per_day) ;	
	prob_thunder:long_name = "probability of thunder" ;
	prob_thunder:units = "percent" ;
float cprob_rain(max_site_num, days, fc_times_per_day) ;	
	cprob_rain:long_name = "conditional probability of rain" ;
	cprob_rain:units = "percent" ;
float cprob_snow(max_site_num, days, fc_times_per_day) ;	
	cprob_snow:long_name = "conditional probability of snow" ;
	cprob_snow:units = "percent" ;
float cprob_ice(max_site_num, days, fc_times_per_day) ;	
	cprob_ice:long_name = "conditional probability of ice" ;
	cprob_ice:units = "percent" ;
float prob_precip01(max_site_num, days, fc_times_per_day) ;	
	prob_precip01:long_name = "probability of precipitation, 1 hr" ;
	prob_precip01:units = "percent" ;
float prob_precip03(max_site_num, days, fc_times_per_day) ;	
	prob_precip03:long_name = "probability of precipitation, 3 hr" ;
	prob_precip03:units = "percent" ;
float prob_precip06(max_site_num, days, fc_times_per_day) ;	
	prob_precip06:long_name = "probability of precipitation, 6 hr" ;
	prob_precip06:units = "percent" ;
float prob_precip24(max_site_num, days, daily_time) ;	
	prob_precip24:long_name = "probability of precipitation, 24 hr" ;
	prob_precip24:units = "percent" ;
float qpf01(max_site_num, days, fc_times_per_day) ;	
	qpf01:long_name = "amount of precipitation" ;
	qpf01:units = "meters" ;
float qpf03(max_site_num, days, fc_times_per_day) ;	
	qpf03:long_name = "amount of precipitation" ;
	qpf03:units = "meters" ;
float qpf06(max_site_num, days, fc_times_per_day) ;	

netCDF Variable Name & Dimension	netCDF Variable Content Definition
	qpf06:long_name = "amount of precipitation" ;
	qpf06:units = "meters" ;
float wind_u(max_site_num, days, fc_times_per_day) ;	
	wind_u:long_name = "eastward-component of wind" ;
	wind_u:units = "meters per second" ;
float wind_v(max_site_num, days, fc_times_per_day) ;	
	wind_v:long_name = "northward-component of wind" ;
	wind_v:units = "meters per second" ;
float visibility(max_site_num, days, fc_times_per_day) ;	
	visibility:long_name = "visibility" ;
	visibility:units = "km" ;
float wind_speed(max_site_num, days, fc_times_per_day) ;	
	wind_speed:long_name = "windspeed" ;
	wind_speed:units = "meters per second" ;
float wind_speed_mph(max_site_num, days, fc_times_per_day) ;	
	wind_speed_mph:long_name = "windspeed in mph" ;
	wind_speed_mph:units = "miles per hour" ;
float wind_dir(max_site_num, days, fc_times_per_day) ;	
	wind_dir:long_name = "wind direction clockwise from north" ;
	wind_dir:units = "degrees north" ;
float rh(max_site_num, days, fc_times_per_day) ;	
	rh:long_name = "relative humidity" ;
	rh:units = "decimal" ;
float rh_pct(max_site_num, days, fc_times_per_day) ;	
	rh_pct:long_name = "percent relative humidity" ;
	rh_pct:units = "percent" ;
float precip_rate(max_site_num, days, fc_times_per_day) ;	
	precip_rate:long_name = "precip (SWE) rate" ;
	precip_rate:units = "mm/hr" ;
float precip_rate_inches(max_site_num, days, fc_times_per_day) ;	
	precip_rate_inches:long_name = "precip (SWE) rate" ;
	precip_rate_inches:units = "in/hr" ;
float precip_type(max_site_num, days, fc_times_per_day) ;	

netCDF Variable Name & Dimension	netCDF Variable Content Definition
	precip_type:long_name = "precipitation type" ;
	precip_type:units = "0=NONE, 1=RAIN, 2=SNOW, 5=ICE" ;
float precip_accum(max_site_num, days, fc_times_per_day) ;	
	precip_accum:long_name = "3 hr precip accumulation" ;
	precip_accum:units = "mm" ;
float precip_accum_inches(max_site_num, days, fc_times_per_day) ;	
	precip_accum_inches:long_name = "3 hr precip accumulation" ;
	precip_accum_inches:units = "inches" ;
float TempF(max_site_num, days, fc_times_per_day) ;	
	TempF:long_name = "temperature" ;
	TempF:units = "Fahrenheit" ;
float dewptF(max_site_num, days, fc_times_per_day) ;	
	dewptF:long_name = "dewpoint" ;
	dewptF:units = "Fahrenheit" ;
float snow_rate(max_site_num, days, fc_times_per_day) ;	
	snow_rate:long_name = "snowfall rate" ;
	snow_rate:units = "mm/hr" ;
float snow_rate_inches(max_site_num, days, fc_times_per_day) ;	
	snow_rate_inches:long_name = "snowfall rate" ;
	snow_rate_inches:units = "in/hr" ;
float snow_accum(max_site_num, days, fc_times_per_day) ;	
	snow_accum:long_name = "3 hr snowfall accumulation" ;
	snow_accum:units = "mm" ;
float snow_accum_inches(max_site_num, days, fc_times_per_day) ;	
	snow_accum_inches:long_name = "3 hr snowfall accumulation" ;
	snow_accum_inches:units = "inches" ;
float snow_accum_total(max_site_num, days, fc_times_per_day) ;	
	snow_accum_total:long_name = "snowfall accumulation since start of forecast" ;
	snow_accum_total:units = "mm" ;
float snow_accum_total_inches(max_site_num, days, fc_times_per_day) ;	
	snow_accum_total_inches:long_name = "snowfall accumulation since start of forecast" ;

netCDF Variable Name & Dimension	netCDF Variable Content Definition
	snow_accum_total_inches:units = "inches" ;
float snow_accum_48hr_total_inches(max_site_num, days, fc_times_per_day) ;	
	snow_accum_48hr_total_inches:long_name = "48hr snowfall accumulation since start of forecast" ;
	snow_accum_48hr_total_inches:units = "inches" ;
float prob_precip03_pct(max_site_num, days, fc_times_per_day) ;	
	prob_precip03_pct:long_name = "probability of precipitation, 3 hr" ;
	prob_precip03_pct:units = "percent (0-100)" ;
float blowing_snow_potential(max_site_num, days, fc_times_per_day) ;	
	blowing_snow_potential:long_name = "blowing snow potential" ;
	blowing_snow_potential:units = "index (0-3) (low-high)" ;
float blowing_snow_pot_vals(max_site_num, days, fc_times_per_day) ;	
	blowing_snow_pot_vals:long_name = "blowing snow potential values" ;
	blowing_snow_pot_vals:units = "floating point (0-1) (low-high)" ;
float P_sfc(max_site_num, days, fc_times_per_day) ;	
	P_sfc:long_name = "Pressure at 2m above sfc" ;
	P_sfc:units = "millibars" ;
float T_cb(max_site_num, days, fc_times_per_day) ;	
	T_cb:long_name = "cloud base temp" ;
	T_cb:units = "Celsius" ;
float T_bls(max_site_num, days, fc_times_per_day) ;	
	T_bls:long_name = "sub-sfc temperature" ;
	T_bls:units = "Celsius" ;
float T_lbls0(max_site_num, days, fc_times_per_day) ;	
	T_lbls0:long_name = "0-10 cm layer sub-sfc temperature" ;
	T_lbls0:units = "Celsius" ;
float T_lbls1(max_site_num, days, fc_times_per_day) ;	
	T_lbls1:long_name = "10-40 cm layer sub-sfc temperature" ;
	T_lbls1:units = "Celsius" ;
float T_lbls2(max_site_num, days, fc_times_per_day) ;	

netCDF Variable Name & Dimension	netCDF Variable Content Definition
	T_lbls2:long_name = "40-100 cm layer sub-sfc temperature" ;
	T_lbls2:units = "Celsius" ;
float T_lbls3(max_site_num, days, fc_times_per_day) ;	
	T_lbls3:long_name = "100-200 cm layer sub-sfc temperature" ;
	T_lbls3:units = "Celsius" ;
float snow_depth(max_site_num, days, fc_times_per_day) ;	
	snow_depth:long_name = "water equiv of accum snow depth" ;
	snow_depth:units = "kg/m2" ;
float cloud_low(max_site_num, days, fc_times_per_day) ;	
	cloud_low:long_name = "low cloud layer amt" ;
	cloud_low:units = "decimal" ;
float cloud_middle(max_site_num, days, fc_times_per_day) ;	
	cloud_middle:long_name = "middle cloud layer amt" ;
	cloud_middle:units = "decimal" ;
float cloud_high(max_site_num, days, fc_times_per_day) ;	
	cloud_high:long_name = "high cloud layer amt" ;
	cloud_high:units = "decimal" ;
float dlwrf_sfc(max_site_num, days, fc_times_per_day) ;	
	dlwrf_sfc:long_name = "downward long wave radiation flux at surface" ;
	dlwrf_sfc:units = "W/m2" ;
float dswrf_sfc(max_site_num, days, fc_times_per_day) ;	
	dswrf_sfc:long_name = "downward short wave radiation flux at surface" ;
	dswrf_sfc:units = "W/m2" ;
float albedo_sfc(max_site_num, days, fc_times_per_day) ;	
	albedo_sfc:long_name = "albedo at surface" ;
	albedo_sfc:units = "percent" ;

7.8.2.2 netCDF Schema for Road Surface Condition Forecast Data

Road Surface Condition Forecast data is generated in a file of type netCDF. A new file is generated once per hour. The Road Surface Condition Forecast data files are located on the Pikalert Server in the following location, where the final path element is the year, month and date of creation of files in the directory:

```
/d1/vii/data/forecast/merge_rec_tmt/YYYYMMDD/
```

The netCDF files are named as follows, with the date and time in the name:

`merge_rec_tmt.YYYYMMDD.HHMM.nc`

Table 7-10. netCDF Dimensions for Road Surface Condition Forecast Data File

netCDF File Dimensions
max_site_num = 6080 ;
days = 8 ;
fc_times_per_day = 24 ;
max_str_len = 80 ;
num_times = 78 ;

Table 7-11. netCDF Variable Definitions for Road Surface Condition Forecast Data File

netCDF Variable Name & Dimension	netCDF Variable Content Definition
double creation_time ;	
	creation_time:long_name = "time at which forecast file was created" ;
	creation_time:units = "seconds since 1970-1-1 00:00:00" ;
double forc_time ;	
	forc_time:long_name = "time of earliest forecast" ;
	forc_time:units = "seconds since 1970-1-1 00:00:00" ;
int num_sites ;	
	num_sites:long_name = "number of actual_sites" ;
int site_list(max_site_num) ;	
	site_list:long_name = "forecast site id numbers" ;
int type ;	
	type:long_name = "cdl file type" ;
float application_rate(max_site_num, days, fc_times_per_day) ;	
	application_rate:long_name = "chemical application rate" ;
	application_rate:units = "lb/lane-mile" ;
	application_rate:reference = "units for solids" ;
float apply_chem(max_site_num, days, fc_times_per_day) ;	
	apply_chem:long_name = "apply chemicals" ;
	apply_chem:values = "0 or 1" ;
float available_H2O(max_site_num, days, fc_times_per_day) ;	
	available_H2O:long_name = "water available for chemical dilution" ;
	available_H2O:units = "lb/ft2" ;
float available_chem(max_site_num, days, fc_times_per_day) ;	
	available_chem:long_name = "pure de-icing chemicals on road" ;

netCDF Variable Name & Dimension	netCDF Variable Content Definition
	available_chem:units = "lb/ft2" ;
float bridge_T(max_site_num, days, fc_times_per_day) ;	
	bridge_T:long_name = "bridge surface temperature" ;
	bridge_T:units = "Celsius" ;
float bridge_TempF(max_site_num, days, fc_times_per_day) ;	
	bridge_TempF:long_name = "road surface temperature" ;
	bridge_TempF:units = "Fahrenheit" ;
float bridge_frost_potential_index(max_site_num, days, fc_times_per_day) ;	
	bridge_frost_potential_index:long_name = "potential for frost on bridge category" ;
	bridge_frost_potential_index:value0 = "None" ;
	bridge_frost_potential_index:value1 = "Low" ;
	bridge_frost_potential_index:value2 = "Medium" ;
	bridge_frost_potential_index:value3 = "High" ;
float chem_form(max_site_num, days, fc_times_per_day) ;	
	chem_form:long_name = "chemical form" ;
	chem_form:value0 = "Dry" ;
	chem_form:value1 = "Prewet" ;
	chem_form:value2 = "Liquid" ;
float chem_type(max_site_num, days, fc_times_per_day) ;	
	chem_type:long_name = "chemical type" ;
	chem_type:value0 = "Not set" ;
	chem_type:value1 = "NACL" ;
	chem_type:value2 = "CACL2" ;
	chem_type:value3 = "MGCL2" ;
	chem_type:value4 = "CMA" ;
	chem_type:value5 = "KAC" ;
	chem_type:value6 = "Caliber" ;
	chem_type:value7 = "IceSlicer" ;
	chem_type:value8 = "IceBan" ;
float chemical_concentration(max_site_num, days, fc_times_per_day) ;	
	chemical_concentration:long_name = "chemical concentration" ;
	chemical_concentration:units = "percent" ;
float do_plowing(max_site_num, days, fc_times_per_day) ;	
	do_plowing:long_name = "do plowing" ;

netCDF Variable Name & Dimension	netCDF Variable Content Definition
	do_plowing:values = "0 or 1" ;
float mobility(max_site_num, days, fc_times_per_day) ;	
	mobility:long_name = "net mobility" ;
	mobility:values = "0.0 to 1.0" ;
float nominal_chem(max_site_num, days, fc_times_per_day) ;	
	nominal_chem:long_name = "theoretical chem concentration" ;
	nominal_chem:units = "percent" ;
float phase_type(max_site_num, days, fc_times_per_day) ;	
	phase_type:long_name = "road water phase" ;
	phase_type:value0 = "Dry" ;
	phase_type:value1 = "Wet" ;
	phase_type:value2 = "Chemically wet" ;
	phase_type:value3 = "Chemically ice" ;
	phase_type:value4 = "Slush" ;
	phase_type:value5 = "Snow" ;
	phase_type:value6 = "Ice" ;
float precip_type(max_site_num, days, fc_times_per_day) ;	
	precip_type:long_name = "precip type on road" ;
	precip_type:value0 = "None" ;
	precip_type:value1 = "Rain" ;
	precip_type:value2 = "Snow" ;
	precip_type:value3 = "Mixed rain/snow" ;
	precip_type:value4 = "Mixed snow/rain" ;
	precip_type:value5 = "Freezing rain" ;
float road_T(max_site_num, days, fc_times_per_day) ;	
	road_T:long_name = "road surface temperature" ;
	road_T:units = "Celsius" ;
float road_TempF(max_site_num, days, fc_times_per_day) ;	
	road_TempF:long_name = "road surface temperature" ;
	road_TempF:units = "Fahrenheit" ;
float road_frost_potential_index(max_site_num, days, fc_times_per_day) ;	
	road_frost_potential_index:long_name = "potential for frost on road category" ;
	road_frost_potential_index:value0 = "None" ;
	road_frost_potential_index:value1 = "Low" ;

netCDF Variable Name & Dimension	netCDF Variable Content Definition
	road_frost_potential_index:value2 = "Medium" ;
	road_frost_potential_index:value3 = "High" ;
float snow_depth(max_site_num, days, fc_times_per_day) ;	
	snow_depth:long_name = "snow depth on road" ;
	snow_depth:units = "mm" ;
float snow_depth_inches(max_site_num, days, fc_times_per_day) ;	
	snow_depth_inches:long_name = "snow depth on road" ;
	snow_depth_inches:units = "in" ;
char treatment_explanation(max_site_num , days, fc_times_per_day, max_str_len) ;	
	treatment_explanation:long_name = "treatment explanation string" ;
float treatment_explanation_index(max_site_num, days, fc_times_per_day) ;	
	treatment_explanation_index:long_name = "treatment explanation index" ;
float treatment_time(max_site_num, days, fc_times_per_day) ;	
	treatment_time:long_name = "offset from current hour to apply treatment" ;
	treatment_time:units = "hour" ;
	treatment_time:values = "-1 to num_times" ;
float bridge_T(max_site_num, days, fc_times_per_day) ;	
	bridge_T:long_name = "bridge surface temperature" ;
	bridge_T:units = "Celsius" ;
float bridge_TempF(max_site_num, days, fc_times_per_day) ;	
	bridge_TempF:long_name = "road surface temperature" ;
	bridge_TempF:units = "Fahrenheit" ;
float bridge_frost_potential_index(max_site_num, days, fc_times_per_day) ;	
	bridge_frost_potential_index:long_name = "potential for frost on bridge category" ;
	bridge_frost_potential_index:value0 = "None" ;

7.8.3 Pikalert Weather Forecast Data: Oracle Schema

```
create table PIKALERT_SITE (
      SITE_NUM number(12,0) unique not null,
      SITE_ID varchar2(10 char) unique not null,
      DATA_TIME_UTC timestamp(0),
      OBS_ALERT_CODE varchar2(20 char),
      HR06_ALERT_CODE varchar2(20 char),
      HR24_ALERT_CODE varchar2(20 char),
      HR72_ALERT_CODE varchar2(20 char),
      IS_RWIS_SITE char(1),
      IS_WX_OBS_SITE char(1),
      IS_ROAD_COND_SITE char(1),
      LON number(9,6),
      LAT number(8,6),
      DESCRIPTION varchar2(100));

create table PIKALERT_TIME_SAMPLE (
      SITE_NUM number(12,0) not null,
      TIME_UTC timestamp(0) not null,
      PAVEMENT varchar2(50),
      CHEM_FORM varchar2(50),
      VISIBILITY varchar2(50),
      EXPLANATION varchar2(50),
      TREATMENT_ALERT_CODE varchar2(50),
      PLOW varchar2(50),
      PRECIP varchar2(50),
      CHEMICAL varchar2(50),
      CHEM_TYPE varchar2(50),
      CHEMICAL_CONCENTRATION number(5,0),
      ALERT_CODE varchar2(50),
      ROAD_TEMP number(5,0));
```

7.9 WYDOT Conditions/Closures

7.9.1 Oracle Table Structure for Conditions/Closures

To create messages for WYDOT road conditions the data is collected from six Oracle tables: WRR.SEGMENTS, WRR.SEGROADS_JOIN, WRR.ROADS, GIS.WTI2_EVENTS, GIS.MOB_APP_COORDS_FC_WM and WRR.WTI_CURRENT. These tables provide the reported conditions as well as information about each reported road section such as route, landmarks and mileposts with corresponding latitude and longitude.

All of the information is collected through a view: WRR.DATAFEED_COND_VW. The view utilizes one existing function, WRR.COMMON_NAMES_LU, to provide the public name for the route such as I-80/US-30. The data is then translated into TMDD V3.03c compliant messages as defined in the Messages section below.

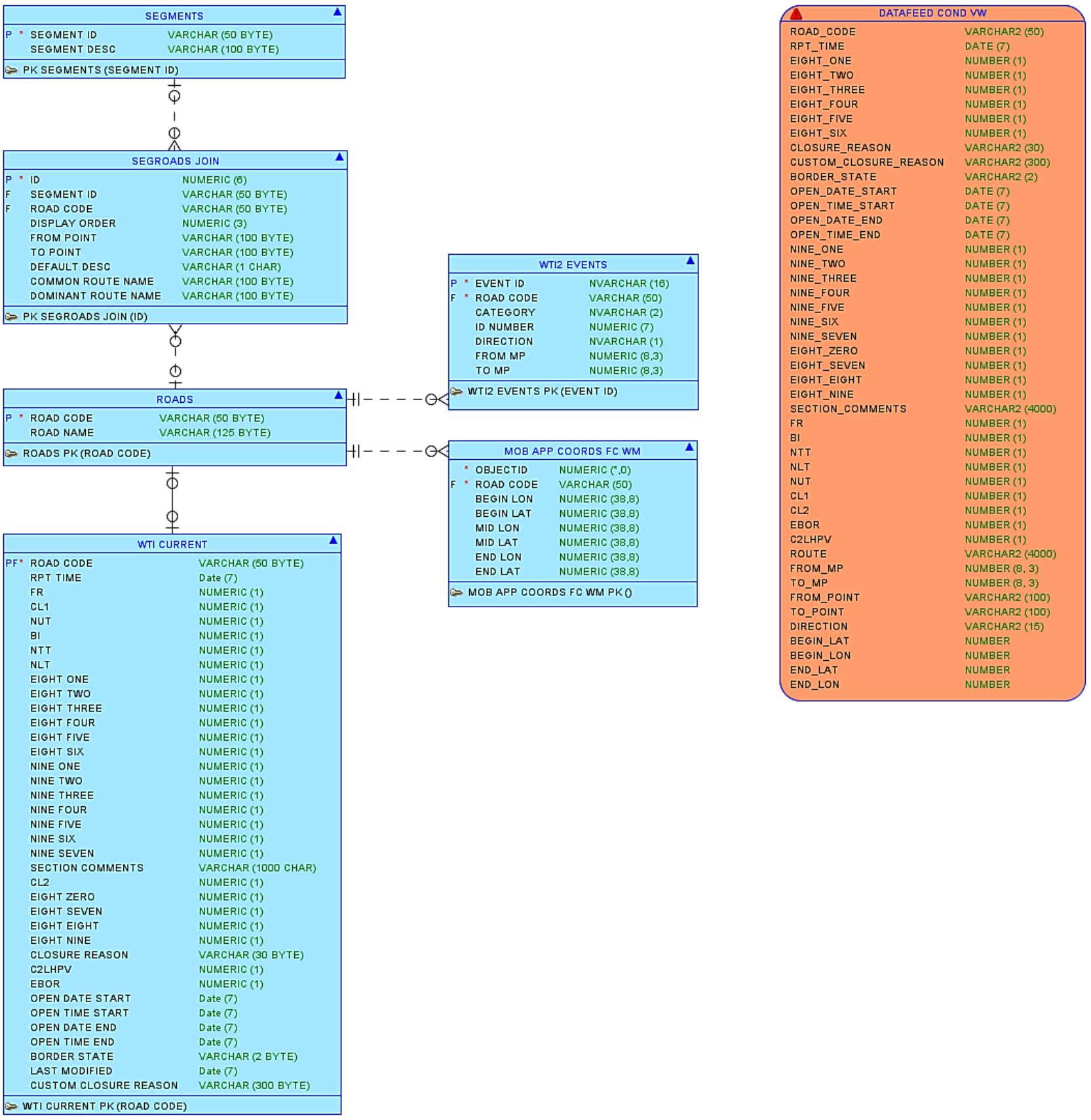


Figure 7-4. Oracle Table Structure for WYDOT Conditions/Closures

7.9.2 TMDD Elements for Road Conditions

WYDOT road condition, advisory and closure codes are passed through the TPI using the TMDD FullEventUpdate message and map to TMDD elements as follows:

Table 7-12: TMDD ITIS codes for WYDOT Road Conditions, Advisories and Closures

WYDOT Code	WYDOT Description	TMDD Element Name	TMDD Element Type	TMDD Element Value	Comments
81	Dry	pavement-conditions	itis:PavementConditions	dry pavement	
82	Wet	pavement-conditions	itis:PavementConditions	wet pavement	
83	Slick	pavement-conditions	itis:PavementConditions	ice	
84	Slick in Spots	pavement-conditions	itis:PavementConditions	icy patches	
85	Drifted Snow	pavement-conditions	itis:PavementConditions	snow drifts	
86	Closed	closures	itis:Closures	closed	
Closure Reason	Winter Conditions	pavement-conditions	itis:PavementConditions	winter conditions	Added to ITIS-Local-03-00-02
Closure Reason	Construction	roadwork	itis:Roadwork	road construction	
Closure Reason	Crash	accidents-and-incidents	itis:AccidentsAndIncidents	accident	
Closure Reason	Fire	disasters	itis:Disasters	fire	Added to ITIS-Local-03-00-02
Closure Reason	Hazardous Material	accidents-and-incidents	itis:AccidentsAndIncidents	hazardous materials spill	
Closure Reason	Weather Emergency	disasters	itis:Disasters	weather emergency	Added to ITIS-Local-03-00-02
Closure Reason	Landslide or Rock fall	obstruction	itis:Obstruction	landslide	
Closure Reason	Avalanche Control	roadwork	itis:Roadwork	avalanche control activities	
Closure Reason	Livestock	obstruction	itis:Obstruction	herd of animals on roadway	
Closure Reason	Wide Load	mobile-situation	itis:MobileSituation	wide load	
Closure Reason	Local Celebration	special-events	itis:SpecialEvents	local celebration	Added to ITIS-Local-03-00-02
Closure Reason	Seasonal Closure	closures	itis:Closures	closed for the season	
Closure Reason	Border State Request from Colorado	closures	itis:Closures	closed due to border state request from Colorado	Added to ITIS-Local-03-00-02
Closure Reason	Border State Request from Idaho	closures	itis:Closures	closed due to border state request from Idaho	Added to ITIS-Local-03-00-02
Closure Reason	Border State Request from Montana	closures	itis:Closures	closed due to border state request from Montana	Added to ITIS-Local-03-00-02

WYDOT Code	WYDOT Description	TMDD Element Name	TMDD Element Type	TMDD Element Value	Comments
Closure Reason	Border State Request from Nebraska	closures	itis:Closures	closed due to border state request from Nebraska	Added to ITIS-Local-03-00-02
Closure Reason	Border State Request from South Dakota	closures	itis:Closures	closed due to border state request from South Dakota	Added to ITIS-Local-03-00-02
Closure Reason	Border State Request from Utah	closures	itis:Closures	closed due to border state request from Utah	Added to ITIS-Local-03-00-02
Closure Reason	Border State Request from Multiple States	closures	itis:Closures	closed due to border state request from Multiple States	Added to ITIS-Local-03-00-02
Closure Reason	Custom	closures	itis:Closures	closed	Custom closures will generate a closure element as well as a description element to contain the free text closure reason.
Closure Reason		description	Event-description-notes-and-comments	Free text element	
Closure Reason	Law Enforcement Request	closures	itis:Closures	closed due to law enforcement request	Added to ITIS-Local-03-00-02
Closure Reason	Local Authority Request	closures	itis:Closures	closed due to local authority request	Added to ITIS-Local-03-00-02
Closure Reason	Blowing Snow	visibility-and-air-quality	itis:VisibilityAndAirQuality	blowing snow	
Closure Reason	Reduced Visibility	visibility-and-air-quality	itis:VisibilityAndAirQuality	visibility reduced	
92	Snow	precipitation	itis:Precipitation	snow	
93	Rain	precipitation	itis:Precipitation	rain	
94	Strong Wind	winds	itis:Winds	strong winds	
95	Fog	visibility-and-air-quality	itis:VisibilityAndAirQuality	fog	
96	Blowing Snow	visibility-and-air-quality	itis:VisibilityAndAirQuality	blowing snow	
97	Reduced Visibility	visibility-and-air-quality	itis:VisibilityAndAirQuality	visibility reduced	
BI	Black Ice	pavement-conditions	itis:PavementConditions	black ice	
NTT	No Trailer Traffic	restriction-class	itis:RestrictionClass	no trailers	
ANLT	Advise No Light Trailers	restriction-class	itis:RestrictionClass	advise no light trailers	Added to ITIS-Local-03-00-02
CL1	Chain Law 1	winter-driving-restrictions	itis:WinterDrivingRestrictions	snow tires or chains required	Added to ITIS-Local-03-00-02
CL2	Chain Law 2	winter-driving-restrictions	itis:WinterDrivingRestrictions	chains or all wheel drive with snow tires required	Added to ITIS-Local-03-00-02

WYDOT Code	WYDOT Description	TMDD Element Name	TMDD Element Type	TMDD Element Value	Comments
NUT	No Unnecessary Travel	adviceInstructionsRecommendations	itis:AdviceInstructionsRecommendations	only travel if absolutely necessary	
FR	Falling Rock	adviceInstructionsRecommendations	itis:AdviceInstructionsRecommendations	watch for falling rock	Added to ITIS-Local-03-00-02
EBOR	Extreme Blow Over Risk	warningAdvice	itis:WarningAdvice	extreme blow over risk	Added to ITIS-Local-03-00-02
C2LHPV	Closed to light, high profile vehicles	restriction-class	itis:RestrictionClass	closed to light, high profile vehicles	Added to ITIS-Local-03-00-02

7.10 WYDOT Construction Projects

7.10.1 Oracle Table Structure for Construction Projects

To create messages for WYDOT construction projects the data is collected from nine Oracle tables: CONADMIN.DELAY_CHOICES, CONADMIN, DAYSOFWEEK_LUT, CONADMIN.DELAYS, CONADMIN.ROAD_SUB_EVENTS, CONADMIN.PROJECTS, CONADMIN.CONTACT_CHOICES, CONADMIN.CONTRACTOR_CHOICES, CONADMIN.TOWNS, CONADMIN.TOWN_CHOICES. These tables provide project information such as description, location, delays and contact information.

All of the information is collected through two views: WRR.CONST_ALL_DELAYS_VW and WRR.CONST_ACTIVE_PROJECTS_VW. The data is then translated into TMDD V3.03c compliant messages as defined in the Messages section below.

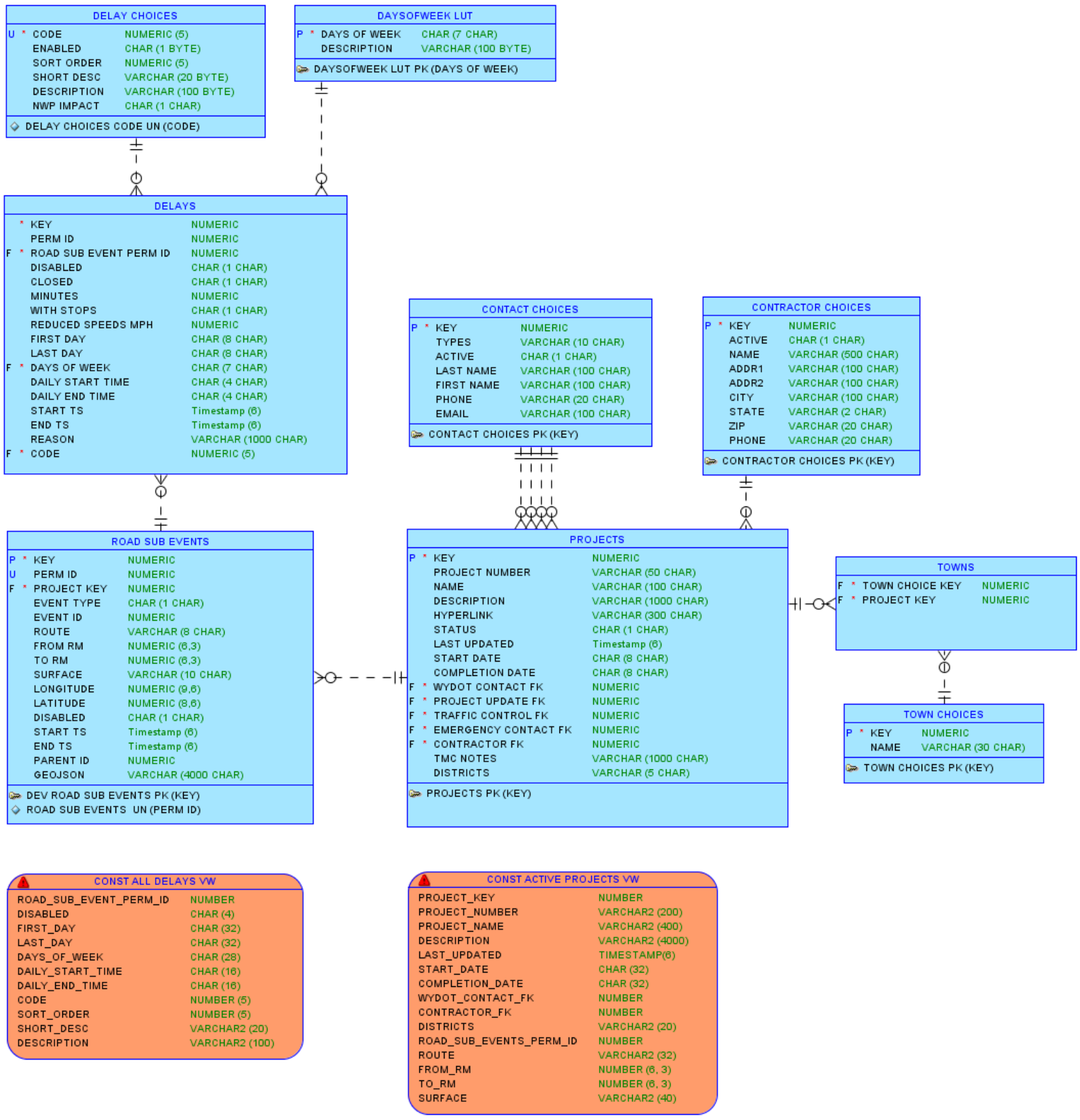


Figure 7-5. Oracle Table Structure for WYDOT Construction Projects.
Source: WYDOT

7.11 WYDOT Incidents

7.11.1 Oracle Table Structure for Incidents

To create messages for WYDOT incidents the data is collected from one Oracle table: TMCTOOLS.INCIDENT. This table provides incident information such as the problem, effect, recommended action and location.

The information is collected through the WRR.DATAFEED_INCIDENT_VW view. The data is then translated into TMDD V3.03c compliant messages as defined in the Messages section below.

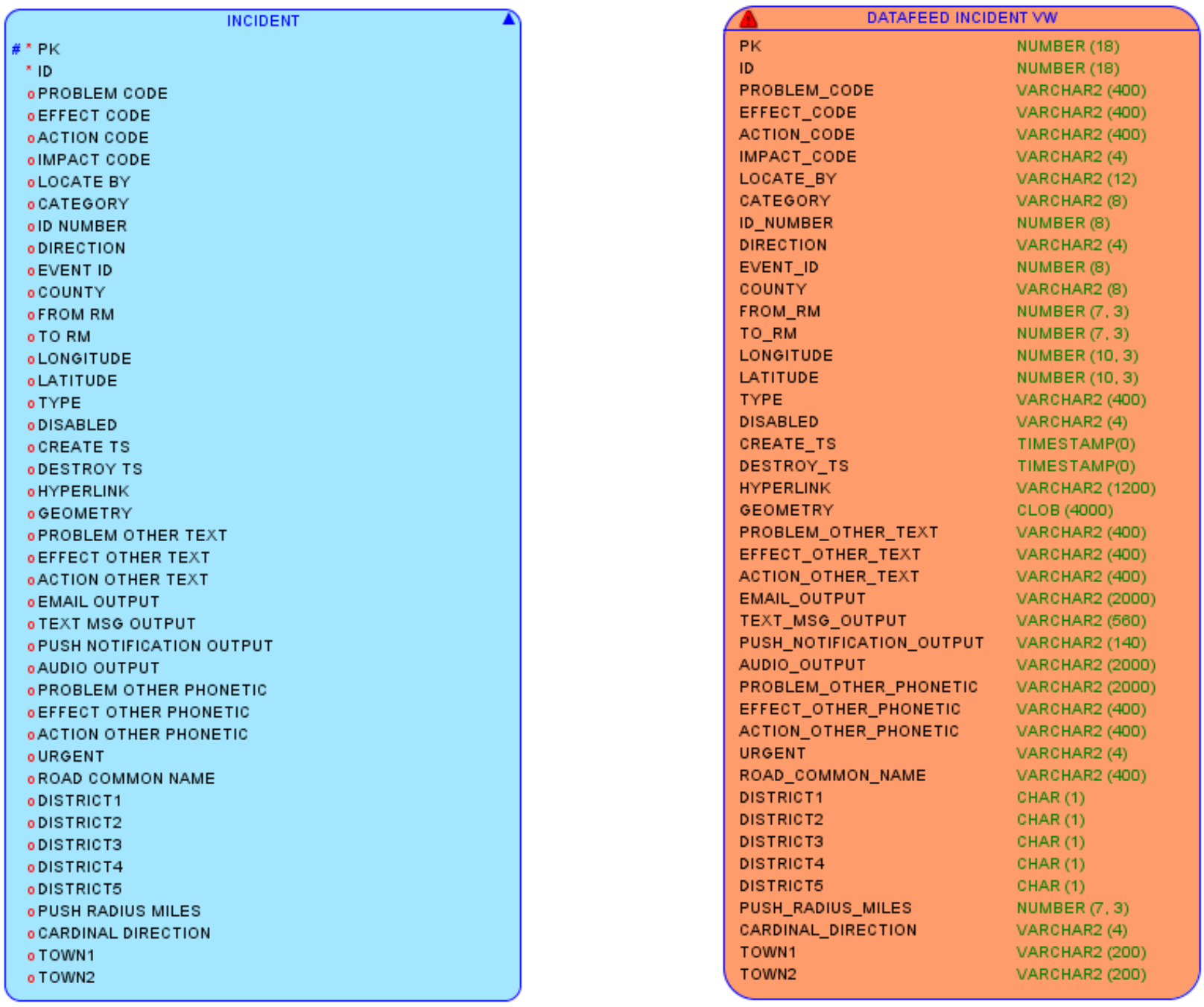


Figure 7-6. Oracle Table Structure for WYDOT Incidents
Source: WYDOT

7.11.2 TMDD Elements for Incident Problem Codes

WYDOT incident problem codes are passed through the TPI using the TMDD FullEventUpdate message and map to TMDD elements as follows:

Table 7-13: WYDOT Incident Problem Codes to ITIS Codes

Incident Console Code	Incident Console Problem Description	TMDD Element Name	TMDD Element Type	TMDD Element Value	Comments
crash	Crash	accidents-and-incidents	itis:AccidentsAndIncidents	accident	
crashes	Multiple crashes	accidents-and-incidents	itis:AccidentsAndIncidents	numerous accidents	
hazMat	Hazardous material clean-up	incidentResponseStatus	itis:IncidentResponseStatus	hazardous material clean-up	Added to ITIS-Local-03-00-02
trainDerail	Train derailment	disasters	itis:Disasters	rail crash	
livestock	Livestock on highway	obstruction	itis:Obstruction	herd of animals on roadway	
local	Local event	special-events	itis:SpecialEvents	local celebration	Added to ITIS-Local-03-00-02
stall	Stalled vehicle	accidents-and-incidents	itis:AccidentsAndIncidents	stalled vehicle	
stallSemi	Stalled semi truck	accidents-and-incidents	itis:AccidentsAndIncidents	disabled semi trailer	
slow	Slow moving traffic	traffic-conditions	itis:TrafficConditions	slow traffic	
slowOver	Slow, oversize load	mobile-situation	itis:MobileSituation	slow, oversize load	Added to ITIS-Local-03-00-02
stop	Stopped traffic	traffic-conditions	itis:TrafficConditions	stopped traffic	
flood	Area flooding	obstruction	itis:Obstruction	flooding	
avalanche	Avalanche	obstruction	itis:Obstruction	avalanche	
avalancheControl	Avalanche control	roadwork	itis:Roadwork	avalanche control activities	
mudslide	Mudslide	obstruction	itis:Obstruction	mudslide	
landslide	Landslide	obstruction	itis:Obstruction	landslide	
rockslide	Rockslide	obstruction	itis:Obstruction	rockfall	
fire	Fire	disasters	itis:Disasters	fire	Added to ITIS-Local-03-00-02
wildfire	Wildfire	disasters	itis:Disasters	wildfire	

Incident Console Code	Incident Console Problem Description	TMDD Element Name	TMDD Element Type	TMDD Element Value	Comments
downPowerline	Downed power line	obstruction	itis:Obstruction	downed power lines	
roadwork	Roadwork	roadwork	itis:Roadwork	road construction	
signInstall	Sign installation	roadwork	itis:Roadwork	sign installation	Added to ITIS-Local-03-00-02
roadDamage	Road damage	pavement-conditions	itis:PavementConditions	road surface in poor condition	
pilotCar	Pilot car in operation	warningAdvice	itis:WarningAdvice	pilot car in operation	
maintenance	Watch for maintenance personnel	warningAdvice	itis:WarningAdvice	look out for workers	
mowing	Mowing operations	roadwork	itis:Roadwork	mowing operations	Added to ITIS-Local-03-00-02
cops	Law enforcement activity	warningAdvice	itis:WarningAdvice	law enforcement activity	Added to ITIS-Local-03-00-02
emerVeh	Emergency vehicles	unusual-driving	itis:UnusualDriving	emergency vehicles on roadway	
other	Other	accidents-and-incidents	itis:AccidentsAndIncidents	incident	"Other" incidents will generate an accidents and incidents element as well as a description element to contain the free text incident description.
		description	Event-description-notes-and-comments	Free text element	

7.11.3 TMDD Elements for WYDOT Incident Effect Codes

WYDOT incident effect codes are passed through the TPI using the TMDD FullEventUpdate message and map to TMDD elements as follows:

Table 7-14: WYDOT Incident Effect Codes to ITIS Codes

Incident Console Code	Incident Console Effect Description	TMDD Element Name	TMDD Element Type	TMDD Element Value	Comments
leftClosed	Left lane blocked	closures	itis:Closures	left lane blocked	Added to ITIS-Local-03-00-02
centerClosed	Center lane blocked	closures	itis:Closures	center lane blocked	Added to ITIS-Local-03-00-02

rightClosed	Right lane blocked	closures	itis:Closures	right lane blocked	Added to ITIS-Local-03-00-02
allClosed	All lanes closed	closures	itis:Closures	all lanes closed	Added to ITIS-Local-03-00-02
shoulderClosed	Shoulder closed	closures	itis:Closures	shoulder closed	Added to ITIS-Local-03-00-02
travelBlocked	Travel lane blocked	closures	itis:Closures	travel lane blocked	Added to ITIS-Local-03-00-02
other	Other	description	Event-description-notes-and-comments	Free text element	

7.11.4 TMDD Elements for Incident Action Codes

WYDOT incident action codes are passed through the TPI using the TMDD FullEventUpdate message and map to TMDD elements as follows:

Table 7-15: WYDOT Incident Action Codes to ITIS Codes

Incident Console Code	Incident Console Action Description	TMDD Element Name	TMDD Element Type	TMDD Element Value	Comments
caution	Proceed with caution	adviceInstructions Recommendations	itis:AdviceInstructions Recommendations	proceed with caution	Added to ITIS-Local-03-00-02
delays	Expect delays	adviceInstructions Recommendations	itis:AdviceInstructions Recommendations	expect delays	Added to ITIS-Local-03-00-02
other	Other	description	Event-description-notes-and-comments	Event-description-notes-and-comments	Free text element
slow	Prepare to slow down	adviceInstructions Recommendations	itis:AdviceInstructions Recommendations	prepare to slow down	Added to ITIS-Local-03-00-02
stop	Be prepared to stop, expect delays	adviceInstructions Recommendations	itis:AdviceInstructions Recommendations	be prepared to stop	This action code will create two elements in the xml. Use with the "Expect delays" element.
delays		adviceInstructions Recommendations	itis:AdviceInstructions Recommendations	expect delays	
toRamp	Traffic being diverted onto interchange ramps	adviceInstructions Mandatory	itis:AdviceInstructions Mandatory	traffic being diverted onto interchange ramps	Added to ITIS-Local-03-00-02
toShoulder	Traffic being diverted onto shoulder. Expect delays	adviceInstructions Mandatory	itis:AdviceInstructions Mandatory	traffic being diverted onto shoulder	This action code will create two elements in the xml. Use with the "Expect delays" element.
delays		adviceInstructions Recommendations	itis:AdviceInstructions Recommendations	expect delays	
useAlt	Use alternate route	alternateRoute	itis:AlternateRoute	use alternate route	Added to ITIS-Local-03-00-02

7.12 WYDOT Road Restrictions

7.12.1 Oracle Table Structure for Restrictions

To create messages for WYDOT restrictions the data is collected from a view that uses an existing Oracle database link to the WYDOT headquarters restriction database. The view, WRR.DATAFEED_RESTRICTIONS_VW, provides information such as route, restriction type and location. The data is then translated into TMDD V3.03c compliant messages as defined in the Messages section below.

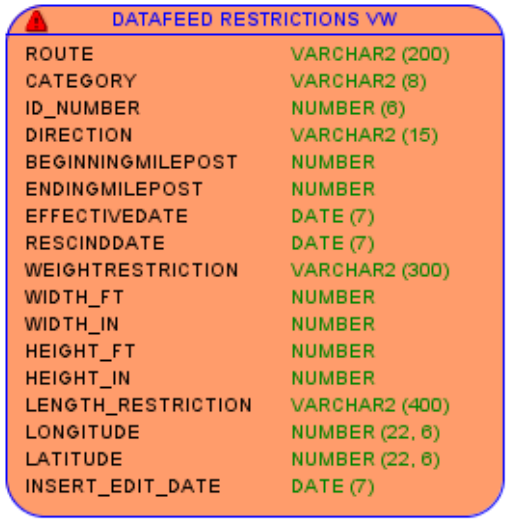


Figure 7-7. Oracle Table Structure for WYDOT Restrictions
Source: WYDOT

7.13 OBU, RSU, HMI Log Files

7.13.1 Log Files

Note: Some details about the OBU log files are still under review. The missing details in the table below will be updated in the next release of the ICD.

File Size Limit and Compression

- Logs will be kept under 100kb in size
- Each log file will be zipped (gzip)

Signatures and ODE Handling

- Each log file will be encrypted with the ODE public key (ODE using SSH key not SCMS)
- ODE will need to parse and retain data from the log file name and additional fields within log (like time from BSM)
- All TIMs and BSMs that are logged need to have signatures validated and the log file needs to note if the validations passed or failed (for RSUs and OBUs).

Time Stamps

- Time stamps will be UTC in ISO format (2017-06-30T19:53:00:000)
- Time for log files will be in UTC in 1 milliseconds from UNIX epoch (this time will be from the logging OBU system time sync'ed to GPS, so not from the 1609.2 header based approach from the generating system security header)

Log file retention:

- Logs deleted if over 7 days old
- Logs purge order defined below for automated purging by OBU firmware to protect storage
- Logs deleted when sent to ODE
- Logs retained through reboots

Log File Names

- Log file names must be unique to previously uploaded files.
- File name will contain integrated time/date stamp (time of log file creation). The UTC portion of the file name will include (4) characters for the year, (2) characters for the month, (2) characters for the day, (2) characters for the hour, (2) characters for the minute and (2) characters for the seconds.
- File name will contain IPv6 OBU address
- File name will contain type of log
- Examples:
    - <type identifier>_<UTC time and date stamp>_<IPv6 addr>.<TXT. or CSV or JSON>gzip

Table 7-16: OBU Log Files

OBU Log Type, Priority	Log File Name & ODE Upload Destination	Covered Records (Defined in sub-section: **7.13.2**)	Note:
Driver Alert (sent third, purge ninth)	/mnt/chroot/uploads/backups/ Driver_Alert_<date-time>_<OBUIP>	driverAlertRecord	Contains: Location, time, alert (FCW, TIM, not DNM) Example: 2558670-driverAlert_1593028657570_2620:31:40e0:846:226:adff:fe05:5c21.csv
BSM 30 Sec (sent eighth, purge second)	/usr/local/src/ode/jpo-ode/uploads/messageframe/ BSM_30Second_<date-time>_<OBUIP>.UPER.gzip	bsmTxRecord	Add time to each record for all BSMs (from system time)
BSMs for Event (sent ninth, purge first)	BSM_Event_<date-time>_<OBUIP>.UPER.gzip	bsmTxRecord for V2I bsmTxRecord bsmRxRecord for V2V	10 seconds before, event, 10 seconds after all at 10 Hz) (sent ninth, purge first) Driver alert Received BSMs from remote vehicle(s), also record host vehicle BSMs If event is longer than 1-minute drop to 1 Hz for host and remove vehicles Add time to each record for all BSMs (from system time)
Received TIM Messages (sent sixth, purge third)	/usr/local/src/ode/jpo-ode/uploads/messageframe Received_Message_<date-time>_<OBUIP>.UPER.gzip	receivedMsgRecord	TIMs from RSU and Satellite, message, location, method of reception (Sat/RSU) and time, only log messages within 20-mile radius and only log first time message is received
Environmental (sent second, purge seventh)	Environmental _<date-time>_<OBUIP>.txt.gzip	The content of this log file is defined in Section: **7.7**.	The Lear HMI application will periodically transfer environmental log files from the HMI to the OBU. The Lear HMI application will also take care of purging log files from the HMI according to the design specified in the **SDD Section 3.2.5.1.3** and **SDD Section 3.2.6.6.4.2**.

OBU Log Type, Priority	Log File Name & ODE Upload Destination	Covered Records (Defined in sub-section: **7.13.2**)	Note:
DNM (sent first, purge eight)	/mnt/chroot/wyocv/uploads/backup/ dnMsg_<date-time>_<OBUIP>	dnmMsgRecord	Location, time, DNM (log first unique DNM for Distressed vehicle and for each relay/received vehicle) Example: 1457649559-dnMsg_1586299492846_2620:31:40e0:850:226:adff:fe05:5c21.csv
OBU upgrades (sent forth, purge fourth)		updatesSystemLogRecord	Log success/fail of firmware updates Log availability of firmware updates
SCMS (sent seventh, purge fifth)		N/A	Log connections to SCMS
System Log (send fifth, purge sixth)		updatesSystemLogRecord	Very PII sensitive, just for internal use and will have to be locked down and encrypted, may want to exclude collection of this once the pilot is working well. Boot and shutdown location/time Application errors and re-starts OBU unique identifier

Table 7-17: RSU Log Files

RSU Log Type	Log File Name & Upload Destination	Covered Records (Defined in sub-section: 7.13.2)	Note:
All received BSMs	/mnt/chroot/wyocv/uploads/backup/ rxMsg_<date-time>_<RSUIP>.	receivedMsgRecord	Add time to each record for all BSMs (from system time) Example: 2700951-rxMsg_1580549991314_2620:31:40e0:804::1.csv

RSU Log Type	Log File Name & Upload Destination	Covered Records (Defined in sub-section: 7.13.2)	Note:
Received TIM Messages	/usr/local/src/ode/jpo-ode/uploads/messageframe Received_Message_<date-time>_<RSUIP>.UPER.gzip	receivedMsgRecord	IMs from RSU and Satellite, message, location, method of reception (Sat/RSU) and time, only log messages within 20-mile radius and only log first time message is received
RSU upgrades			
SCMS			
System Log		updatesSystemLogRecord	

Table 7-18: HMI Log Files

HMI Log Type	Log File Name & Upload Destination	Covered Records (Defined in sub-section: 7.13.2)	Note:
Driver Alert	/mnt/chroot/wyocv/uploads/backup/ Driver_Alert_<date-time>_<OBUIP>	driverAlertRecord	Contains: Location, time, alert (FCW, TIM, not DNM) Example: 2558670-driverAlert_1593028657570_2620:31:40e0:846:226:adff:fe05:5c21.csv
Application start/stop and crashes log		receivedMsgRecord	Add time to each record for all BSMs (from system time)
DNM	/mnt/chroot/wyocv/uploads/backup/ dnMsg_<date-time>_<OBUIP>	dnmMsgRecord	Location, time, DNM (log first unique DNM for Distressed vehicle and for each relay/received vehicle) 1457649559-dnMsg_1586299492846_2620:31:40e0:850:226:adff:fe05:5c21.csv
Environmental			Application errors

7.13.2 OBU Log File Record Definitions (C Header file)

```
/*
 * Copyright (c) 2017 Lear Corporation. All rights reserved.
 * Proprietary and Confidential Material.
 *
 */
#ifndef _LOG_CONFIGURATIONS_H_
#define _LOG_CONFIGURATIONS_H_

#define MAX_ISO_TIME_LEN 23
#define MAX_STRING_LEN 255
#define MAX_PAYLOAD_SIZE 2302 //as per 1609.3 std

/* securityResultCode contains below result codes */
typedef enum _securityResultCode { /* from dot3 */
      success = 1,
      inconsistentInputParameters = 2,
      spduParsingInvalidInput = 3,
      spduParsingUnsupportedCriticalInformationField = 4,
      spduParsingCertificateNotFound = 5,
      spduParsingGenerationTimeNotAvailable = 6,
      spduParsingGenerationLocationNotAvailable = 7,
      spduCertificateChainNotEnoughInformationToConstructChain = 8,
      spduCertificateChainChainEndedAtUntrustedRoot = 9,
      spduCertificateChainChainWasTooLongForImplementation = 10,
      spduCertificateChainCertificateRevoked = 11,
      spduCertificateChainOverdueCRL = 12,
      spduCertificateChainInconsistentExpiryTimes = 13,
      spduCertificateChainInconsistentStartTimes = 14,
      spduCertificateChainInconsistentChainPermissions = 15,
      spduCryptoVerificationFailure = 16,
      spduConsistencyFutureCertificateAtGenerationTime = 17,
      spduConsistencyExpiredCertificateAtGenerationTime = 18,
      spduConsistencyExpiryDateTooEarly = 19,
      spduConsistencyExpiryDateTooLate = 20,
      spduConsistencyGenerationLocationOutsideValidityRegion = 21,
      spduConsistencyNoGenerationLocation = 22,
      spduConsistencyUnauthorizedPSID = 23,
      spduInternalConsistencyExpiryTimeBeforeGenerationTime = 24,
      spduInternalConsistencyextDataHashDoesntMatch = 25,
      spduInternalConsistencynoExtDataHashProvided = 26,
      spduInternalConsistencynoExtDataHashPresent = 27,
      spduLocalConsistencyPSIDsDontMatch = 28,
      spduLocalConsistencyChainWasTooLongForSDEE = 29,
      spduRelevanceGenerationTimeTooFarInPast = 30,
      spduRelevanceGenerationTimeTooFarInFuture = 31,
      spduRelevanceExpiryTimeInPast = 32,
      spduRelevanceGenerationLocationTooDistant = 33,
      spduRelevanceReplayedSpdu = 34,
      spduCertificateExpired = 35
} securityResultCode;
```

```
typedef enum _rxSource {
      RSU = 0,
      SAT, //XM satelite
      RV, /* for BSM rx */
      SNMP /* for SRM payload from backend/ODE*/
} rxSource;

/* below elements units are as per SAE-2735 */
typedef struct _location {
      uint32_t latitude;
      uint32_t longitude;
      uint32_t elevation;
      uint16_t heading;
      uint32_t speed;
} __attribute__((__packed__)) location;

/*
 * LEAR:
 * Respective log files will have dump of below mentioned respective records.
 * "DriverAlert_msec_ipv6.csv.gzip" file will have dump of continues
"driverAlertRecord" records.
 *
 * Reading records from file:
 * fd = open("BSM30Sec_msec_ipv6.csv", O_RDONLY, 0666);
 * read(fd, &bsmTxRecord.timeInISO, MAX_ISO_TIME_LEN);
 * read(fd, &bsmTxRecord.length, 2(size of length:uint16_t));
 * read(fd, &bsmTxRecord.payload, bsmTxRecord.length);
 */

typedef struct _driverAlertRecord {
      location curLocation;
      char timeInISO[MAX_ISO_TIME_LEN];
      uint16_t length;
      char alert[MAX_STRING_LEN]; //LEAR: Alert will be a string.
} __attribute__((__packed__)) driverAlertRecord;

typedef struct _bsmTxRecord {
      //location curLocation;
      char timeInISO[MAX_ISO_TIME_LEN];
      uint16_t length;
      uint8_t payload[MAX_PAYLOAD_SIZE]; //LEAR: RAW 1609.2 format of
      Transmitted BSM
} __attribute__((__packed__)) bsmTxRecord;

typedef struct _receivedMsgRecord {
      location curLocation;
      char timeInISO[MAX_ISO_TIME_LEN];
      rxSource rxFrom;
      int8_t verificationStatus;
      uint16_t length;
      uint8_t payload[MAX_PAYLOAD_SIZE]; //LEAR: RAW 1609.2 format of TIM
} __attribute__((__packed__)) receivedMsgRecord;
```

```
typedef struct _bsmRxRecord {
      char timeInISO[MAX_ISO_TIME_LEN];
      int8_t verificationStatus;
      uint16_t length;
      uint8_t payload[MAX_PAYLOAD_SIZE]; //LEAR: RAW 1609.2 format of Rx BSM
} __attribute__((__packed__)) bsmRxRecord;

typedef struct _dnmMsgRecord {
      location curLocation;
      char timeInISO[MAX_ISO_TIME_LEN];
      int8_t verificationStatus;
      uint16_t length;
      uint8_t payload[MAX_PAYLOAD_SIZE]; //LEAR: RAW 1609.2 format of Tx & Rx DN
      TIM
} __attribute__((__packed__)) dnmMsgRecord;

/*
 * LEAR:
 * FW upgrade, System Logs will be logged to
 * respective log files in "syslog" format as mentioned
 * in below eaxmple:
 * May 2 21:30:36 wsarx: Consistency check failed [WS_ERR_NO_CA_CERTIFICATE].
 */
typedef struct _scmsRecord {
      /* TODO */
} __attribute__((__packed__)) scmsRecord;

/*
 * Same record format for both OBU upgrades & Sysmlog
 *
 */
typedef struct _updatesSystemLogRecord {
      //LEAR: Location & time are added in this record to know where & when
      exactly updates, boot, shutdown and any system events(application re-
      starts/crashes/errors) are happend. Since frequency of these messages are
      less not much over air over head by adding these.
      location curLocation;
      char timeInISO[MAX_ISO_TIME_LEN];
      uint16_t length;
      char logString[MAX_STRING_LEN]; //LEAR: will be a string
} __attribute__((__packed__)) updatesSystemLogRecord;
#endif
```

7.14 SDC Data

The SDC System uses Amazon's Simple Storage Service (S3) to store uploaded data files and route these data files to a more structured and organized storage location, also in S3, which holds raw data files for consumption by analysis systems and evaluators. Uploading files to the ingest location requires connecting to the AWS S3 system. Manual uploads and automated data streams have separate ingest locations and permissions. The following sub-sections describe the difference between manually uploaded data and automated data uploads and streams.

7.14.1 File Naming Convention for Uploaded Files

Note: Some details about the data files uploaded to AWS buckets are still under review. The missing details in the table below will be updated in the next release of the ICD.

File Size Limit and Compression

- Logs will be kept under 100kb in size
- Each log file will be zipped (gzip)

Encryption

- Log files at rest in AWS buckets will not be encrypted.

Time Stamps

- Time will be UTC in ISO format (2017-06-30T19:53:00:000)
- Time for log files will be in UTC in 1 milliseconds from UNIX epoch (this time will be from the logging OBU system time sync'd to GPS)

Log File Names

- Log file names must be unique to previously uploaded files.
- File name will contain integrated time/date stamp (time of log file creation). The UTC portion of the file name will include (4) characters for the year, (2) characters for the month, (2) characters for the day, (2) characters for the hour, (2) characters for the minute and (2) characters for the seconds.
- File name will contain type of log
- Examples:
    - <type identifier>_<UTC time and date stamp>.TXT

7.14.2 Automated Data Types

Automated data types come from reliable data streams such as the JPO's Operational Data Environment. This data has a consistent structure throughout a datatype, a consistent file type, and important data fields such as location and time stamps are rarely absent. File types are also easy to parse for business logic scripts. JSON, csv, txt and more are all acceptable file formats as long as the data contained in the file is well-structured and the number of data objects contained in a single file is relatively consistent.

7.14.2.1 Driver Alerts

OBUs issue driver alerts to vehicle drivers regarding FCWs, TIMs and DNMs (eg., severe weather conditions, local road hazards and other relevant road way information). OBUs record the time, date, and reason for each notification, along with other vehicle system information each time they issue an alert to the driver. OBUs maintain a log of driver notifications and regularly upload this log to the ODE. The ODE is responsible for processing these uploaded driver alert logs. ODE processing includes structuring each driver alert into a single data record, assembling multiple records into files, and uploading the files the SDC. The data record format, file format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and SDC:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**ALERT**
- File name: ALERT_<date-time>. json
- File format: <json>
- Data elements: Note: a single record of a driver alert must contain all of the following:
    - timestamp
    - gps location

- exactly one of:
  - alert specific data for FCW
  - receivedMsgRecord (TIM which triggered notification)
  - dnmMsgRecord (DNM which triggered notification)
- bsmTxRecord (10 seconds before alert)
- bsmTxRecord (10 seconds after alert)
- bsmRxRecord (10 seconds before alert)
- bsmRxRecord (10 seconds after alert)

7.14.2.2 Received TIMs for OBUs and RSUs

OBUs receive TIMs from RSUs and satellites. RSUs receive TIMs from satellites only. Both OBUs and RSUs keep a record of received TIMs. For each TIM they record: the date, time, gps location, and source from which each TIM messages is received, along with the TIM itself. Note, the OBUs and RSUs only log messages within a 20-mile radius and only log the first time a message is received. Logs of received TIMs are regularly uploaded to the ODE. The ODE is responsible for processing these uploaded TIM logs. ODE processing includes structuring data from the TIM logs into data records, assembling multiple records into files, and uploading the files to the SDC. The data record format, file format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and SDC:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**TIM**
- File name: TIM_<date-time>.json/UPER
- File format: <json/UPER>
- Data elements: Note: a single record of a received TIM must contain all of the following:
  - timestamp
  - gps location
  - OBU or RSU
  - Identifier for OBU or RSU
  - receivedMsgRecord

7.14.2.3 DNMs

OBUs issue Distress Notification Messages when ~~their vehicle becomes disabled, its air bag is deployed or when~~ requested by vehicle driver. OBUs keep records when they declare a Distress Situation, when they receive DNMs broadcast by remote vehicles and when they broadcast DNMs either on their behalf or on behalf of a remove vehicle. RSUs also record whenever they receive DNMs broadcasts by remove vehicles. OBUs and RSUs upload these DNM logs to the ODE. The ODE is responsible for processing these uploaded DNM logs. ODE processing includes structuring data from these DNM logs into data records, assembling multiple records into files, and uploading the files to the SDC. The data record format, file format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and SDC:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**DNM**
- File name: DNM_<date-time>.json
- File format: <json>
- Data elements: Note: a single record of a sent or received DNM must contain all of the following:
  - timestamp
  - gps location
  - OBU or RSU
  - Identifier for OBU or RSU
  - One of: DECLARED, RECEIVED, RECEIVED & BROADCAST

- dnmMsgRecord (first unique message received or broadcast)

7.14.2.4 Environmental Data from Vehicles

Vehicles with environment weather sensors (eg. WYDOT Maintenance Vehicles with Snow Plows) continuously collect data and upload it to the ODE. The ODE is responsible for processing these uploaded environmental logs. ODE processing includes structuring data from these logs into data records associated with an OBU identifier, assembling multiple records into files, and uploading the files to the SDC. The data record format, file format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and SDC:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**ENV**
- File name: ENV_<date-time>.json
- File format: <json>
- Data elements: Note: All environmental records in the file must be from the file name specified on line one of the file.
  - Original file name which was uploaded to ODE
  - 1 or more JSON records as defined in Section: **7.7.1**.

7.14.2.5 BSM Data from RSUs

RSUs continuously log the BSMs they receive from passing vehicles. These BSM log files are continually uploaded to the ODE and RSUs purge logs after uploading them to the ODE. The ODE is responsible for processing these uploaded BSM logs. ODE processing includes structuring data from these logs into data records, assembling multiple records into files, and uploading the files to the SDC. The data record format, file format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and SDC:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**BSM**
- File name: BSM_<RSUID>_<date-time>. Json/UPER
- File format: <json/UPER>
- Data elements: bsmRxRecord

7.14.2.6 OBU System Log Data

OBUs periodically log system events such as boot and shutdown location and time, application errors and restarts and OBU unique identifiers. OBUs regularly upload system log data the ODE. The ODE is responsible for processing these uploaded System Update logs. ODE processing includes structuring data from these logs into data records, assembling multiple records into files, and uploading the files to the SDC. The data record format, file format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and SDC:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**OBUSYSLOG**
- File name: OBUSYSLOG_<date-time>. json
- File format: <json>
- Data elements: updatesSystemLogRecord

7.14.2.7 RSU System Log Data

RSUs periodically log system events such as boot and shutdown location and time, application errors and restarts. RSUs regularly upload system log data the ODE. The ODE is responsible for processing these uploaded System Update logs. ODE processing includes structuring data from these logs into data records, assembling multiple records into files, and uploading the files to the SDC. The data record format, file format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and SDC:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**RSUSYSLOG**
- File name: RSUSYSLOG_<date-time>.json
- File format: <json>
- Data elements: updatesSystemLogRecord

7.14.2.8 OBU Update Data

OBUs record the success, failure and availability of firmware updates. OBUs upload update log data the ODE. The ODE is responsible for processing these uploaded update logs. ODE processing includes structuring data from these logs into data records, assembling multiple records into files, and uploading the files to the SDC. The data record format, file format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and SDC:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**OBUUPDATE**
- File name: OBUUPDATE_<date-time>.json
- File format: <json>
- Data elements: updatesSystemLogRecord

7.14.2.9 RSU Update Data

RSUs record success, failure and availability of firmware updates. RSUs upload update log data the ODE. The ODE is responsible for processing these uploaded update logs. ODE processing includes structuring data from these logs into data records, assembling multiple records into files, and uploading the files to the SDC. The data record format, file format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and SDC:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**RSUUPDATE**
- File name: RSUUPDATE_<date-time>.json
- File format: <json>
- Data elements: updatesSystemLogRecord

7.14.2.10 OBU SCMS Log Data

OBUs record their interactions with the SCMS. OBUs regularly upload SCMS log data the ODE. The ODE is responsible for processing these uploaded logs. ODE processing includes structuring data from these logs into data records, assembling multiple records into files, and uploading the files to the SDC. The data record format, file format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and SDC:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**OBUSCMS**
- File name: OBUSCMS_<date-time>.json
- File format: <json>

- Data elements: <Lear Defined structure>

7.14.2.11 RSU SCMS Log Data

RSUs record their interactions with the SCMS. RSUs regularly upload SCMS log data the ODE. The ODE is responsible for processing these uploaded logs. ODE processing includes structuring data from these logs into data records, assembling multiple records into files, and uploading the files to the SDC. The data record format, file format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and SDC:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**RSUSCMS**
- File name: RSUSCMS_<date-time>.json
- File format: <json>
- Data elements: <Lear Defined structure>

7.14.3 Manually Uploaded Data

Manually uploaded data is classified as data that will be uploaded by individuals at the pilot site. This data may not be well structured or have a consistent file format. Some of this data may be in complex file formats that are difficult to process by means of simple ETL logic systems. These manual uploads also may be prone to errors such as incorrect upload location, incomplete time stamp information, etc.

7.14.3.1 Crash Data

WYDOT may occasionally generate reports of accidents and other road incidents and upload such reports to the SDC. The data may not be structured to facilitate automated data import and may need to be manually interpreted by consumers of the SDC. Data related to accidents on Wyoming highways will be uploaded to the following location:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**CRASH**
- File name: CRASH_<date-time>.xlsx
- File format: Excel
- Data elements: <NA> variable based on what is collected

7.14.3.2 Roadway Weather

Observed weather conditions from RWIS stations and as reported by drivers of WYDOT maintenance vehicles.

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**ROADWEATHER**
- File name: ROADWEATHER_<date-time>.PDF
- File format: PDF
- Data elements: <NA> this is a document

7.14.3.3 Variable Speed Data

Records of variable speed postings in the VSL zones. Measurements of speeds in the VSL zones.

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**VSL**
- File name: VSL_<date-time>.xlsx
- File format: Excel

- Data elements: <Speed, location, time, lane>

7.14.3.4 Surveys

Occasional survey results from CV participants.

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**SURVEY**
- File name: SURVEY_<date-time>.xlsx
- File format: Excel
- Data elements: <NA> this is a document

7.14.3.5 Interviews

Occasional interview responses from CV participants.

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-ingest/**INTERVIEW**
- File name: INTERVIEW_<date-time>.pdf
- File format: PDF
- Data elements: <NA> this is a document

7.15 Research Data Exchange (RDE) Data

The RDE System uses Amazon's Simple Storage Service (S3) to store uploaded data files and route these data files to a more structured and organized storage location, also in S3, which holds raw data files for consumption by public research community. Data uploaded to the RDE will not contain PII data. Uploading files to the ingest location requires connecting to the AWS S3 system. Manual uploads and automated data streams have separate ingest locations and permissions. The following sub-sections describe the difference between manually uploaded data and automated data uploads and streams.

7.15.1 File name conventions for objects uploaded to AWS S3 Buckets

Note: Some details about the data files uploaded to AWS buckets are still under review. The missing details in the table below will be updated in the next release of the ICD.

File Size Limit and Compression

- Logs will be kept under 100kb in size
- Each log file will be zipped (gzip)

Encryption

- Log files at rest in AWS buckets will not be encrypted.

Time Stamps

- Time will be UTC in ISO format (2017-06-30T19:53:00:000)
- Time for log files will be in UTC in 1 milliseconds from UNIX epoch (this time will be from the logging OBU system time sync'd to GPS)

Log File Names

- Log file names must be unique to previously uploaded files.
- File name will contain integrated time/date stamp (time of log file creation). The UTC portion of the file name will include (4) characters for the year, (2) characters for the month, (2) characters for the day, (2) characters for the hour, (2) characters for the minute and (2) characters for the seconds.
- File name will contain type of log
- Examples:
    - <type identifier>_<UTC time and date stamp>.TXT

7.15.2 Automated Data Types

Automated data types come from reliable data streams such as the JPO's Operational Data Environment. This data has a consistent structure throughout a datatype, a consistent file type, and important data fields such as location and time stamps are rarely absent. File types are also easy to parse for business logic scripts. JSON, csv, txt and more are all acceptable file formats as long as the data contained in the file is well-structured and the number of data objects contained in a single file is relatively consistent.

7.15.2.1 BSM Data from RSUs

RSUs continuously log the BSMs they receive from passing vehicles. These BSM log files are continually uploaded to the ODE and RSUs purge logs after uploading them to the ODE. The ODE is responsible for processing these uploaded BSM logs. ODE processing includes removing PII data, structuring data from these logs into data records, assembling multiple records into files, and uploading the files to the RDE. The data record format, file

format and file name are defined below, in accordance with an established agreement between the WYDOT CV Pilot and RDE organization:

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-public-ingest/**BSM**
- File name: BSM_<RSUID>_<date-time>. Json/UPER
- File format: <Json/UPER>
- Data elements: bsmRxRecord

7.15.3 Manually Uploaded Data

Manually uploaded data is classified as data that will be uploaded by individuals at the pilot site. This data may not be well structured or have a consistent file format. Some of this data may be in complex file formats that are difficult to process by means of simple ETL logic systems. These manual uploads also may be prone to errors such as incorrect upload location, incomplete time stamp information, etc.

7.15.3.1 <TEMPLATE FOR DATA TYPE>

<Describe the type of data being uploaded>

- AWS S3 Bucket: s3://usdot-its-cvpilot-wydot-public-ingest/**file_type**
- File name: <TYPE>_<date-time>. Json (PDF/TXT/CSV)
- File format: <Json/PDF/TXT/CSV>
- Data elements: <defined in data dictionary for data type>

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