SURFACE VEHICLE INFORMATION REPORT

J3067 AUG2014

Issued 2014-08

Candidate Improvements to Dedicated Short Range Communications (DSRC) Message Set Dictionary [SAE J2735] Using Systems Engineering Methods

RATIONALE

The SAE DSRC Technical Committee (TC) has received this recommendation for a comprehensive revision of SAE J2735, including documentation of the Systems Engineering (SE) process that is the foundation for the suggested normative content found herein. The committee is publishing this recommendation in this non-normative information report (IR) in the interest of exposing the recommendation to a large number of stakeholders. This IR does not replace the SAE J2735 standard.

The TC is considering this recommendation along with other suggested revisions. Any revision of SAE J2735 will be produced by the DSRC TC using normal SAE procedures. The committee takes no position at this time with regard to the content of the recommendations. Some material in this recommendation might eventually be reflected in other technical reports produced by the DSRC TC, including SAE standard J2735, while other material might not. The recommendation is written in the form of a standard, and includes language that suggests normative requirements and options. In the context of this information report, however, these statements are intended purely for information to the reader about the recommendation, and not as normative statements from SAE.

While some of the information in this document can aid in understanding or implementing a test deployment of DSRC, the committee recommends that the document not be used to form implementation requirements. The current published revisions in SAE J2735 remain normative and shall take precedence over any conflicting portions of this document.

There is no conformance statement for this information report. The DSRC TC welcomes comments about this recommendation, as well as suggestions related to all DSRC standards within the scope of this committee.

This document was provided by USDOT FHWA to SAE as:

SAE J2735 Systems Engineering Version,
Candidate Standard for Consideration by SAE
Version v01c
April 15, 2013

Prepared for the: U.S. Department of Transportation

NOTICE

This SAE Information Report is a compilation of engineering reference data and educational material from various sources deemed useful to the technical community. Normative language contained herein should not be considered as an SAE Recommended Practice or SAE Standard.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
http://www.sae.org

DOCUMENT REVISION HISTORY

Filename	Version	Date	Author	QC Review	Comment
J2735 SE Candidate v1.doc	1	12/15/12	Chan	Eisenhart, Sumner, Baker	Final Candidate Standard
J2735 SE Candidate v1a.doc	1a	02/15/12	Chan	Eisenhart, Baker	Incorporates Noblis comments
J2735 SE Candidate v1b.doc	1b	04/01/13	Chan	Eisenhart	Incorporates additional Noblis comments
J2735 SE Candidate v1b.doc	1c	04/15/13	Chan		Incorporates additional Noblis comments dated 4/3/13 and 04/11/13
		03/10/2013	DCK		Document entered SAE process to become an IR after DSRC TC review

TABLE OF CONTENTS

...formation Report is a compilation of engineering reference data and educational material from various sources deemed useful to the technical ...tained herein should not be considered as an ...mmended Practice or SAE Standard.

1. SECTION 1 - GENERAL [INFORMATIVE]

1.1 Scope

This document is not a standard, it is a candidate for a standard being submitted to SAE for their consideration as a comment to SAE J2735. The term SAE J2735 SE candidate is used within this document to refer to this submission.

This document specifies dialogs, messages, and the data frames and data elements that make up the messages specifically for use by applications intended to utilize the 5.9 GHz Dedicated Short Range Communications for Wireless Access in Vehicular Environments (DSRC/WAVE, referenced in this document simply as “DSRC"), communications systems. Although the scope of this Standard is focused on DSRC, these dialogs, messages, data frames and data elements have been designed, to the extent possible, to be of use for applications that may be deployed in conjunction with other wireless communications technologies. This standard therefore specifies the definitive message structure and provides sufficient background information to allow readers to properly interpret the message definitions from the point of view of an application developer implementing the messages according to the DSRC Standards.

1.2 References

The following standards (normative references) contain provisions that, through reference in this text, constitute provisions of SAE J2735 SE. Other documents and standards (other references) are referenced in these documents, which might provide a complete understanding of the entire protocol and the relations between all parts of the protocol. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on SAE J2735 SE are encouraged to investigate the possibility of applying the most recent editions of the standards listed below.

1.2.1 Normative References

Document Identifier	Document Title
FMCSA MCS-150	Federal Motor Carrier Safety Administration (FMCSA), Form MCS-150, Motor Carrier Identification Report (Revision 06/12/07)
FIPS Publication 5-2	Federal Information Processing Standards Publication 5-2, May 29 1987
IEEE Std 1609.2-2006	IEEE Trial-Use Standard for Wireless Access in Vehicular Environments - Security Services for Applications and Management Messages.
IEEE Std 1609.3-2010	IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services
IEEE Std 1609.4-2010	IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Multi-channel Operation
ISO 3166-2:2007	ISO 3166-2:2007, Codes for the Representation of Names of Countries and their Subdivisions - Part 2: Country Subdivision Code.
ISO 3780:2009	Road Vehicles - World Manufacturer Identifier (WMI) Code
NMEA 0183 Version 4.00	NMEA 0183 The Standard For Interface Marine Electronics
NTCIP 1202, v2.19f	National Transportation Communications for ITS Protocol - Object Definitions for Actuated Traffic Signal Controller Units, v02.19f
NTCIP 1204, v3.08r2	National Transportation Communications for ITS Protocol - Environmental Sensor Station Interface Protocol, Version v03
RTCM 10402.3	RTCM 10402.3 Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service
RTCM 10403.1	Differential GNSS (Global Navigation Satellite Systems) Services - Version 3
SAE J2354	Message Set for Advanced Traveler Information System (ATIS)
SAE J2540/2	ITIS Phrase List (International Traveler Information Systems)
SAE J2735	Dedicated Short Range Communications (DSRC) Message Set Dictionary
Title 49 CFR 395.16 - Regulation for On Board Recorders, Appendix A	Title 49 CFR 395.16 - Regulation for On Board Recorders, Appendix A, April 5, 2010

1.2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

Document Identifier	Document Title
APTA TCIP-S-001 3.0.3	Transit Communications Interface Profiles - APTA, January 10, 2009
NHTSA 09-118	Cooperative Intersection Collision Avoidance System for Violation (CICAS-V) for Avoidance of Violation-Based Crashes, Michael Maile, Luca Delgrossi, NHTSA Paper Number 09-0118
Core System Concept of Operations Rev C	Core System Concept of Operations Rev C, Lockheed Martin Corporation, April 19, 2011.
DSRC Implementation Guidance:	DSRC Implementation Guidance: A guide to users of the SAE J2735 message sets over DSRC. [16-Feb-10]. Pp., 210.
FHWA-JPO-09-038 Final Report	Vehicle Infrastructure Integration (VII) Proof of Concept (POC) Test - Executive Summary. FHWA, February 2009
IEEE 830-1998	IEEE Recommended Practice for Software Requirements Specifications, June 25, 1998.
Final Report: Vehicle Infrastructure Integration Proof of Concept	Final Report: Vehicle Infrastructure Integration Proof of Concept, The VII Consortium, May 19, 2009.
Manual of Uniform Traffic Control Devices (MUTCD): 2009	Manual on Uniform Traffic Control Devices for Streets and Highways, 2009 Edition, U.S. Department of Transportation, Federal Highway Administration
NTCIP 1211 v01.38	Object Definitions for Signal Control and Prioritization - AASHTO / ITE / NEMA, May 2008.
SAE J1587	Electronic Data Interchange Between Microcomputer Systems in Heavy Duty Vehicle Applications
SAE J1708	Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications
SAE J1939	Serial Control and Communications Heavy Duty Vehicle Network - Top Level Document
SAE DSRC Implementation Guide	SAE DSRC Implementation Guide, A guide to users of SAE J2735 message sets over DSRC, SAE International, February, 2010.
Vehicle Safety Communications-Applications Final Report (VSC-A)	Vehicle Safety Communications - Applications (VSC-A) Final Report, Ahmed-Zaid, F., et. al., CAMP Vehicle Safety Communications 2, April 26, 2011
VII Privacy Polices Framework	VII Privacy Policies Framework, Version 1.0.2 February 16, 2007, Institutional issues Subcommittee of the National VII Coalition

1.3 General Statements

Not Applicable

1.4 Terms

For the purposes of this candidate standard, the following terms and definitions apply.

Term	Description
Aftermarket Safety Device	A connected device in a vehicle that operates while the vehicle is mobile, but which is not connected to the data bus of the vehicle.
Allowed Movements	In the context of this standard, the directions of movement that are legally allowed at a specific point in time based upon the state of the intersection signals.
Application	A software program with an interface, enabling people to accomplish a specific task. In the context of this standard, it is a software program that provides functionality to realize safety, mobility, and environmental benefits.
BLOB	Binary Large OBject, a term used in software to describe sequences of octets or bytes where any inner encoding or meaning is not visible.
Commercial Motor Vehicle	Commercial motor vehicle means any self-propelled or towed motor vehicle used on a highway in interstate commerce to transport passengers or property when the vehicle: (1) Has a gross vehicle weight rating or gross combination weight rating, or gross vehicle weight or gross combination weight, of 4,536 kg (10,001 pounds) or more, whichever is greater; or (2) Is designed or used to transport more than 8 passengers (including the driver) for compensation; or (3) Is designed or used to transport more than 15 passengers, including the driver, and is not used to transport passengers for compensation; or (4) Is used in transporting material found by the Secretary of Transportation to be hazardous under 49 U.S.C. 5103 and transported in a quantity requiring placarding under regulations prescribed by the Secretary under 49 CFR, subtitle B, chapter I, subchapter C. (Source: 49 U.S.C. 31132)
Commercial Motor Vehicle On-Board Unit	An OBU or ASD mounted or in a vehicle moving goods, heavy equipment, or people. Includes motor coaches.
Connected Device	Any device used to transmit to or receive messages from another device. A connected device can be sub-categorized as an OBU, ASD, or RSU. In many cases the connected device will be a DSRC device, but other types of communications could be supported.
Connected Vehicle	A vehicle containing an OBU or ASD.
Control Channel	A single radio channel, not a service channel, intended for the exchange of management frames, including Wireless Access in Vehicular Environments (WAVE) Service Advertisements, and WAVE Short Messages. (Source: IEEE 1609.3)
Controller Area Network	A Controller Area Network (CAN) bus is a message-based protocol, designed specifically for automotive applications. The CAN bus is one of five protocols used in the OBD-II vehicle diagnostics standard. The OBD-II standard has been mandatory for all cars and light trucks sold in the United States since 1996.
Eco-Driving	The practice of driving in such a way as to minimize fuel consumption and emissions.
Eco-Lane	A dedicated lane(s) optimized for the environment similar to high-occupancy vehicle lanes; however, these lanes are optimized for the environment using connected vehicle data. These lanes would be targeted toward low-emission, high-occupancy freight, transit, and alternative-fuel vehicles (AFV). Drivers would be able to opt in to these dedicated eco-lanes to take advantage of eco-friendly applications such as eco-speed limits, eco-cooperative adaptive cruise control and connected eco-driving applications.
Electronic On-Board Recorders	A device on-board a commercial vehicle used to record driver information such as hours of service.
Event Snapshot	A snapshot generated when the connected vehicle when a sensor value exceeds a specific threshold.
Geoid	The equipotential surface of the Earth's gravity field which best fits, in a least squares sense, global mean sea level. (Source: National Geodetic Society)

Term	Description
Horizontal Dilution of Precision	The horizontal dilution of precision (HDOP) allows a person or application to more precisely estimate the accuracy of GPS horizontal (latitude/longitude) position fixes by adjusting the error estimates according to the geometry of the satellites used.
Host Vehicle	A connected vehicle that receives messages from a remote vehicle. [In this document, the host vehicle is also used to describe the originator of a vehicular transmission of information to the RSU.] (See Remote Vehicle)
Intelligent Transportation Systems (ITS)	Systems that apply data processing and data communications to surface transportation, to increase safety and efficiency. Another appropriate meaning of the ITS acronym is integrated transportation systems, which stressed that ITS systems will often integrate components and users from many domains, both public and private.
Interoperability	The ability of two or more systems or components to exchange information and to use the information that has been exchanged. (Source: IEEE 610.12-1990)
Intersection	In the context of this standard an intersection is a nexus where two or more approaches (links) meet and vehicles and other type users may travel between the connecting links. Typically this is a signalized intersection when considered by this standard, and as such the modes of allowed movement are reflected in the signal phases, the geometry of the intersection, and the local regulatory environment. The messages of this J2735 SE candidate convey some of this intersection information to the traveling public. Specifically, the MAP message conveys the relevant road geometry, while the SPaT message conveys the current allowed movements to control movement in the intersection.
Interval	The part of a signal cycle during which signal indications are stable and do not change. In the SPaT message the current timing value for the remaining interval time estimate as well as the anticipated interval for yellow change interval is provided for each lane. Because signal interval times commonly change based on triggering events in many types of signaling systems, the value provided in the SPaT message may represent a minimal value that is extended and updated as the message is re-issued each time.
Interval Sequence	The order of appearance of signal indications during successive intervals of a signal cycle.
ITIS	International Traveler Information Systems, the term commonly associated with the standard for incident phrases developed by the SAE ATIS Committee in conjunction with ITE TMDD and other standards. This work contains a wide variety of standard phrases to describe incidents and is expected to be used throughout the ITS industry. The codes found there can be used for sorting and classifying types of incident events, as well as creating uniform human readable phrases. In the capacity of classifying incident types, ITIS phrases are used in many areas. ITIS phrases can also be freely mixed with text and used to describe many incidents.
Lane	In the context of this standard a lane is a portion of the transportation network (typically a section of roadway geometry) which is being described (its paths and various attributes about it) or referred to. In the DSRC message set, the lane object is widely used. Lanes consist not only of sections of drivable roadway traversed by motor vehicles, but other types of lanes including pedestrian and bicycle walkways, trains and transit lanes, and certain types of dividers and barriers. When used in describing an intersection, a lane is defined for each possible path into and out of the intersection (in the MAP message). The current allowed movements then applicable to that lane or its approach is provided in the SPaT message.
Lane-use control signal	A signal face displaying signal indications to permit or prohibit the use of specific lanes of a roadway or to indicate the impending prohibition of such use.
Latency	A measure of time delay experienced in a system, the precise definition of which depends on the system and the time being measured. For a data element in this context, latency is the time difference between the time that data value is acquired by the source and the time the message is transmitted.
Link (RF)	A communications channel being used in support of application data transfer needs.
Link (traffic)	A segment of a road network. While highway links are generally separated by one data collection node (such as an RSU or a vehicle detector station), local road links tend to be limited by intersections with cross streets. Other common usages of the word "link," such as those used in telecommunications, may also appear in the document.
Low Emissions Zone	A geographically defined area that seeks to restrict or deter access by specific categories of high-polluting vehicles to improve the air quality within the geographic area. The low-emissions zone can be dynamic, allowing the operating entity to change the location, boundaries, or time of the low-emissions zone.

Term	Description
MAP	Map Data Message. In the context of J2735 SE, the MAP message provides the road geometry at an intersection.
On-Board Unit	A vehicle mounted device used to transmit and receive a variety of message traffic to and from other connected devices (other OBUs and RSUs). Among the message types and applications supported by this device are vehicle safety messages, a primary subject of this standard, used to exchange information on each vehicle's dynamic movements for coordination and safety.
Periodic Snapshots	Snapshots that are generated at fixed intervals (distance or time).
Point Speed	The velocity (of a device) at a specific point in time.
Power Unit	The control and pulling vehicle for trailers or semitrailers. Also includes straight trucks, and single-unit trucks.
Precondition	A condition that must exist or be established before something can occur or be considered.
Provider Service Context	A field associated with a Provider Service Identifier (PSID) containing supplementary information related to the service. The internal format of the PSC is PSID dependent.
Provider Service Identifier	An octet string that identifies a service provided by a higher layer entity.
Public Safety On-Board Unit	An OBU or ASD mounted or in an authorized public safety vehicle.
Remote Vehicle	A connected vehicle that periodically and dynamically broadcasts a message about its general situation to a host vehicle. (See Host Vehicle).
Road Sign	A physical traffic control device intended to communicate specific information to road users through a word, symbol, and/or arrow legend. Road signs do not include highway traffic signals, pavement markings, delineators, or channelization devices.
Roadside unit	A connected device that is only allowed to operate from a fixed position (which may in fact be a permanent installation or from temporary equipment brought on-site for a period of time associated with an incident, road construction, or other event). Some RSUs may have connectivity to other nodes or the Internet.
Roadway Segment	A section of a highway improved, designed, or ordinarily used for vehicular travel and parking lanes, or that portion of a highway improved, designed, or ordinarily used for vehicular travel and parking lanes, but exclusive of the sidewalk, berm, or shoulder even though such sidewalk, berm, or shoulder is used by persons riding bicycles or other human-powered vehicles. (MUTCD, 2009, Section 1A.13)
Service Channel	Any channel that is not the control channel, intended for management frames and higher layer information exchanges. There may be more than one service channel defined in a given spectrum.
Signal Indication	Illumination of a signal lens or equivalent device. The signal face of a signal indication is an assembly of one or more signal sections that is provided for controlling one or more traffic movements on a single approach. (MUTCD, 2009, Section 1A.13).
Signal Control Zone	A geo-physical area of an intersection used for an approaching vehicle to request a preempt or priority request of a traffic signal.
Snapshot	A report including one or more status elements in the vehicle at a single point in time, along with a set of position and heading elements.
SPaT	In the context of this standard, Signal Phase And Timing (SPaT), is a message type that describes the current state of a signal system and its phases and relates this to the specific lanes (and therefore to movements and approaches) in the intersection. It is used along with the MAP message to allow describing an intersection and its current allowed movements.
Speed	The rate of progress, or change in position, usually without regard to direction. The distance traveled divided by time (if speed is constant). A scalar quantity which refers to how fast an object is moving.
Start and Stop Snapshots	Snapshots generated when a connected vehicle is stopped, and when the connected vehicle starts up again.
Timing Advertisement frames	A management frame specified in IEEE Std 802.11p used to carry timing information. [IEEE Std. 1609.4]
Transit Vehicle On-Board Unit	An OBU or ASD mounted or in a transit vehicle.
Vehicle	A self-propelled transport device, along with any attachments (e.g., trailers), that is a legal user of the transportation network.

Term	Description
Vehicle Bus	A specialized internal communications network that interconnects components within a vehicle. A commonly used protocol on the vehicle bus is the Controller Area Network (CAN). CAN (or CAN-bus) is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other within a vehicle without a host computer.
Vehicle type	In the context of this standard the vehicle type is a data element used to define overall gross size and mass of a vehicle. Observe that this definition differs from the (multiple other) vehicle types defined elsewhere in other standards used in ITS.
Vendor Specific Action Frame	A management frame specified in IEEE Std 802.11. Despite the name, when the first 36 bits of the Organization Identifier are equal to 0x0050C24A4, the contents are specified within the 1609 standards for use in carrying IEEE 1609 management information including Wireless Access in Vehicular Environments (WAVE) Service Advertisements. [IEEE Std. 1609.4]
Wireless Access in Vehicular Environments (WAVE) device	A device that is compliant to IEEE Std 1609.3, IEEE Std 1609.4, and IEEE Std 802.11, operating outside the context of a basic service set. (See IEEE Std 802.11p specification of station [STA] transmission of data frames outside the context of a basic service set.)
Wireless Access in Vehicular Environments (WAVE) Management Entity (WME)	A set of management functions required to provide WAVE networking services. It is specified in IEEE Std 1609.3.
Wireless Access in Vehicular Environments (WAVE) Service Advertisement (WSA)	A data structure specified in IEEE Std 1609.3 containing information including the announcement of the availability of services.
Wireless Access in Vehicular Environments (WAVE) Short Message Protocol (WSMP)	A protocol for rapid exchange of messages in a rapidly varying radio frequency (RF) environment where low latency is also an important objective. It is specified in IEEE Std 1609.3.
Work Zone	An area of a highway with construction, maintenance, or utility work activities. A work zone is typically marked by signs, channelizing devices, barriers, pavement markings, and/or work vehicles. A work zone extends from the first warning sign or high-intensity rotating, flashing, oscillating, or strobe lights on a vehicle to the END ROAD WORK sign or the last Temporary Traffic Control device (MUTCD 2009, Section 6C.02).

1.5 Abbreviations

The abbreviations used in this Standard Publication are defined as follows:

ABS	Anti-lock Brake System
ADA	Americans with Disabilities Act
ALC	A La Carte
ASD	Aftermarket Safety Device
BER	Basic Encoding Rules
BLOB	Binary Large OBject
BSM	Basic Safety Message
BSW	Blind Spot Warning
CAMP	Crash Avoidance Metrics Partnership
CAN	Controller Area Network
CFCW	Cooperative Forward Collision Warning
CICAS	Cooperative Intersection Collision Avoidance System
CICAS-V	Cooperative Intersection Collision Avoidance System - Violation
CLW	Control Loss Warning
CMV	Commercial Motor Vehicle
CVOBU	Commercial Motor Vehicle On-Board Unit
ConOps	Concept of Operations
CSR	Common Safety Request
DNPW	Do Not Pass Warning
DSRC	Dedicated Short Range Communications

EEBL	Emergency Electronic Brake Lights
EMV	Emergency Management Vehicle
EOBR	Electronic On-Board Recorders
FCC	Federal Communications Commission
FCW	Forward Collision Warning
FHWA	Federal Highway Administration
FIPS	Federal Information Processing Standard
FMCSA	Federal Motor Carrier Safety Administration
GPS	Global Positioning System
HAZMAT	HAZardous MATerial
HDOP	Horizontal Dilution of Precision
HMI	Human Machine Interface
HOT	High Occupancy Toll
HOV	High Occupancy Vehicle
HRI	Highway Rail Intersection
ICA	Intersection Collision Avoidance
ID	Identifier
IEEE	Institute of Electrical and Electronics Engineers
IMA	Intersection Movement Assist
ITIS	International Traveler Information Systems
ITS	Intelligent Transportation Systems
LCW	Lane Change Warning
MAC	Medium Access Control
MAP	Map Data Message
MH	Message Handler
mph	miles per hour
mSec	ms
MUTCD	Manual of Uniform Traffic Control Devices
NMEA	National Marine Electronics Association
NRTM	Needs to Requirements Traceability Matrix
NTCIP	National Transportation Communications for ITS Protocols
OBD	On-board Diagnostics
OBU	On-Board Unit
OEM	Original Equipment Manufacturer
OER	Octet Encoding Rules
OTA	Over-The-Air
PER	Packed Encoding Rules
PHY	Physical Layer
PIN	Personal Identification Number
POC	Proof-of-Concept
PRL	Protocol Requirements List
PSC	Provider Service Context
PSID	Provider Service IDentifier
PSN	Probe Segment Number
PSOBU	Public Safety On-Board Unit
PTV	Public Transit Vehicle
RF	Radio Frequency
RITA	Research and Innovative Technology Administration
RSU	Roadside Unit
RTCM	Radio Technical Commission for Maritime Services
SAE	Society of Automotive Engineers
SCH	Service CHannel
SE	Systems Engineering
SME	Subject Matter Expert
SPaT	Signal Phase and Timing
SRS	Software Requirements Specification
TA	Basic Threat Arbitration Module

TC	Target Classification (module)
TCIP	Transit Communications Interface Profiles
TrVOBU	Transit Vehicle On-Board Unit
URL	Uniform Resource Locator
USDOT	United States Department of Transportation
UTC	Coordinated Universal Time
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
VII	Vehicle Infrastructure Integration
VIN	Vehicle Identification Number
VMT	Vehicle Miles of Travel
VSC-2	Vehicle Safety Communications II - (a consortium at CAMP)
VSC-A	Vehicle Safety Communications - Applications. (a joint effort of USDOT, Vehicle Safety Communications 2 (VSC2) and CAMP)
WAVE	Wireless Access in Vehicular Environments
WME	Wireless Access in Vehicular Environments (WAVE) Management Entity
WMI	World Manufacturer Identifier
WMO	World Meteorological Organization
WSA	Wireless Access in Vehicular Environments (WAVE) Service Advertisement
WSM	Wireless Access in Vehicular Environments (WAVE) Short Message
WSMP	Wireless Access in Vehicular Environments (WAVE) Short Message Protocol

2. SECTION 2 - CONCEPT OF OPERATIONS [NORMATIVE]

This Section 2 describes the Concept of Operations (ConOps) for the SAE J2735 SE candidate, which covers the information exchange between applications that may be deployed in conjunction with wireless communications related to the next generation intelligent transportation system, currently referred to as the *Connected Vehicle* program.

A ConOps describes the ways a proposed system will be used from the users' perspective. The ConOps is one of the first key outputs of the systems engineering process and forms the basis for the definition of requirements. The ConOps stage of the systems engineering process is used to ensure that the system developers document a thorough understanding of the users' needs.

For the SAE J2735 SE candidate, the ConOps identifies and documents the various operational needs (capabilities) that users may have for SAE J2735 SE information, and that subsequent sections within the SAE J2735 SE candidate will address.

The ConOps provides the reader with:

- A detailed description of the scope of the SAE J2735 SE candidate;
- An explanation of how the SAE J2735 SE candidate is expected to fit into the larger context of the Connected Vehicle environment;
- A starting point in the procurement process; and
- An understanding of the perspective of the designers of the SAE J2735 SE.

The ConOps is intended to be used by the following groups of users:

- Transportation Agencies;
- Transportation Enforcement Agencies;
- Systems Integrators;
- Vehicle Manufacturers; and

- Device Manufacturers.

Readers will find this section useful for understanding how the SAE J2735 SE candidate can be used in their system(s). It serves as the starting point in the procurement and specification process. Procurers and specification writers, such as the transportation agencies and transportation enforcement agencies, can become familiar with each capability addressed by the SAE J2735 SE candidate and determine whether that capability is appropriate for their implementation. If it is, then their implementation will require the capability and all of the mandatory requirements related to that capability.

The last three bulleted groups of users will find this section useful to gain a more thorough understanding as to why the more detailed requirements (as specified in later sections of this standard) exist.

2.1 Tutorial [Informative]

A concept of operations describes a proposed system from the users' perspective. Typically, a concept of operations is used on a project to ensure that the system developers understand the users' needs. Within the SAE J2735 SE candidate, the concept of operations documents the scope of the standard, the interfaces addressed by the standard, and various operational needs (features) that users may have for SAE J2735 SE information. The concept of operations also serves as the starting point for agencies to select those features that may be appropriate for a specific procurement.

The concept of operations starts with a discussion of the current situation and issues that have led to the need to deploy systems within the scope of the standard and to the development of the standard itself. This discussion permits both potential users and system developers to understand the situation.

The concept of operations then documents key aspects of the proposed system, including:

- Reference Physical Architecture (Section 2.3) - The reference physical architecture defines the overall context of the proposed system and defines which specific interfaces are addressed.

- Architectural Needs (Section 2.4) - The architectural needs discuss issues and needs relative to the system architecture.

- Features (Section 2.5) - The features identify and describe the various functions that users may want the system to perform. These features are derived from the high level user needs identified in the problem statement but are refined and organized into a more manageable structure that forms the basis of the traceability table contained in Section 3 (Functional Requirements).

Architectural needs and features are collectively called “user needs". In Section 3, these user needs are traced to the various functional requirements of the connected vehicles environment. Basic systems engineering requires that:

- Each user need traces to one or more functional requirement(s), and

- Each functional requirement derives from at least one user need.

This traceability is shown in the Protocol Requirements List (PRL) in Section 3.3.3.

The SAE J2735 SE is intended for use in a broad range of prospective implementations. Within the PRL, each user need and requirement is identified as mandatory, optional, or conditional, and users of this standard may complete the PRL to clearly define unique aspects of their implementation. Within the SAE J2735 SE, items marked mandatory are those that relate to the most basic functionality of connected devices. For specific implementations, the user identifies those optional or conditional needs appropriate for a specific implementation.

In Appendix A, each requirement is presented in a Requirements Traceability Matrix (RTM), which defines how the requirement is fulfilled through data concepts, such as dialogs, messages, and data element definitions.

NOTE: Off-the-shelf interoperability and interchangeability can only be obtained by using well documented user needs, along with their corresponding requirements and design, which are broadly supported by the industry as a whole. Users should be aware that designing a system that uses environments or features not defined in a standard or not typically deployed in combination with one another, may inhibit the goals of interoperability and interchangeability, especially if the documentation of these user needs is not available for distribution to system integrators. The standards allow implementations to support additional user needs in order to support innovation, which is constantly needed within the industry; but users should be aware of the risks involved with using such environments or features.

The concept of operations concludes by:

- Describing the degree to which security issues have been addressed by the standard (Section 2.6);
- Describing the extent to which policies or constraints relative to the operational environment have a direct impact on the implementation of this standard (Section 2.7);
- Providing a description of how the SAE J2735 SE candidate relates to the National ITS Architecture; (Section 2.8) and
- Presenting operational scenarios that demonstrate how a proposed system using the SAE J2735 SE candidate should operate and interact with its users under specific circumstances (Section 2.9).

2.2 Current Situation and Problem Statement [Informative]

2.2.1 Background

One of the key concepts of the original VII program was to use DSRC to provide vehicle-to-vehicle and vehicle-to-infrastructure connectivity for exchanging data that supported safety and mobility applications both in the vehicle and in the infrastructure. An interim version of the SAE J2735 standard was developed and tested as part of the Proof of Concept in Detroit. Following several years of effort, the current version of SAE J2735 was published in 2009. The scope of the current SAE J2735 is focused on the message set, data frames, and data elements exchanged between applications on vehicles and the roadside via wireless communications technologies. The current standard does not define its scope in more detail in the normative sections of the standard, but does contain a series of informational appendices that describe use and operation of the key messages defined in the standard.

The current standard does have a clear statement of objectives, which is:

“Public sector organizations throughout the world have identified the need to reduce fatalities and serious injuries that result from vehicle crashes, as well as the need to reduce traffic congestion. The use of wireless and computer technologies in vehicles, and on the roadway infrastructure, has been identified as promising areas to provide solutions for these needs. Intelligent Transportation System (ITS) planning in many regions of the world has therefore become focused on supporting applications that utilize a common platform to address three priorities:

- *Safety*
- *Mobility*
- *Commercial (or Private)*

Safety applications, in particular, must be interoperable between vehicles from different manufacturers and between vehicles and roadway infrastructure within all the areas where the vehicle is likely to travel. This requirement for interoperability is also relevant to contemplated mobility applications. This SAE Standard specifies messages, data frames and data elements that allow interoperability at the application layer without the need to standardize applications. This approach supports innovation and product differentiation through the use of proprietary applications, while maintaining interoperability by providing a standard message set that can be universally generated and recognized by these proprietary applications."[1] Note that an additional environment priority has also been defined by the USDOT, which is performing research to define connected vehicle applications relating to the environment.

To describe the needs and operations supported by SAE J2735, this document will use the following terminology, which have been taken from the proof-of-concept (POC) programs implemented by the Crash Avoidance Metrics Partnership (CAMP) and the Cooperative Intersection Collision Avoidance System (CICAS) project:

- **RSU - Roadside Unit**. A connected device that is only allowed to operate from a fixed position (which may in fact be a permanent installation or from temporary equipment brought on-site for a period of time associated with an incident, road construction, or other event).

- **OBU - On-Board Unit**. A vehicle-mounted device used to transmit and receive a variety of message traffic to and from other connected devices (other OBUs and RSUs).

- **Host vehicle[2].** A connected vehicle that receives messages from a remote vehicle. [In this document, the host vehicle is also used to describe the originator of a vehicular transmission of information to the RSU.]

- **Remote vehicle**. A connected vehicle that periodically and dynamically broadcasts a message about its general situation to a host vehicle.

2.2.2 Description of the Current Situation

Currently there are no operational deployments of DSRC for Vehicle-to-Vehicle (V2V) safety or mobility applications. However, there are widespread deployments of Vehicle-to-Infrastructure (V2I) applications using DSRC at 915MHz including electronic toll and transit signal priority. From a V2I perspective, there are only limited deployments of V2I applications using IEEE 1609 (DSRC at 5.9 GHz). One example of this is a recent tolling implementation in Oregon. Although there are initiatives under development to deploy widespread connected vehicle applications (using 5.9 GHz DSRC) in operational environments, to date, there are only a few controlled test beds that support the SAE J2735 SE environment. Select tests have been conducted in Ohio, California, and Virginia for V2I. The proof of concept tests conducted at the Michigan test bed used an earlier version of J2735 as did the demonstrations deployed in New York during the 2008 ITS World Congress.

The V2I field tests were conducted in conjunction with the CICAS project, which was a joint effort of the U.S. Department of Transportation (USDOT) and the CAMP Vehicle Safety Communications II (VSC-2) Consortium. The V2V field tests were conducted by the Vehicle Safety Communications - Applications (VSC-A) which is a joint effort of USDOT and the CAMP VSC-2.

The V2I tests conducted by the CICAS-V program implemented a system as depicted in Figure 1.

[1] SAE J2735, Dedicated Short Range Communications (DSRC) Message Set Dictionary, 2009-11-19, p. 23.

[2] Derived from CAMP definitions for Host and Remote (also called “target”) vehicle roles. See for description of host and remote Vehicle Safety Communications-Applications Final Report (VSC-A) p6.

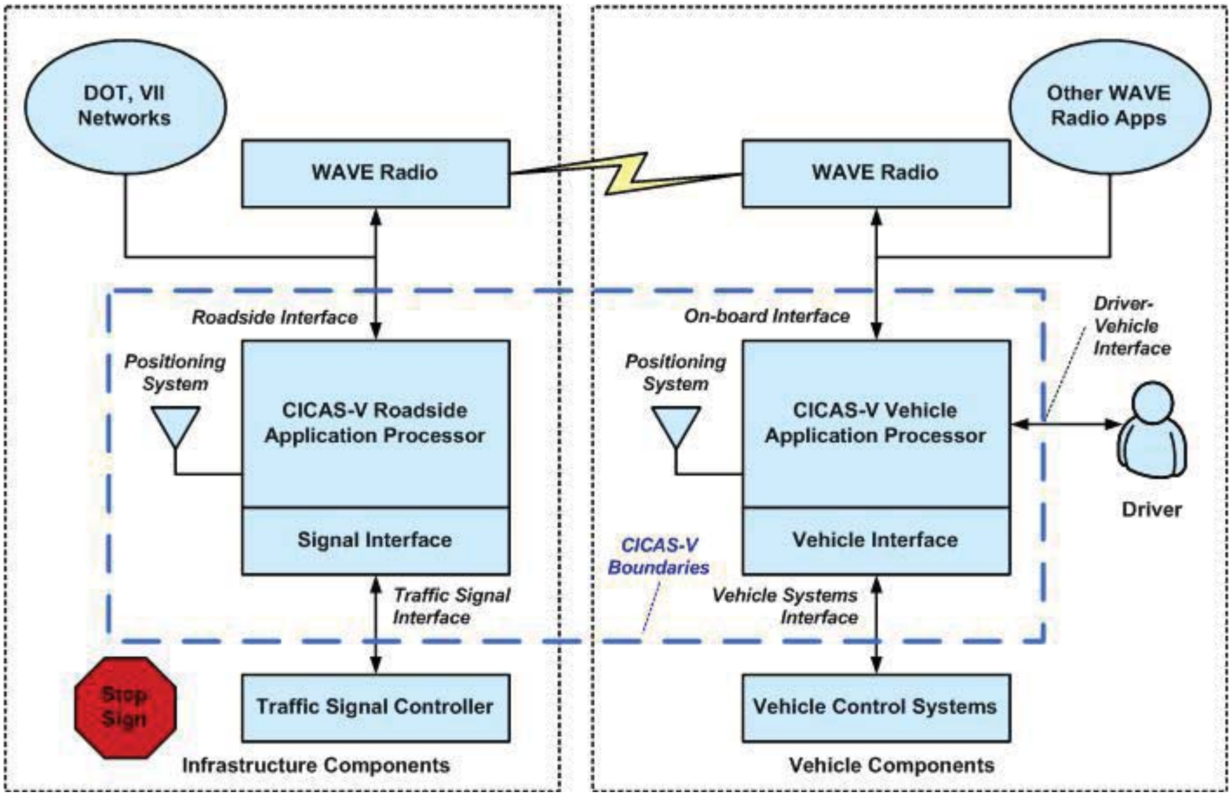


FIGURE 1 - CICAS-V SYSTEM WITH INTERFACES [FROM CICAS-09-0118.PDF]

The VSC-2 tests implemented a suite of standards as follows:

- The Basic Safety Message (BSM) as defined in the SAE J2735 Message Set Dictionary standard;
- The Full-Use 1609.3 and 1609.4 standards published in December 2010;
- The Full-Use 1609.2 draft standard; and
- The 802.11p amendment for the Medium Access Control (MAC) and Physical (PHY) layers as published in June 2010.

There has been no testing of the current SAE J2735 standard. However an earlier version was used in the Proof-of-Concept testing in Detroit in 2005. In this test, various services were provided to the vehicles. Those that are part of the SAE J2735 Message Set included: Probe Data; Probe Data Management and Advisory Message Delivery. The results are reported in FHWA-JPO-09-038 Final Report: Vehicle Infrastructure Integration (VII) Proof of Concept (POC) Test - Executive Summary. Booz Allen Hamilton. February 2009. The report states: “Booz Allen conducted the standards testing during all three phases of the VII test program. The scope of this testing included validating that the IEEE 1609 and 802.11p suite of standards as well as the SAE J2735 standards (POC DSRC Message Sets) function properly throughout the VII network, including in the 5.9 GHz band allocated for use with VII." The conclusions concerning J2735 included: “The usage descriptions and content of some SAE J2735 messages need to be updated to avoid uncertainty during development and implementation. A constant line of communications was open between POC developers and the SAE during development, resulting in the majority of the issues being addressed in SAE J2735 Version 2.0."

2.2.3 Stakeholders and Other Involved Personnel

This section describes the users who have needs to exchange information across the connected vehicle interfaces defined as part of SAE J2735 SE. In most standard development efforts, a user is a “person who will use the system that is developed"[3]. In the development of SAE J2735 SE user needs, the people who will use the system that is developed are certainly present, but due to the nature of the operational policies (Section 2.7), the definition of user includes a vehicle that is equipped as a connected vehicle system. In addition, stakeholders also include groups of users having needs relevant to SAE J2735 SE. The users that have defined needs relative to SAE J2735 interfaces include:

- **Vehicle Drivers.** Drivers of general vehicles, commercial vehicles, heavy vehicles (e.g., snowplows), and transit vehicles have a variety of needs that can be addressed by the interfaces defined in SAE J2735.

- **Vehicles (Remote Vehicle, Host Vehicle).** SAE J2735 is meant to support deployment of on-board vehicle systems operating in general, commercial, heavy, emergency, and transit type vehicles. These equipped vehicles can provide warnings to drivers, automatically perform related actions (e.g., collision avoidance), or provide other forms of travel related information. Because these equipped vehicles may operate without direct intervention by the driver or operator, and their operation is a key aspect of the overall user needs, the vehicles themselves are considered a user. This category also includes aftermarket safety devices (ASDs) and other mobile devices that can perform similar warning or travel information related functions when in the vehicle.

- **Transportation Agencies.** This type of user represents the staff at transportation agencies, which include traffic operations agencies at any level of government (e.g., national, state or local), transit agencies, toll authorities, or private companies operating a highway concession. It also includes private information service providers who might collect vehicle data to support traveler information capabilities. Finally, it includes commercial vehicle credentials and safety agencies, as well as maintenance personnel.

- **Emergency Responders.** This type of user represents the staff of providers of emergency services, including public safety providers. Examples include law enforcement, fire department, ambulances, or environmental protection agencies that respond to hazmat incidents. In some cases this user overlaps with the Vehicle Driver user listed above (for example when considering the driver of an emergency vehicle).

- **Vehicle Manufacturers and Fleet Operators.** This type of user represents companies that manufacturer or operate automobiles, trucks, transit vehicles, or any other specialized vehicles. This type of user is included because of needs identified for the manufacturers or operators to provide data transfers to the vehicles, of which the data may be proprietary to the manufacturer or the fleet operator.

2.2.4 Objectives

The objectives of the proposed system have been articulated very well by the current SAE J2735 standard and are repeated below:

“*Public sector organizations throughout the world have identified the need to reduce fatalities and serious injuries that result from vehicle crashes, as well as the need to reduce traffic congestion. The use of wireless and computer technologies in vehicles, and on the roadway infrastructure, has been identified as promising areas to provide solutions for these needs. Intelligent Transportation System (ITS) planning in many regions of the world has therefore become focused on supporting applications that utilize a common platform to address three priorities:*

- Safety

- Mobility

- Commercial (or Private)

---

[3]NTCIP 1204 v03.06: National Transportation Communications for ITS Protocol Environmental Sensor Station Interface Standard – Version 03, December 2007

Safety applications, in particular, must be interoperable between vehicles from different manufacturers and between vehicles and roadway infrastructure within all the areas where the vehicle is likely to travel. This requirement for interoperability is also relevant to contemplated mobility applications. This SAE Standard specifies messages, data frames and data elements that allow interoperability at the application layer without the need to standardize applications. This approach supports innovation and product differentiation through the use of proprietary applications, while maintaining interoperability by providing a standard message set that can be universally generated and recognized by these proprietary applications."

The USDOT Research and Innovative Technology Administration (RITA), identifies the objective of the connected vehicle (technologies) as to:

"…*tackle some of the biggest challenges in the surface transportation industry, in the areas of safety, mobility, and environment.*

- Safety: In 2009, there were 5.5 million crashes, resulting in 33,808 fatalities and 2.2 million injuries. Our children and young people are particularly vulnerable. Motor vehicle crashes are the leading cause of death for ages 3 through 34. Connected vehicle technologies provide the tools to make transformational improvements in safety - to significantly reduce the number of lives lost each year through connected vehicle crash prevention applications.

- Mobility: U.S. highway users waste 4.8 billion hours a year stuck in traffic - nearly one full work week (or vacation week) for every traveler. The overall cost (based on wasted fuel and lost productivity) reached $115 billion in 2009 - more than $808 for every U.S. traveler. Delays in Truck operations alone result in $33 billion. Connected vehicle mobility applications will enable system users and system operators to make choices that reduce travel delay.

- Environment: The total amount of wasted fuel topped 3.9 billion gallons in 2009 according to the Texas Transportation Institute - 130 days of flow in the Alaska Pipeline (nearly a third of the year). Connected vehicle environmental applications will enable system users and system operators to make choices that reduce the environmental impacts of surface transportation travel."[4]

To that end, the scope of the SAE J2735 SE system environment is the information exchange between a host vehicle and remote vehicles and between a host vehicle and the roadside, to address safety, mobility, and environmental system needs.

The SAE J2735 SE candidate is an information level standard that can be used to develop a system interface for information exchange with a connected vehicle. SAE J2735 SE will specify dialogs, messages, data frames, and data elements specifically for use by applications intended to utilize the 5.9 GHz Dedicated Short Range Communications for Wireless Access in Vehicular Environments (DSRC/WAVE, referenced in this document simply as DSRC). SAE J2735 SE is intended for use over DSRC as defined in the IEEE 1609 suite of standards. However the SAE J2735 SE messages can also be used over other media.

SAE J2735 SE is intended to define over-the-air messages that are transmitted to and from equipment located in vehicles traveling on the surface street and freeway network. The equipment in the vehicle will most likely be connected to the vehicle, but J2735 SE could also be used by equipment that is not connected to the vehicle.

SAE J2735 SE does not define applications, either in the vehicle or in the infrastructure.

[4] USDOT, http://www.its.dot.gov/connected_vehicle/connected_vehicles_FAQs.htm, February 1, 2012.

2.3 Reference Physical Architecture

2.3.1 Typical Physical Architecture [Informative]

The SAE J2735 SE is part of a larger environment currently under development by the USDOT program and a variety of stakeholder groups. The SAE J2735 SE is limited to the over-air messaging between road vehicles (V2V), and between vehicles and roadside units (V2I). Note in this document the term V2I is meant to represent the interface between a vehicle and roadside unit, and unless specifically indicated V2I represents information going either direction on the interface. It covers the information exchange between the OBUs on vehicles of different modes, classes, and manufacturers, and between OBUs on vehicles and RSUs. Furthermore, the J2735 SE is intended for use over Dedicated Short Range Communications (DSRC) protocols. The current SAE J2735 standard requires that all messages can operate over DSRC as defined by the IEEE 1609 suite of standards. However, the SAE J2735 standard also indicates that the messages may be used over other communications technologies. The intention is to continue this approach with SAE J2735 SE.

Figure 2 shows the variety of users that may operate in the SAE J2735 SE environment.

A connected vehicle is a vehicle with an in-vehicle device sending the Basic Safety Message (BSM) for vehicle safety applications. In this document three (3) different in-vehicle systems are considered to be a connected vehicle. Those are:

- **Integrated Vehicles (IV).** Those vehicles have On-board Equipment (OBE) installed by an OEM. The OBEs in those vehicles have full access to all the vehicle information that is available on the vehicle bus.

- **Here I Am Devices (HIA).** Those devices are installed in the vehicle but do not have any safety applications running and are not connected to a vehicle bus.

- **Aftermarket Safety Devices (ASD).** Those devices are installed in the vehicle and have safety applications running. They may or may not have access to vehicle information through a vehicle bus.

Connected vehicles include the following types: passenger, commercial, transit, and emergency. OBUs may be embedded in the vehicle, or ASDs may be installed or operating within the vehicle. The RSU acts as a conduit to connect the *connected vehicles* in the SAE J2735 SE environment to other downstream users such as transportation organizations, centers, and operators or to other ITS roadside equipment. The Core Systems shown in Figure 2 represents center based systems that provide the support services and distribution mechanism to support connected vehicle operations.

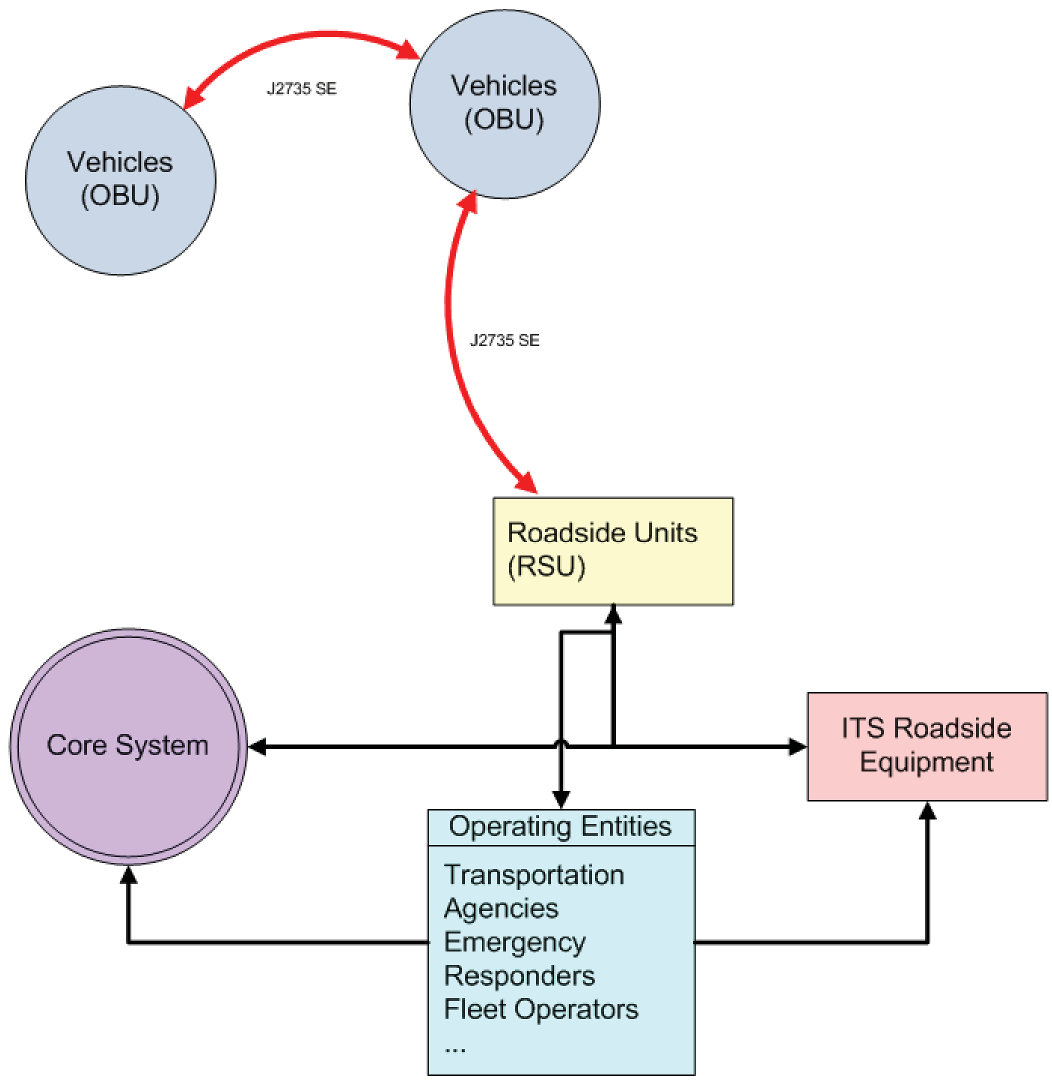


FIGURE 2 - CONNECTED VEHICLES SYSTEM OVERVIEW

2.3.2 SAE J2735 SE Device Characteristics [Normative]

A factor that complicates the development of SAE J2735 SE and that complicates the work of a specification developer is the fact that there are two different types of devices addressed by the SAE J2735 SE candidate - an OBU in a vehicle, and an RSU at the roadside. To promote interoperability among these devices, the J2735 SE must provide a single protocol that is compatible with both types of devices. However, the differences between these two types of (SAE J2735 SE) devices dictates that not all features defined within SAE J2735 SE are applicable to an RSU or an OBU. Thus, the user must categorize those features specific to an OBU or an RSU prior to determining which requirements are mandatory for a particular project.

The SAE J2735 SE recognizes two basic types of devices as described below. In addition, the SAE J2735 SE candidate recognizes there are some user needs that are specific to an On-Board Unit on a specific type of vehicle.

2.3.2.1 On-Board Unit (OBU)

A vehicle mounted device used to transmit and receive a variety of message traffic to and from other devices (other OBUs and RSUs).

2.3.2.2 Roadside Unit (RSU)

Device used to transmit to, and receive from, equipped moving vehicles (OBUs). The RSU transmits from a fixed position on the roadside (which may in fact be a permanent installation or from temporary equipment brought on-site for a period of time associated with an incident, road construction, or other event).

2.3.2.3 Public Safety On-Board Unit (PSOBU)

An OBU or ASD mounted or in an authorized public safety vehicle.

2.3.2.4 Transit Vehicle On-Board Unit (TrVOBU)

An OBU or ASD mounted or in a transit vehicle.

2.3.2.5 Commercial Motor Vehicle On-Board Unit (CVOBU)

An OBU or ASD mounted or in a vehicle moving goods, heavy equipment or people (includes motor coaches).

2.4 Architectural Needs

2.4.1 Fundamental Needs Driving Connected Vehicles Deployment

The provision of timely and reliable information between connected vehicles and between connected vehicles and roadside units is used to support applications to address safety, mobility, and environmental needs.

2.4.2 Operational Environment

SAE J2735 SE addresses the over-the-air interface between connected vehicles, and between a connected vehicle and a roadside unit. Each connected device needs to establish communications with other connected devices within its operational range.

This communications system must support the operation of secure wireless communications between the authorized connected devices. Applications will utilize this communications system to provide a variety of services to different users, including drivers, roadway operators, transit operators, public safety agencies, and maintenance personnel.

2.5 Features

Highway safety efforts over the past few decades have been focused on the reduction of crashes and the amelioration of their effects. Improvement in crash rates over the years have resulted from better education, improved legislation, traffic engineering improvements, and safer vehicles design. While these measures have resulted in reduced traffic fatalities over the past decade, the improvements have shown signs of leveling off in recent years. The connected vehicle program, which is supported by development of SAE J2735, has as one of its goals, a significant reduction in collisions on the roadways, which will translate to a significant improvement in road safety.

The operation of transportation networks and the vehicles that use them has historically been one where little information is known about the traffic flow and levels of congestion. Real-time data has been collected on only a small portion of the interstate network and virtually none of the arterial streets. This lack of data has resulted in the development of traffic operations that includes a lot of guesswork. Information given to drivers is often inefficient and not focused, little or no information is available on alternate routes and the operators who provide the data have no feedback on the efficacy of their actions. The potential exists for connected vehicles to make transformational changes to the way transportation networks operate. By allowing the ubiquitous monitoring of the transportation network, the connected vehicle program will enable new operational strategies. Operators will be able to provide focused, location-based traffic information to drivers prior to congestion points, and to see and measure the consequences of their actions.

Historically in the US, the effects of transportation on the environment have not been a driving factor but this is changing. The connected vehicle program has the ability to use data from vehicles to estimate fuel consumption and emissions. Combining this with transportation operations strategies and other data will allow operations that are optimized for environmental benefits.

The connected vehicle benefits for safety, mobility, and the environment cannot occur without a standardized way of communicating between vehicles and between the vehicles and the infrastructure. These communications must be interoperable and manufacturer-independent to work with the variety of connected devices that are likely to be deployed. This is a formidable task that requires a standardized solution that defines the various communication layers and the data to be sent. The lower level communications layers are defined in IEEE 802.11p and IEEE 1609; the data to be sent is defined in SAE J2735.

Thus, the nature of the changes between the current situation and a future with connected vehicles is extensive. It will impact all drivers, vehicles, and transportation agencies. It will open new fields for innovative applications in the vehicle, in transportation agencies, and in mobile devices.

2.5.1 Introduction to User Needs

Section 2.5 contains specific information on the user needs for the SAE J2735 SE environment. The first step in the development of the revision to the standard is to identify the user operational needs that the proposed SAE J2735 SE candidate will address.

There were two primary sources of user needs for this project. The first source of user needs was a literature review of relevant documentation including the existing SAE J2735 Standard, the outputs of the Core System for Connected Vehicles, and other relevant ongoing research related projects and programs, including other programs similar in concept to Connected Vehicles outside of the United States.

The second source of user needs was interviews with subject matter experts (SMEs) to obtain their inputs on operational needs related to connected vehicle applications. Contributors to these user needs are documented in a User Needs Report.

The user needs provide an expression of the end users' operational needs that can be met by information that goes into or out of a connected vehicle, either from one connected vehicle to another connected vehicle, or from one connected vehicle to the infrastructure (or the reverse).

The following criteria will be used as the basis for documenting well-written needs:

1. **Uniquely Identifiable.** Each need must be uniquely identified (i.e., each need shall be assigned a unique number and title).

2. **Major Desired Capability (MDC).** Each need must express a major desired capability in the system, regardless of whether the capability exists in the current system or situation or is a gap.

3. **Solution Free.** Each need must be solution free, thus giving designers flexibility and latitude to produce the best feasible solution.

4. **Capture Rationale.** Each need must capture the rationale or intent as to why the capability is needed in the system.

The User Needs are divided into two major sets:

- Vehicle-to-vehicle (V2V)

- Vehicle-to-infrastructure (V2I)

Vehicle-to-infrastructure is assumed to be bi-directional that is, vehicle-to-infrastructure and infrastructure-to-vehicle.

The user needs were divided into groups to reflect the differences in the types of information exchanged and to mirror the USDOT connected vehicle program. The needs are further divided into other classes of information needs, some related to the end users as described in Section 2.2.3 Stakeholders and Other Involved Personnel

These classes are grouped as follows:

- V2V
  - Crash Prevention Safety
  - Situational Awareness
  - Emergency Vehicle Alert
  - Vehicle Emergency Response
  - Mayday Request
- V2I
  - Safety Related User Needs
  - Mayday Forward
  - Mayday Request to Infrastructure
  - Commercial Vehicle Operations User Needs
  - Data Capture and Management Needs
    - Vehicle Data for Traffic Operations
    - Vehicle Data for Highway Maintenance and Design
    - Vehicle Data for Environment Monitoring
    - Vehicle Data to Determine Hazardous Road Conditions
    - Vehicle Data for Weather Forecasting
    - Vehicle Data for Emergency Response
    - Vehicle Data for Transit Operations
  - Traveler Related User Needs
  - Emergency Response Needs
  - Transit Operations Needs
  - Vehicle Manufacturers and Fleet Operators User Needs

The sections below list the user needs (in italics) followed by a summary of the rationale for the need.

2.5.2 V2V User Needs

2.5.2.1 Crash Prevention Safety

2.5.2.1.1 Forward Collision Prevention

The host vehicle needs to determine that the conditions of a remote vehicle indicate that a collision with the host vehicle is imminent in order to perform crash prevention actions. Prevention is defined as, “<an> action of stopping something from happening or arising." This capability is intended to help drivers avoid a collision with an equipped vehicle ahead in traffic in the same lane and direction of travel and can be applied to all types of vehicles. This capability covers a range of actions from warnings to the driver to actions taken automatically by the vehicle to avoid an imminent forward collision (e.g., automatically applying the brakes) and is particularly useful when the driver’s line of sight is obstructed by other vehicles, bad weather conditions, or roadway geometry. One type of warning that could be provided is that remote vehicles are performing emergency braking. The host vehicle must take into account the unique characteristics of the size and weight of the remote vehicles, such as commercial vehicles and transit vehicles, which may help determine stopping distances and the distance between the vehicles.

2.5.2.1.2 Intersection Movement Assist

The host vehicle approaching an intersection needs to determine the conditions of remote vehicles entering or currently in the intersection in order to perform intersection crash prevention actions. This capability enables the host vehicle to anticipate impacts where vehicle paths cross and then perform crash prevention actions to reduce the likelihood of crashes at intersections.

2.5.2.1.3 Pre-crash Actions

The host vehicle needs to determine that the conditions of remote vehicles indicate that a collision with the host vehicle is imminent in order to perform actions just before the impact occurs. This capability enables the host vehicle to determine that the crash is about to happen, then to mitigate the injuries in a crash by activating countermeasures in the vehicle. This information would supplement other information within the host vehicle. These countermeasures could include air bag pre-arming, pyrotechnic and non-pyrotechnic seat belt pre-tensioning, bumper extension or lowering, and emergency brake assist.

2.5.2.1.4 Control Loss Warning

The host vehicle needs *to determine* when a nearby remote vehicle is experiencing a loss of control that may result in an unsafe condition for the host vehicle. This capability enables a remote vehicle to broadcast a self-generated, control loss event to surrounding vehicles. Upon receiving such event information, a host vehicle can determine the relevance of the event and take appropriate actions, such as providing a warning to the driver.

2.5.2.1.5 Lane Change Warning

The host vehicle needs to determine that the conditions of nearby remote vehicles make it unsafe for the driver to perform a lane change maneuver. This capability enables the host vehicle to determine if the area into which the host vehicle intends to switch is, or will soon be, occupied by another vehicle traveling in the same direction. The host vehicle can use this information to take appropriate actions, such as warning the driver of the vehicle conflict.

2.5.2.1.6 Do Not Pass Warning

The host vehicle needs to determine if the conditions of nearby remote vehicles make it unsafe for the driver to initiate a passing maneuver past a remote vehicle ahead in its lane. This capability enables a host vehicle to determine if a passing maneuver of a slower moving vehicle, ahead and in the same lane, cannot be safely attempted using a passing zone which is occupied or will be occupied by vehicles with the opposite direction of travel. The host vehicle can use this information to take appropriate action, such as warning the driver of the potential vehicle conflict.

2.5.2.1.7 Blind Spot Warning

The host vehicle needs to determine that the conditions of nearby remote vehicles indicate that a nearby remote vehicle is in the blind spot area of the host vehicle. This capability enables the host vehicle to determine if the area on either side of the host vehicle is occupied by another vehicle traveling in the same direction. The host vehicle can use this information to take appropriate actions, such as warning the driver of the vehicle conflict.

2.5.2.1.8 Facilitate Development and Testing

During development and testing, it is preferable to have information exchanged in a format that contains some amount of redundant formatting so that any informational or encoding errors can more easily be detected.

2.5.2.2 Situational Awareness

The host vehicle needs to determine if the road conditions measured by remote vehicles represent a potential safety hazard for the host vehicle. This capability enables relevant road condition information, such as fog or icy roads, to be broadcast from a remote vehicle and received by the host vehicle. This capability allows connected vehicles to share situational awareness information even in areas where no I2V infrastructure exists. This can be useful to host vehicles that are not fully equipped with sensors, or host vehicles entering an area with hazardous conditions.

2.5.2.3 Emergency Vehicle Alert

The host vehicle needs to receive information about the location and status of nearby emergency vehicles responding to an incident. This capability enables the host vehicle to alert the driver about the location of and the movement of public safety vehicles responding to an incident so the driver does not interfere with the emergency response.

2.5.2.4 Vehicle Emergency Response

Emergency responders need information about remote vehicles involved in a crash to respond safely and effectively to a vehicle crash. Because this information has privacy considerations, drivers need the ability to opt in to this capability. This capability enables public safety vehicles to receive information concerning the vehicles involved in accidents. Information such as HAZMAT data can assist the responders on-board the responding public safety vehicle to prepare. Information about air bag activations can provide useful input to ambulance staff.

2.5.2.5 Mayday Request

The remote vehicle, if involved in an accident, needs to be able to transmit its circumstances to public safety agencies. One capability would be to enable a host vehicle to receive automated mayday requests from remote (disabled) vehicles, so the host vehicle can forward mayday requests to emergency response services. Remote vehicles would automatically transmit these mayday requests when it detects indications of a crash, such as the deployment of airbags. This capability allows a host vehicle to forward mayday requests even in areas where no V2I infrastructure exists. Because this information has privacy considerations, drivers need the ability to opt in to this capability.

2.5.2.6 Transit Vehicle Crash Warning

A connected transit vehicle needs to determine that the conditions of nearby remote vehicles indicate that a nearby remote vehicle is pulling in front of the transit vehicle to make a turn. This capability enables the transit vehicle to determine if the area in front of it will not be occupied as it begins to pull away from a transit stop.

2.5.3 V2I User Needs

2.5.3.1 Safety and Eco Driving Related User Needs

2.5.3.1.1 Data to Determine Stopline Violations at Unsignalized Intersections

A connected vehicle needs the data to determine that a stopline violation may occur at an unsignalized intersection. This capability enables a connected vehicle to receive information from the infrastructure regarding the geometry of the intersection. This capability allows a connected vehicle to predict if the speed and acceleration profile of the vehicle makes it appear likely that the vehicle will enter the intersection in violation of a stop sign.

2.5.3.1.2 Data to Determine Stopline Violations at Signalized Intersections and Grade Crossings

A connected vehicle needs the data to determine that a stopline violation may occur at a signalized intersection or a railroad grade crossing. This capability enables a connected vehicle to receive information from the infrastructure regarding the signal timing and the geometry of the intersection. This capability allows a connected vehicle to predict if the speed and acceleration profile of the vehicle makes it appear likely that the vehicle will enter the intersection in violation of a traffic signal. Another usage may be at a railroad crossing where the violation may include gate crossings.

2.5.3.1.3 Signal Movement at Intersections: Eco-Driving

A connected vehicle needs to receive signal movement information at a signalized intersection or at an active railroad crossing for eco-driving capabilities. This capability enables the vehicle to perform actions to improve the efficiency of vehicle operations (e.g., by making engine adjustments that provide increased fuel efficiency).

2.5.3.2 Infrastructure Restriction Warnings

A connected vehicle needs to receive information about upcoming infrastructure restrictions such as height or weight restrictions. This capability allows transportation agencies to warn vehicles of upcoming infrastructure restrictions, which may result in damage to the vehicle or the roadway infrastructure. Such damage may result from a vehicle that is too high or too wide to travel under a bridge, an overweight vehicle approaching a crossing, or a vehicle making a turning movement that may hit a roadway lighting fixture. This capability also enables transportation agencies to provide route restriction warnings and alternate routes to the vehicle.

2.5.3.2.1 Warnings about Hazards in a Work Zone

Maintenance personnel within a work zone need to be warned about potential hazards within the work zone. This capability enables vehicles or the infrastructure to provide warnings to workers in a work zone when a vehicle is moving in a manner that appears to create an unsafe condition (e.g., moving at high speed or entering the work zone).

2.5.3.2.2 Warnings about Upcoming Work Zone

A connected vehicle needs to receive information about the conditions that exist in a work zone that the vehicle is approaching. This capability provides approaching vehicles with information about work zone activities that may result in unsafe conditions to the vehicle, such as obstructions in the vehicle's travel lane, lane closures, lane shifts, speed reductions or vehicles entering/exiting the work zone.

2.5.3.2.3 Restricted Lane Warnings

A connected vehicle needs to receive information to determine if it is in a restricted lane, such as HOV, eco-lanes, transit, or emergency vehicle only lanes. This capability provides the vehicle with restriction information about the travel lane, such as if the lane is restricted to high occupancy vehicles (HOV), transit, or public safety vehicles only or has defined eco-lane criteria.

2.5.3.2.4 Roadway Hazards Information

A connected vehicle needs to receive information about the current road hazard conditions. This capability enables the vehicle to advise the driver who may take appropriate actions, such as slowing down the vehicle, to reduce the risk of a crash based on the vehicle's location, speed, trajectory and the road conditions. Examples of hazardous roadway conditions include fog, high winds, ice, objects in the road and other poor pavement conditions.

2.5.3.2.5 Pedestrian and Turning Vehicle Crash Warning

The connected vehicle driver needs to know if there are pedestrians in the crosswalk when the vehicle is making a right or left turn at an intersection. This capability would provide to the vehicle information from the infrastructure that indicates the possible presence of pedestrians in a crosswalk into which the vehicle is about to turn. The infrastructure based indication could include the outputs of pedestrian sensors or simply an indication that the pedestrian call button has been activated. This capability was initially defined for transit vehicles, but can be applicable to any class of vehicle.

2.5.3.3 Mayday Forward

A connected vehicle needs to forward to the infrastructure a mayday request received from a disabled vehicle. This capability enables a host vehicle to forward automated mayday requests from remote vehicles to the infrastructure, where the requests are then routed to emergency response services. Remote vehicles automatically transmit these mayday requests when the vehicle detects indications of a crash, such as the deployment of airbags. The mayday would include additional information about the vehicle, such as fuel type vehicle make and model that might impact the emergency response. For example, different car makes require differing responses due to variation in manufacturing materials; this information is used by fire truck crews when working on cutting open cars.

2.5.3.4 Mayday Request to Infrastructure

A connected vehicle needs to transmit a mayday request to the infrastructure. This capability enables a connected vehicle to send automated mayday requests to the infrastructure, where the requests are then routed to emergency response services. Connected vehicles automatically transmit these mayday requests when the vehicle detects indications of a crash, such as the deployment of airbags.

2.5.3.5 Commercial Vehicle Operations User Needs

2.5.3.5.1 Commercial Vehicle Credentialing and Permitting

The commercial vehicle credentials agency needs commercial vehicle information to support credentialing and permitting functions. This capability enables commercial vehicles to provide identifying information to the infrastructure to allow the credentials or permitting to be verified without requiring the commercial vehicle to stop. The commercial vehicle would transmit its identifying information to the infrastructure, where the commercial vehicle agency can verify the proper fees have been paid and the permits are valid. The commercial vehicle may also transmit driver identification, duty logs, trailer data and cargo data to the infrastructure. As this service uses sensitive information, commercial vehicle drivers have to opt-in for these services.

2.5.3.5.2 Safety Inspection Data

Commercial vehicle safety agencies need to access the electronic safety inspection data from a commercial vehicle. This capability allows commercial vehicle inspectors to electronically download inspection data from the vehicle via the infrastructure without requiring the commercial vehicle to stop. This capability allows the commercial vehicle agencies to inspect more commercial vehicles and saves the commercial vehicle drivers' time. This capability also allows commercial vehicle agencies to select those vehicles that are of interest for physical inspections at an inspection site. Note: For the purpose of this project it is assumed that the power unit will have all data pertaining to the trailers. As this service uses sensitive information, commercial vehicle drivers (or fleet operators) have to opt-in for these services.

2.5.3.5.3 Vehicle Clearance

The commercial vehicle driver needs to know if the commercial vehicle has received electronic clearance at an inspection site. This capability enables the commercial vehicle and inspection agencies to transmit clearance via the infrastructure to the commercial vehicle, allowing the commercial vehicle to bypass inspection and wayside stations. Clearance may be provided after all the electronic safety inspections, weight inspections, tariff payments, credentials, permits, etc. have been checked and verified. This capability allows a commercial vehicle driver to continue on his trip without needing to stop at the inspection station, saving the driver time. A toll booth may be used to implement this feature. As this service uses sensitive information, commercial vehicle drivers (or fleet operators) have to opt-in for these services.

2.5.3.5.4 Receive Parking Space Availability and Service Information

Commercial vehicle drivers need the availability of parking spaces and services at upcoming parking lots or rest area facilities. This capability provides commercial vehicle drivers with information about the availability of parking and services information, including availability times and parking space dimensions. This capability has a safety aspect to it since commercial vehicle drivers that exceed hours of service requirements represent a safety hazard on the roads.

2.5.3.6 Data Capture and Management User Needs

2.5.3.6.1 Vehicle Data for Traffic Operations

2.5.3.6.1.1 Vehicle Data for Traffic Data Collection

Transportation agencies and private traveler information companies need to collect vehicle data to support traffic data collection. This capability enables transportation agencies to obtain data from vehicles in the network to determine network performance measures such as speed and travel times.

2.5.3.6.1.2 Vehicle Data for Incident Detection

Transportation agencies need to collect vehicle data to support incident detection. This capability enables transportation agencies to determine the location of potential incidents so the agencies can respond more quickly to the incident and mitigate any negative impacts to the transportation network. Vehicle data that can be used to detect potential incidents include changes in vehicle speeds indicating the disruption of traffic flow, when a vehicle's safety systems have been activated or deployed, or sudden vehicle turns or deceleration at a specific location (indicating a potential obstacle in the roadway).

2.5.3.6.1.3 Vehicle Data for Traffic Operations Strategies

Transportation agencies need to collect vehicle data to support the implementation of operations strategies. This capability enables transportation agencies to use vehicle data to optimize traffic operations through the implementation of localized operational strategies. One example of optimizing traffic operations include knowing what vehicles are approaching a signalized intersection and their trajectories to minimize delay, improve traffic flow, and improve safety. Another example involves knowing how many vehicles are on a freeway mainline and on a freeway ramp to optimize the ramp metering rate or to employ speed harmonization.

2.5.3.6.2 Vehicle Data for Highway Maintenance and Design

Transportation agencies need to collect vehicle data to support performance monitoring and other uses of historical data including transportation planning, safety analyses, and research. This capability enables transportation agencies to collect transportation data to support performance monitoring of the transportation infrastructure, for transportation planning, condition monitoring, and to improve safety.

2.5.3.6.3 Vehicle Data for Environmental Monitoring

Transportation agencies need to gather data from the vehicles to support environmental monitoring. This capability enables transportation agencies to collect vehicle and emissions data to improve forecasting models, to measure the effectiveness of transportation strategies, and to provide input to real-time operations strategies that can be implemented when environmental conditions dictate. Vehicle data collected includes the type of vehicle(s), engine(s), and fuel type used by each vehicle on the roadway, emissions from each vehicle, vehicle weight and speeds, and vehicle operating data.

2.5.3.6.4 Vehicle Data to Determine Hazardous Road Conditions

Transportation agencies need to collect data from vehicles to support detection of weather-related hazardous road conditions. This capability enables transportation agencies to determine road conditions based on vehicle status data collected from the vehicle. Vehicle status data such as slippage detected by the vehicle, status of windshield wipers, vehicle (front) lights, fog lamps and hazard lights can be used by transportation agencies to determine road conditions such as low visibility, icy roads, heavy rains, or flooding.

2.5.3.6.5 Vehicle Data for Weather Forecasting

Transportation agencies need to collect vehicle data to enhance weather forecasting. This capability enables transportation agencies to determine current or forecasted road weather condition on a link-by-link basis using environmental data collected by vehicles, such as slippery road conditions, temperature, air pressure, and the presence of precipitation. This information can augment the road weather information collected from fixed environmental sensor systems, provide input into traveler information systems, and enhance the operations of snow plows and maintenance vehicles.

2.5.3.7 Traveler Related User Needs

2.5.3.7.1 Speed Advisories

Transportation agencies need to provide vehicle speed advisories directly to vehicles for safety and to encourage progression through arterial signal systems. This capability allows transportation agencies to provide speed advisories to drivers. Potential scenarios include encouraging vehicles to lower their vehicle speeds due to poor roadway conditions (e.g., ice, fog), upcoming work zones, or to encourage vehicle platoons on the roadway thereby improving vehicle density and reducing delays and emissions. The variable speed limits can also be used by in-vehicle navigation systems to update estimated travel times.

2.5.3.7.2 Location-Based Traveler Information and Advisories

The driver needs to receive traveler information and advisories based on the vehicle's current position and heading. This capability allows the driver to receive focused transportation related traveler information of interest. Such information could include travel advisories, warnings on upcoming road conditions (including weather and speed limits), and toll information. This information could also include availability and location of electrical charging stations or alternative fueling stations to support eco driving.

2.5.3.7.3 Vehicle Restrictions

Transportation agencies need to provide travel restriction or route restrictions relevant to all or to specific types of vehicles as part of the implementation of travel demand strategies. This capability enables transportation agencies to restrict travel for certain types of vehicles (or for all vehicles) based on demand strategies that may be implemented due to some predetermined set of environmental or security conditions.

2.5.3.7.4 Curve Speed Warning

The vehicle needs to receive information that it is approaching a curve along with the recommended speed for the curve. This capability allows the vehicle to provide a warning to the driver regarding the curve and its recommended speed. In addition, the vehicle could perform additional warning actions if the actual speed through the curve exceeds the recommended speed.

2.5.3.8 Emergency Response Needs

2.5.3.8.1 Minimize Delay to Emergency Vehicles at Traffic Signals

Emergency responders need to have their trip through the traffic network expedited. This capability allows emergency responders to more quickly and safely go through a signalized intersection (or follow a planned route) in response to an incident or emergency. The potential scenarios include an emergency vehicle requesting traffic signal pre-emption and the traffic signal providing the emergency responder with an indication that the preemption action has been taken.

2.5.3.9 Transit Operation Needs

2.5.3.9.1 Transit Signal Priority

Transit operators need transit signal priority to assist transit vehicles in maintaining their schedules. This capability allows transit schedules to be more predictable, improving transit service for transit users, and allowing transit operators to reduce their fleet size and operating costs. This capability includes feedback to the transit driver if the signal priority has been granted or not, and how to manage conflicting priority requests. This capability can also contribute to improved operating performance of the transit vehicles by reducing the time spent stopped at a red light.

2.5.3.10 Vehicle Manufacturers and Fleet Operators User Needs

The following are user needs identified by vehicle manufacturers and fleet operators to support vehicle maintenance and customer support activities.

2.5.3.10.1 Ad Hoc Messages

Vehicle manufacturers and fleet operators need the ability to transfer data to and from the vehicle. This capability enables vehicle manufacturers and fleet operators to transmit customized data to and from specific vehicles. For example, snow plows may want to send plow and material status, fleet operators may wish to collect data from vehicle data buses, and some vehicle manufacturers transmit software updates as part of vehicle servicing. These messages are meant to be unique to the group providing them (e.g., a specific vehicle manufacturer) and are not interoperable outside of the particular group.

2.6 Security

There is a need to ensure that the information being exchanged is protected from attacks such as eavesdropping, spoofing, alteration, and replay, while respecting end users' right to privacy.

2.7 Operational Policies and Constraints

The implementation of systems using the data concepts defined by SAE J2735 SE will occur within the constraints included in the original FCC requirements which provided restrictions on usage and range of the 5.9 GHz frequency (FCC Docket 03-324 Adopted December 17, 2003)[5]. These requirements prescribed safety as the overriding justification, defined the band plan, the limits and the range of the communications, the directionality of the antennas, and other technical issues.

The emphasis of the SAE J2735 SE candidate is the data dictionary for the interface for V2V and V2I messages. Note that V2I includes both infrastructure-to-vehicle and vehicle-to-infrastructure interchanges. Although the SAE J2735 SE candidate is based upon the WAVE (Wireless Access in Vehicular Environments) mode of operation used by IEEE 802.11 devices to operate in the DSRC band, this ConOps is technology neutral - that is, the ConOps does not assume any specific communications technology or protocol to manage and exchange SAE J2735 SE messages.

There is a wide range of users which were defined in Section 2.2.3. The vehicles as users come from different manufacturers, different vehicle modes, differing operating platforms, with differing software versions. This becomes even more complex when aftermarket products can also be used in the vehicles. Of prime concern is interoperability since each vehicle must work with all others and with infrastructure deployed by a variety of agencies.

It is the position of the various industries including the automakers and the aftermarket device manufacturers, that how each application uses the data exchanged should be determined by the application developer. These industries consider the applications and processes they run to be proprietary and a discriminator between brands. Thus, this standard does not involve the design of the applications or the presentation to the users. This standard deals only with the data that is transmitted on the wireless link to a connected vehicle.

Privacy is one of the key issues or constraints for the development of SAE J2735 SE. In order to ensure privacy of the users of the system, any message (or data frame) that contains information that can be considered personally identifiable information should be specifically noted so that only opt-in applications can use those messages (or data frames). SAE J2735 itself cannot ensure anonymity; however, it can identify which messages (or data frames) are not anonymous. Only the builders of the systems or applications that use the messages can ensure anonymity. But from a constraint viewpoint, the standard needs to identify any data that contains personal information.

---

5 https://docs.google.com/viewer?url=http%3A%2F%2Fhraunfoss.fcc.gov%2Fedocs_public%2Fattachmatch%2FFCC-03-324A1.pdf

Privacy policies are needed to ensure buy-in from consumers. To that end, message privacy and security need to be preserved. Fleet and other users, who may opt-in from the point of view of their drivers, will be able to apply security procedures to their information.

Guiding principles for privacy policies can be summarized as follows:

“Anonymous information means data collected, disclosed or used by or through the National VII Program that does not identify or relate to an identifiable individual. Some of the types of anonymous information that will be in the National VII Program include information collected without personal identifiers, personal information that has been stripped of personal identifiers, or aggregated and summarized, and impersonal vehicle data as defined below that relates only to vehicles or vehicle parts, and not to any particular owner, occupant or operator of a vehicle. The essence of anonymous information is that it cannot be linked with an identifiable individual"[6]

The explanation for this (from the same reference) includes: “…anonymous information regarding a vehicle or a vehicle part that cannot be associated with a specific individual and does not reflect on the owner, operator, or occupants of a vehicle …" Note the VII Program referenced here has evolved into the current Connected Vehicle Program.

2.8 Relationship to the National ITS Architecture [Informative]

The SAE J2735 SE candidate addresses two key interfaces that exist in the National ITS Architecture

- Vehicle to Other Vehicle
- Vehicle to Roadway

2.8.1 Vehicle to Other Vehicle Interface

The following are the architecture flows from the National ITS Architecture that are addressed by SAE J2735 SE:

- **vehicle intersection safety data** (Architecture Flow) - Vehicle path and acceleration data provided by vehicles approaching or occupying an intersection. It identifies the intersection, vehicle position and motion, the anticipated lane and movement that will be used in the intersection, and notification of potential violations or other detected safety hazards.

- **vehicle safety data** (Architecture Flow) - Vehicle safety data indicating vehicle location, vehicle motion (speed, heading, acceleration), vehicle control (brakes, steering, throttle, exterior lights), basic vehicle characteristics (length, width). This architecture flow may also include additional vehicle status information (e.g., anti-lock brake activation, stability control system activation).

These flows exist on both the Vehicle to Other Vehicle and Other Vehicle to Vehicle interfaces.

Note there is a third architecture flow on this interface that is not covered by the planned SAE J2735 SE. That is the **vehicle control coordination** flow, which is related to platoon operations.

Table 1 shows how these architecture flows are mapped to the Service Packages providing ITS services that are supported by the user needs of Section 2.5. A Service Package is the subset of the National ITS Architecture that provides a specific ITS Service.

[6] *VII Privacy Policies Framework, Version 1.0.2 February 16, 2007,* Institutional Issues Subcommittee of the National VII Coalition

TABLE 1 - NATIONAL ITS ARCHITECTURE MAPPING - V2V

Architecture Flow	Service Packages
vehicle intersection safety data	AVSS05- Intersection Safety Warning AVSS10- Intersection Collision Avoidance
vehicle safety data	AVSS06- Pre-Crash Restraint Deployment AVSS12- Cooperative Vehicle Safety Systems

2.8.2 Vehicle to Roadway Interface

The following architecture flows from Vehicle to Roadway (and from Roadway to Vehicle) are addressed by SAE J2735 SE:

- **environmental probe data** (Architecture Flow) - Data from vehicle safety and convenience systems that can be used to estimate environmental conditions, including measured air temperature, exterior light status, wiper status, sun sensor status, rain sensor status, traction control status, anti-lock brake status, and other collected vehicle system status and sensor information. The collected data is reported along with the location, heading, and time that the data was collected. Both current data and snapshots of recent events (e.g., traction control or anti-lock brake system activations) may be reported.

- **probe archive data** (Architecture Flow) - Probe data that allows calculation of travel times, volumes, and other measures that support transportation planning. Optionally, this flow also includes origin and destination information for vehicles that opt to provide this information.

- **traffic probe data** (Architecture Flow) - Vehicle data that is used to determine traffic conditions. In a basic implementation, the data could be limited to time stamped unique identifiers that can be used to measure a vehicle's progress through the network. In more advanced implementations, the vehicle may report current position, speed, and heading and snapshots of recent events including route information, starts and stops, speed changes, and other information that can be used to estimate traffic conditions.

- **vehicle diagnostics data** (Architecture Flow) - Information about the vehicle and its current operational status that supports vehicle performance monitoring, service, and repair. The flow identifies the vehicle and vehicle type and provides information about the vehicle's current operational status, the current performance of engine-related components, and notification of any identified malfunctions.

- **vehicle intersection safety data** (Architecture Flow) - Vehicle path and acceleration data provided by vehicles approaching or occupying an intersection. It identifies the intersection, vehicle position and motion, the anticipated lane and movement that will be used in the intersection, and notification of potential violations or other detected safety hazards.

- **vehicle safety data** (Architecture Flow) - Vehicle safety data indicating vehicle location, vehicle motion (speed, heading, acceleration), vehicle control (brakes, steering, throttle, exterior lights), basic vehicle characteristics (length, width). This architecture flow may also include additional vehicle status information (e.g., anti-lock brake activation, stability control system activation).

The following architecture flows from Roadway to Vehicle are addressed by SAE J2735 SE:

- **broadcast traveler information** (Architecture Flow) - General traveler information that contains traffic and road conditions, link travel times, incidents, advisories, restrictions, transit service information, weather information, parking information, and other related traveler information.

- **intersection status** (Architecture Flow) - Intersection status including current operational status, signal phase and timing information, intersection geometry, surface conditions, warnings of potential violations or hazardous conditions, and approaching vehicle information. This may include information about the position, velocity, acceleration, and turning status of approaching vehicles.

- **roadway safety data** (Architecture Flow) - Information about potential safety hazards in the vehicle path such as stalled vehicles, wrong way drivers, debris, or standing water.

- **vehicle signage data** (Architecture Flow) - In-vehicle signing data that augments regulatory, warning, and informational road signs and signals. The information provided would include static sign information (e.g., stop, curve warning, guide signs, service signs, and directional signs) and dynamic information (e.g., current signal states, grade crossing information, local traffic and road conditions, advisories, and detours).

Table 2 shows how these architecture flows are mapped to the Service Packages providing ITS services that are supported by the user needs of Section 2.5.

TABLE 2 - NATIONAL ITS ARCHITECTURE MAPPING - V2I

Architecture Flow	Service Packages
environmental probe data	MC11-Environmental Probe Surveillance
probe archive data	AD1- ITS Data Mart AD2 - ITS Data Warehouse
traffic probe data	ATMS02-Traffic Probe Surveillance
vehicle diagnostics data	ATMS11-Emissions Monitoring and Management
vehicle intersection safety data	AVSS05-Intersection Safety Warning AVSS10-Intersection Collision Avoidance
vehicle safety data	AVSS12- Cooperative Vehicle Safety Systems
broadcast traveler information	ATIS01-Broadcast Traveler Information ATIS04-Dynamic Route Guidance
Intersection status	AVSS05-Intersection Safety Warning AVSS10-Intersection Collision Avoidance
roadway safety data	AVSS12-Cooperative Vehicle Safety Systems
vehicle signage data	ATIS09-In Vehicle Signing

2.9 Operational Scenarios [Informative]

The proposed system uses on-board and roadside devices. These devices wirelessly communicate with each other to exchange information concerning the status of vehicles and the transportation network. When two vehicles are communicating the vehicle receiving the information is referred to as the host vehicle and the vehicle(s) sending the information is referred to as the remote vehicle. The operational scenarios will deal with the information that is transmitted on the V2V or V2I (or I2V) interfaces and will only identify what the receiving device might do with the information. The operational scenarios do not define the details of these applications or limit their scope.

2.9.1 System Environment Description with External Stakeholders

For the purposes of the system description in Figure 2, the host and remote vehicle functions are separated into two components. The system environment, from a SAE J2735 SE perspective, is composed only of the two OBU functions (host and remote) and the RSU. It is envisioned that the RSU will be responsible for communicating with core systems and centers (public and private), and field equipment. The core system provides a series of support services. Examples of these include providing security to enable confidentiality and validity of messaging. The core system also provides distribution mechanisms such as publish and subscribe that enable distribution of vehicle data to the potential users. The core system will also support multiple other core systems to enable other core systems to share information across geographical boundaries.

2.9.2 Operational Scenario Categories

An operational scenario is a sample of interactions between actors that may occur in the environment wherein stakeholders recognize how they will interact in the system. The approach used in this document groups like scenarios into an operational scenario category. In these operational scenario categories, the actors (associated with stakeholders) direct information flows from and to the vehicles operating in the environment. As such, categories are divided by information flow direction - Vehicle-to-vehicle (remote to host service), Vehicle-to-infrastructure, and Infrastructure-to-vehicle. The operational scenarios in these three categories are applicable to all stakeholders and types of vehicles. An additional operational scenario category was included, called Special Cases, for specific stakeholders and vehicle types. These stakeholders and vehicle types are commercial vehicle operations, transit operations, emergency vehicle operations, vehicle manufacturers, and fleet operators.

Since this standard is defining an interface there are a range of applications that are not yet developed and likely more applications that are not yet conceived. This means that the operational scenarios are best described in categories. Most of the operational scenarios involve broadcast of information to or from any vehicle, but some of the scenarios involve dialogs such as an information request to a specific vehicle and a response from that vehicle.

Each operational scenario category includes operational scenarios that provide descriptions of the actors, tasks and activities (their roles and responsibilities), operational elements, and information exchanges required to accomplish the category objectives and meet the set of user needs. Because the system result looks like an information flow, particular attention will be paid towards the preconditions (data supported by a system element) and message transmitted and/or received. Limited detail will be applied to describe the functions and processes internal to each system element (e.g., OBU or RSU).

Each operational scenario category is composed of the following:

- **Category Name.** Title and identification of the operational scenario category.
- **Description.** A short paragraph that describes the category characteristics and the related operational scenarios.
- **Alternative Operational Scenarios.** Exceptions or specialization to the category based on a specialization of an actor, for example, emergency vehicles may broadcast unique messages.
- **Needs Addressed.** A list of the User Needs supported by the category.

2.9.2.1 Actor Definitions

Actors are people or subsystems that interact within the system. In the SAE J2735 SE environment, they may be subsystems within the overall system. Actors also represent the external users who may interact with the system, for example, the private and public sector centers.

Table 3 lists the actors, gives a description of the actor, and gives examples of related stakeholders who apply to the actor category.

TABLE 3 - ACTOR DESCRIPTION AND ASSOCIATED STAKEHOLDERS

Actor	Description	Stakeholder Examples
Remote OBU	A vehicle OBU that periodically and dynamically broadcasts a message about its general situation to a host vehicle (OBU). The OBU may be included in a factory installed unit, after market device or in a mobile unit that is plugged into a vehicle.	Vehicle (Vehicle Driver) (special case: emergency management vehicle (EMV))
Host OBU	A vehicle OBU that receives messages from a Remote OBU. The Host OBU also sends and receives messages from an RSU.	Vehicle (Vehicle Driver) (special case: EMV)
RSU	A device at a fixed location on the roadside transmitting to and receiving from the Host OBU.	Field equipment owned typically by Transportation Agencies (special case - EMV stopped at the scene of an incident)
Vehicle Manufacturer or Fleet Managers	Vehicle Manufacturers, Fleet Managers; other organizations that operate a fleet of vehicles with whom they need to communicate.	Specific Vehicle Manufacturer, Commercial Vehicle Fleet Manager
Transportation Agencies	Traffic operations agencies at any level of government (e.g., state or city), transit agencies, toll authorities, or private companies operating a highway concession. This type of actor would also include private information service providers who might collect vehicle data to support traveler information capabilities, as well as commercial vehicle credentials and safety agencies, and maintenance personnel. The transportation agencies need to communicate with or collect information from vehicles.	Traffic Management Center operated by State DOT, Transit Agency
Emergency Responders	Providers of emergency services, including public safety providers who need to communicate with or collect information from vehicles	Law enforcement, Fire department, Ambulances

2.9.2.2 Operational Scenario Category Definitions

Several operational scenario categories are defined for the J2735 SE. They include the following:

- Vehicle-to-vehicle
    - General Conditions (host vehicle)
    - Vehicle Maneuver (remote vehicle)
    - Mayday (also include data forwarding to Infrastructure)
- Infrastructure-to-vehicle
    - Situational Awareness: Infrastructure Conditions
    - Situational Awareness: Flow Conditions
- Vehicle-to-infrastructure
    - Data Collection
    - E-Commerce

- Special Cases - Data Communications
  - Commercial Vehicle Operations
  - Transit Operations
  - Emergency Vehicle Operations
  - Vehicle Manufacturers and Fleet Operators

2.9.2.2.1 Vehicle-to-vehicle - General Conditions

Category Name:	General Condition
Description:	General Condition describes operational scenarios that leverage the broadcast and processing of basic vehicle information such as location and motion from remote vehicles within a certain proximity. Safety warnings are based on an assessment of the situation. These consider conditions of surrounding vehicles and are derived from this information flow. The types of operational scenarios may include information flows related to forward, side, and back crash prevention warnings. These include a host vehicle's general movement; assist in turning, changing lanes, situational awareness of road conditions conveyed by remote vehicles, and other crash prevention warnings. The major stakeholder of this category is the host vehicle that receives, filters, and processes information.
Alternative Operational Scenarios:	
Needs Addressed:	2.5.2.1.1 Forward Collision Prevention 2.5.2.1.2 Intersection Movement Assist 2.5.2.1.3 Pre-Crash Actions 2.5.2.1.5 Lane Change Warning 2.5.2.1.6 Do Not Pass Warning 2.5.2.1.7 Blind Spot Warning 2.5.2.2 Situational Awareness

2.9.2.2.2 Vehicle-to-vehicle - Vehicle Maneuver

Category Name:	Vehicle Maneuver
Description:	Each (remote) vehicle broadcasts information about its status, path, operational conditions, and other pertinent information. A host vehicle can use this data in accident prevention. The vehicle maneuver category describes various alternative maneuvers that may precipitate different information flows including: Turning (Changing Direction); Changing lanes/passing / pulling out of parking space (Same Direction); Intersection approach (Crossing Paths); and Stopping/slowing/accelerating (Changing Speed). NOTE: these scenario types are derived from the VSC-A test cases.
Alternative Operational Scenarios:	Parked on side of the Road Pulls out from Parking space (or changes a lane) Speeds up on road Slows down Turns Left Uncontrolled Vehicle
Needs Addressed:	2.5.2.1.1 Forward Collision Prevention 2.5.2.1.4 Control Loss Warning 2.5.2.1.5 Lane Change Warning 2.5.2.1.7 Blind Spot Warning 2.5.2.6 Transit Vehicle Crash Warning

2.9.2.2.3 Vehicle-to-vehicle – Mayday

Category Name:	Mayday
Description:	Disabled vehicles can automatically generate and transmit data relating to the position and status of the disablement. Such information may be used by emergency vehicles approaching the disabled vehicle. Passing vehicles may receive such data, store it, and forward to an RSU at a later time.
Alternative Operational Scenarios:	
Needs Addressed:	2.5.2.4 Vehicle Emergency Response 2.5.2.5 Mayday Request 2.5.3.2 Mayday Forward 2.5.3.3 Mayday Request to Infrastructure

2.9.2.2.4 Infrastructure-to-vehicle - Situational Awareness: Infrastructure Conditions

Category Name:	Situational Awareness: Infrastructure Conditions
Description:	Vehicles receive information about infrastructure conditions. These conditions include: Static information such as roadway design, bridge clearance, restricted lanes geometry where appropriate (curve speed profile); Planned conditions such as detours, work zones, restricted lanes by day type / day of week or time period; Traveler information such as roadway weather forecasts/conditions, congestion, and diversion information; and Traffic signal data and intersection geometry.
Alternative Operational Scenarios:	
Needs Addressed:	2.5.3.1.4 Infrastructure Restriction Warnings 2.5.3.1.6 Warnings about Upcoming Work Zone 2.5.3.1.7 Restricted Lane Warnings 2.5.3.1.8 Roadway Hazards Information 2.5.3.6.4 Vehicle Restrictions

2.9.2.2.5 Infrastructure-to-vehicle - Situational Awareness: Flow Conditions

Category Name:	Safety Warnings and Situational Awareness: Flow Conditions
Description:	Vehicles receive dynamic safety and situational status and performance information about the flow conditions on specific roads and lanes. The dynamic or adaptive information may include: Safety warnings about flow conditions such as upcoming work zones, restricted lanes, intersection and rail interchange warnings, and impending violations; Hazardous and events such as location of disabled vehicle, accidents, lane closures; Travel times; and Speed advisories.
Alternative Operational Scenarios:	This category may be extended to include information about parking and other time-constrained services.
Needs Addressed:	2.5.3.1.4 Infrastructure Restriction Warnings 2.5.3.1.5 Warnings about Hazards in a Work Zone 2.5.3.1.6 Warnings about Upcoming Work Zone 2.5.3.1.7 Restricted Lane Warnings 2.5.3.1.8 Roadway Hazard Information 2.5.3.6.1 Speed Advisories 2.5.3.6.4 Vehicle Restrictions

2.9.2.2.6 Vehicle-to-infrastructure (V2I) - Data Collection

Category Name:	Data Collection
Description:	A host vehicle collects, processes, and forwards information from connected devices about the status and condition of the behavior and performance of the connected vehicles. This includes collection of information for/from all modes (OBU). Data capture and processing data sets include: Transportation network performance and flow conditions (including capacity from transit vehicles); Environmental monitoring; and Infrastructure condition (e.g., potholes, ice).
Alternative Operational Scenarios:	Weather information Fleet Monitoring
Needs Addressed:	2.5.3.5.1 Vehicle Data for Traffic Operations 2.5.3.5.2 Vehicle Data for Highway Maintenance and Design 2.5.3.5.3 Vehicle Data for Environmental Monitoring 2.5.3.5.4 Vehicle Data to Determine Hazardous Road Conditions 2.5.3.5.5 Vehicle Data for Weather Forecasting

2.9.2.2.7 Vehicle-to-infrastructure - E-Commerce

Category Name:	E-Commerce
Description:	Payment for services or subscriptions that may be consumed while a vehicle is within the J2735 SE environment. Services may include: Congestion pricing such as VMT, HOT, or parking; and Commercially available traveler information such as trip planning, location services, charging stations, and parking reservations services.
Alternative Operational Scenarios:	Environmental charging for vehicles with higher pollutant levels in non-attainment areas
Needs Addressed:	2.5.3.6.3 Payment for Services

2.9.2.2.8 Special Cases - Commercial Vehicle Operations

Category Name:	Commercial Vehicle Operations
Description:	Describes the information that flows between a commercial vehicle and transportation regulatory agencies or transportation agencies. The types of information flows may support: Credentialing and permitting; and Safety inspection. These two examples are currently implemented with the vehicle sending identification to the roadside where the processing takes place in the infrastructure Vehicle clearance - I2V providing a message to the vehicle to proceed; and Infrastructure measured vehicle data (weight, size, and height) (I2V providing e.g. weight to the vehicle for later transmission to another roadside unit)
Alternative Operational Scenarios:	Parking space availability and service information (I2V)
Needs Addressed:	2.5.3.4.1 Commercial Vehicle Credentialing and Permitting 2.5.3.4.2 Safety Inspection Data 2.5.3.4.3 Vehicle Clearance 2.5.3.4.4 Receive Parking Space Availability and Service Information

2.9.2.2.9 Special Cases - Transit Operations

Category Name:	Transit Operations
Description:	Transit signal priority (5 approaches, see NTCIP 1211) and queue jumping strategies.
Alternative Operational Scenarios:	
Needs Addressed:	2.5.3.8.1 Transit Signal Priority

2.9.2.2.10 Special Cases - Emergency Vehicle Operations

Category Name:	Emergency Vehicle Operations
Description:	Describes the information flow for emergency vehicle operational strategies. Information about the emergency response vehicle is broadcast as it responds to an emergency. While on route, receiving vehicles are made aware of the position and heading and can advise their drivers. Traffic signals can use the information to provide preemption. They include: Vehicle Emergency Response; and Signal Preemption.
Alternative Operational Scenarios:	
Needs Addressed:	2.5.2.4 Vehicle Emergency Response 2.5.3.7.1 Minimize Delay to Emergency Vehicles at Traffic Signals

2.9.2.2.11 Special Cases - Vehicle Manufacturers and Fleet Operators

Category Name:	Vehicle Manufacturers and Fleet Operators
Description:	Describes the information flow between Vehicle Manufacturers and Fleet Operators with consumer and commercial vehicles, respectively. They include: Remote Diagnosis; Customer Support; and Ad-hoc Messages.
Alternative Operational Scenarios:	Service patrol vehicles, snow plows, and other fleets may be remotely monitored.
Needs Addressed:	2.5.3.9.1 Ad Hoc Messages

2.9.3 Specific Operational Scenarios

2.9.3.1 Introduction to Specific Operational Scenarios

Operational scenarios provide the overview of the system processes. They comprise the steps taken as actors accomplish tasks and pass information to another actor. These operational scenarios represent only a subset of the total possible. They also include the rationales and user needs developed earlier. It is likely that other applications could be developed and use many of these same processes.

Each operational scenario category may contain one or more operational scenarios. The format that describes the operational scenario is defined as follows:

- **Operational Scenario Name.** Title and identification of the Operational Scenario
- **Description.** A short paragraph that describes the operational scenario and its general flow of events.
- **Actors Involved.** The actors who participate in the operational scenario.
- **Initiator (actor).** The actor who initiates the scenario is explicitly identified.
- **Prerequisites.** Information that is needed to implement the operational scenario, for example, (1) identifying the lane in which an OBU occupies requires a micro geometric map of the road or intersection; or (2) identifying the initiator of the information flow requires a user or message identifier.
- **Flow of Events.** The typical flow of events that occurs as part of the operational scenario.
- **Alternative Scenarios.** These are the exception and special cases that characterize alternative information or information flows to meet the Operational Scenario.
- **References.** Citations from which all or parts of the operational scenarios were derived.

2.9.3.2 General Conditions

Operational Scenario Name:	General Conditions
Description:	A Host Vehicle receives information from Remote Vehicles within a coverage area.
Actors Involved:	Host OBU, Remote OBU.
Initiator (actor):	All vehicles broadcast their basic vehicle information, such as vehicle location, vehicle dimensions, and vehicle motion (e.g., direction, speed, momentum) (see Vehicle Maneuver)
Prerequisites:	Host and remote vehicles are within range. Both vehicles have current positioning data of sufficient accuracy.
Flow of Events:	A host vehicle receives transmissions of messages from remote vehicles containing information on the location, trajectory, and vehicle operating parameters that the remote vehicle may transmit. Location includes elevation to ensure that the host vehicle and remote vehicles are at the same level. The host vehicle processes the information to determine proximity (forward, back, and lateral) of remote vehicle locations and predicted trajectories relative to its own position. If the host vehicle does not identify a potential problem, then it remains on course.
Alternative Scenarios:	The host vehicle may detect that a remote vehicle is too close (forward, backward or laterally) and undertakes preventative measures. Alternative #1- Turns Left: A driver of the host vehicle is stopped in the left lane at an intersection with its left turn blinker on. The flow of events are as follows: The host vehicle receives messages from remote vehicles approaching the intersection from the opposite direction. The host vehicle calculates the potential gaps between the approaching vehicles. If there is an insufficient gap to safely turn left, the host vehicle takes preventive action.

2.9.3.3 Vehicle Maneuver

Operational Scenario Name:	Vehicle Maneuver (from Remote Vehicle)
Description:	The remote vehicle periodically transmits a message containing its current location and trajectory information along with other operations information. The driver of the remote vehicle changes the vehicle speed (e.g., stops, brakes hard, speeds up, slows down), turns on a blinker, begins to change lanes, or other type of maneuver. The remote vehicle senses the change in the remote vehicle's location and trajectory and these changes are reflected in a message at the next transmission.
Actors Involved:	Remote OBU, Host OBU
Initiator (actor):	Remote vehicle.
Prerequisites:	In-vehicle or mobile device OBU.
Flow of Events:	Alternative #1- Lane Change A remote vehicle is in an adjacent lane to the host vehicle. The host vehicle indicates that it intends to change lane into the lane with the remote vehicle. The data from the remote vehicle is used by the host vehicle to calculate if the remote vehicle is in or will be in a position of concern to the host vehicle. If this is the case then preventive action is taken by the host vehicle. Alternative #2 - Slows down quickly A driver in a remote vehicle begins to slow down quickly. The remote vehicle senses the decreased speed and trajectory, at the next heartbeat, it transmits a message that shows the decrease in speed and flags the braking data. The flow of events may be as follows: Brake boost applied is detected in the remote vehicle The message is flagged; The message is transmitted; then The host vehicle receives the message. The host vehicle checks position of itself against position of vehicle that applied the brake boost, then if: Same lane - yes Ahead of me - yes Close enough to represent a risk - yes, then Host vehicle takes preventive action Alternative #3 - Uncontrolled Vehicle A host vehicle senses the loss of control of a remote vehicle, or erratic trajectory given the remote vehicle's current location. E.g. vehicles currently are aware if their path is different from their heading. The host vehicle detects this and takes preventative action if appropriate. Alternative #4- Transit Vehicle Crash Warning The host transit vehicle is at a transit stop preparing to pull away from the stop. The host transit vehicle receives messages from vehicles approaching or near it. The host transit vehicle checks position of itself against position and trajectory of remote vehicles to determine if a crash will result when the transit host vehicle pulls away from the stop. The transit host vehicle takes preventative action if a crash appears likely.

2.9.3.4 Mayday

Operational Scenario Name:	Mayday
Description:	A vehicle is in an accident (i.e., an airbag releases). The vehicle generates and sends a Mayday message. The message is then forwarded by the receiving vehicles to an RSU which forwards it to an emergency management center.
Actors Involved:	Host OBU, Remote OBU, RSU
Initiator (actor):	Remote vehicle that initiates the Mayday message.
Prerequisites:	None.
Flow of Events:	An event or sensor in the remote vehicle triggers a mayday message. The remote vehicle broadcasts the mayday message with information on its condition, location, and other pertinent information. The mayday message is received by passing host vehicles. When the host vehicle passes an RSU that advertises that it receives maydays then the host vehicle will transmit the mayday message to the RSU. The RSU will forward the message to a responding agency.
Alternative scenarios:	If the vehicle that transmits the mayday is within range of an RSU that accepts mayday messages then the data is sent directly to the RSU and from there to the responding agency.

2.9.3.5 Emergency Alert

Operational Scenario Name:	Emergency Alert
Description:	Emergency vehicles (EMV) such as police, fire, and ambulance vehicles can alert other vehicles to their presence and status.
Actors Involved:	EMV OBU, RSU
Initiator (actor):	RSU or EMV OBU
Prerequisites:	Public Safety Vehicle messages are properly signed and authorized. Drivers of the emergency vehicle have initiated an alert (for example: a light bar activation automatically triggers the alert transmissions as the vehicle proceeds).
Flow of Events:	An emergency vehicle on a call activates warning lights or sirens and alerts. The emergency vehicle transmits emergency status, vehicle location and heading. The RSU and host vehicles receive the message and determine the relative position of the emergency vehicle. If the emergency vehicle is approaching from behind or stationary ahead of the host vehicle the host vehicle driver is provided with this information.
Alternative scenarios:	Alternative #1: An emergency vehicle with an activated light bar is transmitting a request for a signal priority The RSU receives this message and forwards the message to the local traffic signal controller. The controller grants signal preemption or not and sends the response back to the RSU The RSU forwards the response back to the emergency vehicle.

2.9.3.6 Situational Awareness (Field)

Operational Scenario Name:	Situational Awareness
Description:	An infrastructure field device broadcasts information on conditions in or along the roadway. The conditions may be: Static conditions such as roadway geometry and design, bridge clearance, restricted lanes, or commercial vehicle information such as truck parking and service availability data; Planned conditions such as detours, work zones, restricted lanes by day type / day of week or time period; or Dynamic or adaptive conditions such as rail crossing movement, or roadway weather forecasts/conditions - icing. This data may also include differential GPS corrections and other navigation tracking measurements.
Actors Involved:	RSU, Host OBU
Initiator (actor):	RSU
Prerequisites:	RSU is properly signed and authorized; may also be a mobile unit such as an RSU on an emergency vehicle
Flow of Events:	Traveler information is broadcast as part of the traveler information sent to the vehicles. Example #1 - Hazard Conditions Hazardous conditions on the roadway (e.g., an underpass is flooded) are identified by a traffic management center or possibly by field equipment and the information about the hazardous conditions are sent to the RSU. The RSU begins to broadcast a message regarding the hazardous condition and provides instructions for a detour around the hazard if needed. Example #2 - Traffic congestion ahead A traffic management center collect probe messages. These are used to develop congestion information for transmission to vehicles. The center downloads the traveler information messages to the appropriate RSUs upstream of the congestion which in turn broadcasts this information to all passing OBUs. When the vehicle enters the geographic area where the information is relevant, the OBU delivers the information to the driver. Example #3 - Construction / Merge A temporary RSU is installed at the beginning of a work zone and broadcasts work zone information, including days and times that the work zone is active. The RSU also broadcasts map information showing the geometrics of the roadway, for example indicating a lane merge/detour ahead. Example #4 - HOV/HOT Lanes during Peak Periods The RSU is alerted by the traffic management center that the peak period is active and that a shoulder lane is now operating as an HOV/HOT lane. The RSU begins to broadcast the left lane is now restricted to HOV/HOT mode. This could also include actual restrictions (2+ or 3+ HOV, HOT rates, etc.) Example #5 - Static Information: The RSU provides static condition such as roadway geometry and design, bridge clearance, or lane restrictions. Example #6 - HRI Gate Status: The RSU broadcasts when an active highway rail grade crossing gate moves into the down position.
Alternative Scenarios:	Alternative #1 - Traveler Information: The RSU broadcasts traveler information and advisories to vehicles traveling in a specific direction along a roadway. The advisories may include infrastructure restriction warnings, alternate routes, upcoming amenities (such as fueling stations), and toll information. Alternative #2 - Work Zone Hazards: An RSU (or a stationary maintenance or construction vehicle operating as an RSU) receives information from vehicles approaching the work zone. This information is processed by devices in the work zone (either field devices or within the maintenance or construction vehicle) indicating that the vehicles represent a hazard to the maintenance workers in the work zone. The field device generates an alarm to maintenance workers.

2.9.3.7 Data Collection

Operational Scenario Name:	Data Collection
Description:	Vehicles can collect probe data by sampling their data elements and storing these as snapshots as they traverse the network. In addition, snapshots include starting and stopping data (i.e., major changes in vehicle speed changes) and certain trigger parameters such as ABS activations. This probe information is transmitted by an OBU to an RSU which can forward it to infrastructure elements and operators.
Actors Involved:	Host OBU, RSU
Initiator (actor):	Host OBU
Prerequisites:	OBU has been collecting probe data
Flow of Events:	An RSU advertises that it collects probe data. The OBU has been collecting probe snapshots and has stored them for transmission. When the OBU is in range it sends the probe snapshots to the RSU. The RSU forwards the data to the core system that forwards it to subscribers
Alternative scenarios:	Alternative #1: A maintenance department downloads to all RSUs in its area a request to use probe management to lower the threshold value for reporting vertical acceleration (i.e., acceleration in an upward or downward direction). This is advertised and sent to all vehicles. OBU produces snapshots when threshold exceeded. These are transmitted to the next RSU Maintenance department subscribes to vertical acceleration data and location within its area to aid in surface maintenance monitoring. Alternative #2: A planning department asks drivers to opt-in to an application that plots their path. The department downloads the request to all RSU in the area. The RSU send the information to all OBUs. The OBUs ask the driver to opt-in. Those vehicles whose drivers opt-in stop randomizing the parameters that ensure privacy. The probe messages now have a fixed ID. The probe process continues. The planning department subscribes to the probe data and then sorts the vehicle locations by identifier. This data is used to create origin destination matrices for transportation planners. Alternative #3: An RSU at an intersection sends a probe management message to OBUs. The message asks for vehicle heading in a particular direction to provide trajectory data at short regular intervals. The OBU transmits data at short intervals as it approaches the intersection. The RSU receives this data and forwards it to the local traffic signal controller. The local traffic signal controller uses the data for adaptive signal control.
References:	SAE DSRC Implementation Guide, Section 5.1, page 84

2.9.3.8 E-Commerce

Operational Scenario Name:	E-Commerce
Description:	Payment for services or subscriptions that may be consumed while a vehicle is within the SAE J2735 SE environment. Although in the short term such services may reflect the functionality of most of the current system by transmitting just an identifier, it is likely that a more transaction oriented banking processes may be added in the future. Services may include: Tolls; Congestion pricing such as VMT, HOT, or parking; and Fees for battery recharging for electric vehicles.
Actors Involved:	RSU, Host OBU
Initiator (actor):	Host OBU
Prerequisites:	Registration or certificate from service provider
Flow of Events:	A vehicle travels on a road (or passes an entrance) with a toll facility.

	The toll facility which is connected to an RSU requests payment from the OBU. The OBU responds with the user account identification. The RSU sends the transaction data to the tolling system back office. Optionally the RSU may send account status back to the OBU.
Alternative Scenarios:	Example #1 Vehicle is equipped with a parking application. The parking gate transmits a WAVE message advertising the service. The vehicle detects the service and transmits parking ID. Parking application opens gate and continues its application functions. Example #2: In a VMT application the vehicle receives a request for data from an RSU. The vehicle responds with its registration and odometer reading. The RSU forwards the data to the taxing authority. Example #3 - Anonymous payments. The vehicle owner adds money to an electronic wallet. The RSU requests payment. The wallet removes the payment and transmits data to the RSU. The RSU forwards the transaction information to the bank.

2.9.3.9 Special Cases - Data Communications

Operational Scenario Name:	Special Cases - Data Communications
Description:	When a vehicle of a particular type or a specific vehicle (based on identification) is within range of an RSU, the RSU may have instructions for a specific message delivery. For examples see Section 2.5.3.9.1.
Actors Involved:	Host OBU, RSU
Initiator (actor):	RSU advertises the service
Prerequisites:	Vehicle application signed and registered by an approved transportation operator, fleet manager, vehicle manufacturer or provider stakeholder
Flow of Events:	General Case: An RSU forwards a BLOB (binary large object) and destination address from a provider stakeholder to an OBU. OBUs that have the appropriate application execute the message as appropriate and respond with the reply (also a BLOB) that the OBU forwards to the destination address. For example, a manufacturer of vehicles may want to perform diagnostics on a specific make and model. The BLOB is the diagnostic request; the vehicle performs the diagnostics and sends the results to the RSU that forwards it to the manufacturer.
Alternative Scenarios:	Alternative #1 - Fleet Manager Fleet manager downloads an application to an RSU. The RSU advertises the application with vehicle bus data request and server address and port number A passing vehicle responds with bus data flagged to server and port. The RSU forwards the application accordingly. In the case of CVO usage this may be for trailer contents that are of interest to the TSA or state Homeland Security. Alternative #2 - Vehicle Manufacturer: A vehicle manufacturer transmits recall notices to RSUs for specific makes and models. A passing vehicle detects the application. The RSU transmits the recall notice to the vehicle. Vehicle provides to the driver an indication of the needed action.

2.9.3.10 Transit Operations

Operational Scenario Name:	Transit Operations
Description:	A transit vehicle is behind schedule and a request is made (either by the transit vehicle or by the transit operations center) for signal priority.
Actors Involved:	RSU, Host OBU, Transportation Agencies
Initiator (actor):	RSU
Prerequisites:	RSU is properly signed and authorized.
Flow of Events:	Example #1 - Transit Signal Priority: A transit vehicle behind schedule is transmitting a request for a signal priority. The message includes the approach (to the intersection) and the proposed (turning) movement (at the intersection) and priority. The RSU receives the message from the transit vehicle and forwards the message to the local traffic signal controller. The controller grants signal priority or not and sends the response back to the RSU. The RSU forwards the response back to the transit vehicle which may optionally notify the driver.
Alternative Scenarios:	Alternative #1 - Transit Signal Priority: A traffic signal controller receives a command from the traffic management center to provide transit signal priority at the intersection. The controller grants signal priority or not and sends the information to the RSU. The RSU forwards the information to the transit vehicle.

2.9.3.11 Commercial Vehicle Operations

Operational Scenario Name:	Commercial Vehicle Operations
Description:	An infrastructure field device located along the roadway before an inspection and wayside station broadcasts requests for credentialing, permitting, and safety inspection information from all commercial vehicles. The commercial vehicle transmits the requested information back to the RSU. The RSU responds with instructions specific to the commercial vehicle.
Actors Involved:	RSU, Host OBU, Fleet Managers
Initiator (actor):	RSU
Prerequisites:	RSU is properly signed and authorized.
Flow of Events:	General Case: A commercial vehicle is approaching an inspection and wayside station. An RSU upstream of the inspection and wayside stations broadcasts requests for credentialing, permitting, and safety inspection data as the commercial vehicles approach the inspection and wayside station. The commercial vehicle receives the message from the RSU and responds with its identification information and the requested information. The RSU receives the information from the commercial vehicle and forwards the information for processing. The RSU responds to the commercial vehicle with instructions either to bypass the inspections and wayside station or to pull in.
Alternative Scenarios:	Alternative #1: A commercial vehicle enters an inspection station. An infrastructure device measures the commercial vehicle for vehicle data such as weight, height, and length and forwards the data to the RSU. The RSU forwards the data to the commercial vehicle. Alternate #2: A toll booth may be used for the process and feedback. Alternate #3: A post enforcement action - following inspection. An enforcement action may be required if the inspector needs to know if the vehicle has been previously inspected. In this case if a previous inspection has taken place and the event has been recorded on the vehicle the subsequent inspection station may use this information to not inspect the vehicle a second time.

2.9.3.12 SPaT Broadcast

Operational Scenario Name:	SPaT Broadcast by RSU
Description:	The local signal controller sends its Signal Phase and Timing (SPaT) data to the RSU. The RSU broadcasts this to the vehicles. The receiving vehicle uses the data for a range of applications, some examples of which are included below.
Actors Involved:	RSU, Host OBU, Transportation Agencies
Initiator (actor):	RSU
Prerequisites:	The host vehicle has received the MAP data that defines lanes and approaches in a format coordinated with the SPaT. The host vehicle knows its position. This allows the host vehicle to determine its lane and the current and future status of the signal aspect it is approaching.
Flow of Events:	Alternative #1 - Cooperative Intersection Collision Avoidance System for Violations (CICAS-V): A vehicle approaches a signalized intersection and receives the SPaT data. The vehicle calculates from its speed, position, and the signal status if it is liable to violate the signal. If so, then preventative actions are taken. Alternative #2 - Eco-driving: A vehicle receives the SPaT data and is aware that it will be stopping for some period. During the stopped time the vehicle can moderate its engine control and other systems (e.g. AC) to use less fuel as during the stopped period the demands on the engine will be diminished. Vehicles could also use SPaT information to determine the eco-speed and trajectory when approaching a signalized intersection to get through on green or to decelerate to a stop in the most fuel efficient manner. Alternative #3 - Platoon Progression on Arterials: A traffic engineer in a transportation management center arranges for the traffic signals to be optimized in a particular direction in a commuter corridor. The RSUs in the corridor send the SPaT data and optimal speed advisory information to the vehicles. The vehicles form into platoons that improve signal progression in the subject direction. This improves both safety and eco-driving. Alternative #4- Turning Transit Vehicle Crash Warning A transit vehicle receives the SPaT data which indicates that a pedestrian may be in a crosswalk into which a transit vehicle is preparing to turn. The SPaT data may be a direct indication of pedestrian presence, based on sensor readings, or an indirect indication of pedestrian presence based on a pedestrian call button being activated.

3. SECTION 3 - FUNCTIONAL REQUIREMENTS [NORMATIVE]

This section defines the Functional Requirements based on the user needs identified in the Concept of Operations (see Section 2). This section includes:

- A tutorial.
- The Protocol Requirements List - A Functional Requirement is a requirement to satisfy a given feature and therefore is only required to be implemented if the associated feature (e.g., user need) is selected through the use of the Protocol Requirements List (PRL). The PRL also indicates which of the items are mandatory, conditional, or optional. The PRL can be used by procurement personnel to specify the desired features of a connected device or can be used by a manufacturer to document the features supported by their implementation.
- Architectural Requirements - These are requirements related to the Operational Environment defined in Section 2.4.2.
- Data Exchange Requirements - These are requirements related to the features identified in Section 2.5 that can be realized through a data exchange. For example, this includes the requirement to be able to transmit a vehicle's position and speed.

- Supplemental Non-Communications Requirements - These are additional requirements derived from the Concept of Operations that do not fall into one of the above two categories. For example, they include requirements related to the content of the message to be displayed on a DMS, which may be a supplemental requirement to activating a message, defining a message, etc.

This section is intended for all readers of the document, including:

- Transportation Agencies;
- Transportation Enforcement Agencies;
- Systems Integrators;
- Vehicle Manufacturers; and
- Device Manufacturers.

The last two categories of readers will find this section useful to fully understand what is required of equipment meeting this interface standard. They will also be able to use the table in Section 3.3.3 to document the capabilities of their implementations.

3.1 Tutorial [Informative]

This systems requirements specification (SRS) defines the formal requirements that are intended to satisfy the user needs identified in Section 2.5 of this document. This is achieved through the development of a PRL that traces each user need to one or more requirements defined in this section. The details of each requirement are then presented following the PRL. The functional requirements are presented in three broad categories as follows:

- Architectural Requirements - These requirements define the required behavior of the system in exchanging data across the communications interface, including any restrictions to general architectural requirements, based upon the architectural needs identified in this document.
- Data Exchange and Operational Environmental Requirements - These requirements define the required behavior of the system in exchanging data across the communications interface based upon the features identified in this document.
- Supplemental Non-Communications Requirements - These requirements define additional requirements of the system that are derived from the architectural and/or data exchange requirements, but are not themselves architectural or data exchange requirements. A given supplemental requirement may relate to multiple architectural and/or data exchange requirements. Supplemental requirements include capabilities of the equipment (e.g., response times).

The SRS is a specification for a particular product that performs certain functions in a specific environment. The purpose of this SRS is to document the full set of functions for the SAE J2735 SE candidate. This SRS will address:

- Functionality - What are the functions that the SAE J2735 SE candidate is supposed to support?
- Performance - How well or quickly are the functions supported by the SAE J2735 SE candidate to be executed or achieved?
- Security - How are the functions specific to SAE J2735 SE communications protected from misuse?
- Reliability - What are failure or confidence criteria that the SAE J2735 SE to be measured against?

The following criteria are used when documenting and writing requirements:

1. Is it a well-formed requirement? Some of the attributes of well-formed requirements are:

    a. Necessary - Is the requirement an essential part of the system?

    b. Clear - Can the requirement be interpreted one and only one way?

    c. Complete - Can the requirement stand on its own without further clarification?

    d. Consistent - Does the requirement contradict or duplicate another requirement?

    e. Achievable - Is the requirement technically feasible at a reasonable cost and in a reasonable time?

    f. Verifiable - Can one unambiguously determine if the requirement has been met?

    g. Concise - Is the requirement described succinctly and without superfluous text?

    h. Technology independent - Is the requirement statement technology independent?

2. Is the requirement mapped to one or more user needs? This will also address whether the requirement is in fact needed.

3. Does the requirement, with its sibling requirements, satisfy the intent and all key items of the need?

The well-formed. requirements will generally take the form: [Actor] [Action] [Target] [Constraint] [Localization]. The localization and constraint portions are important, but not all requirements will have both. The constraint identifies how you will measure success or failure of the requirement. The localization identifies the circumstances under which the requirement applies. For example: The System [Actor] shall generate [Action] event reports [Target] containing the following information [Constraint] on a scheduled interval [localization].

3.2 Scope of the Interface [Informative]

SAE J2735 SE covers two primary interfaces as described in Figure 2: the Vehicle to Vehicle Interface and the Vehicle to Roadside Unit (RSU) interface. Figure 2 shows that there are a variety of users that may operate in the SAE J2735 SE environment. Vehicles include the following types: passenger, commercial, transit, and emergency. From a SAE J2735 SE standpoint, the term vehicle covers systems within the vehicle for generating and processing data as well as transmitting or receiving data. These vehicle systems may be embedded in the vehicle, or they might be mobile devices installed or operating within the vehicle. The RSU acts as a conduit to connect the *connected vehicles* in the SAE J2735 SE environment to other downstream users such as transportation organizations, centers, and operators or to other ITS roadside equipment.

To that end, the scope of the SAE J2735 SE system environment is the information exchange between two connected vehicles (the interface between two connected vehicles in Figure 2); and between a vehicle and the roadside (the interface between a connected vehicle and the RSU in Figure 2) to address safety, mobility, and environmental system needs.

The SAE J2735 SE candidate standard is an information level standard that specifies dialogs, messages, data frames, and data elements specifically for use by applications intended to operate in the connected vehicle environment. These applications are expected to utilize the 5.9 GHz Dedicated Short Range Communications for Wireless Access in Vehicular Environments (DSRC/WAVE, referenced in this document simply as DSRC), as defined in the IEEE 1609 suite of standards. However the SAE J2735 SE messages can also be used over other media.

SAE J2735 SE is intended for over-the-air messages that are transmitted to and from equipment located in vehicles traveling on any roadway. The SAE J2735 SE may be used with virtually any device located in the vehicle, further, the device need not be connected to the vehicle. SAE J2735 SE can also be used for communications between devices located in the vehicle.

SAE J2735 SE does not specify applications either in the vehicle or in the infrastructure; it only specifies the interfaces among potential applications.

3.3 Protocol Requirements List (PRL)

The Protocol Requirements List (PRL) presented in Table 8, maps the user needs defined in Section 2.5 to the requirements defined in Section 3.4-3.6 of this document. The table lists each user need to be addressed by SAE J2735 SE, followed immediately by the requirement(s) that supports (and traces to) that user need. The table can be used by:

1. A user or specification writer to indicate which requirements are to be implemented in a project-specific implementation;

2. The interface implementer, as a checklist to reduce the risk of failure to conform to the standard through oversight;

3. The supplier and user, as a detailed indication of the capabilities of the implementation; and

4. The user, as a basis for initially checking the potential interoperability with another implementation.

3.3.1 Notation [Informative]

The following notations and symbols are used to indicate status and conditional status in the PRL within this standard. Not all of these notations and symbols are necessarily used within this standard.

3.3.1.1 Conformance Symbols

The following symbols are used to indicate status in the Conformance column of the PRL table (Section 3.3.3):

TABLE 4 - CONFORMANCE SYMBOLS

Symbol	Value
M	Mandatory
M.#	Support of every item of the group labeled by the same numeral # is required, but only one is active at a time
O	Optional
O.# (range)	Part of an option group. Support of the number of items indicated by the ‘(range)’ is required from all options labeled with the same numeral #
C	Conditional
N/A	Not-applicable (i.e., logically impossible in the scope of the standard)
X	Excluded or prohibited

The O.# (range) notation is used to show a set of selectable options (e.g., O.2 (1..*)) would indicate that one or more of the option group 2 options must be implemented. Two character combinations are used for dynamic requirements. In this case, the first character refers to the static (implementation) status, and the second refers to the dynamic (use); thus .MO. means .mandatory to be implemented, optional to be used.

3.3.1.2 Conditional Status Notation

The following predicate notation may be used:

TABLE 5 - PREDICATE NOTATIONS

<predicate>:	This notation introduces a single item that is conditional on the <predicate>.
<predicate>:	This notation introduces a table or a group of tables, all of which are conditional on the <predicate>.
(predicate)	This notation introduces the first occurrence of the predicate either in the PRL table or that specific user need. The feature associated with this notation is the base feature for all options that have this predicate in their conformance column.

The <predicate>: notation means that the status following it applies only when the PRL states that the feature or features identified by the predicate are supported. In the simplest case, <predicate> is the identifying tag of a single PRL item. When the group predicate is true then the associated section shall be completed. The symbol <predicate> also may be a Boolean expression composed of several indices. .AND., .OR., and .NOT. shall be used to indicate the Boolean logical operations.

The predicates used in this standard map to the following sections:

TABLE 6 - PREDICATES

Predicate	Section
OBU	2.3.2.1
RSU	2.3.2.2
PSOBU	2.3.2.3
TrVOBU	2.3.2.4
CVOBU	2.3.2.5
PathHistory	3.5.1.1.4.8
CSR	3.5.1.2
ICA	3.5.1.3
CMVPresentation	3.5.3.1.1.3
CMVCircle	3.5.3.1.1.3.3
CMVPolygon	3.5.3.1.1.3.5
CMVShape	3.5.3.1.1.3.7
RSUScreening	3.5.3.2.1
CMVScreenAck	3.5.3.2.2
RSUScreenRequest	3.5.3.2.3
CMVScreen	3.5.3.2.4
Probe	3.5.5.3
PreferentialZone	3.5.6.2.2.7.1
Location	3.5.6.4.1 or 3.5.6.4.2
Advisory	3.5.8.2.2.1
Roadsign	3.5.8.2.2.2
ValidTime	3.5.8.3.2
Presentation	3.5.8.3.6
Circular	3.5.8.3.6.3.1
Polygon	3.5.8.3.6.4.1
Shape	3.5.8.3.6.5.1

3.3.1.3 Support Column Symbols

The support column can be used by a procurement specification to identify the required features for the given procurement or by an implementer to identify which features have been implemented. In either case, the user circles the appropriate answer (Yes, No, or N/A) in the support column:

TABLE 7 - SUPPORT COLUMN SYMBOLS

Yes	To be supported (or supported) by the implementation.
No	Does not have to be supported (or not supported) by the implementation.
NA	Not applicable.

3.3.2 Instructions for Completing the PRL [Informative]

The PRL can be used to indicate which of the items are mandatory or optional to a specific project. The PRL also can be used by procurement personnel to specify the desired features of an implementation using SAE J2735 SE or can be used by the systems integrator or programmer to document the features.

For project implementations, if a user need is identified as a need for the project, then the mandatory requirements that trace to the need selected must be supported by the project implementation for that implementation to claim conformance with this standard. As a part of the implementation, some optional requirements (associated with the user need) may be selected by the project. Once these are selected they form (along with all the mandatory requirements) the project implementation specification (relating to the need).

To determine if a user need or requirement is mandatory or optional to a specific project or implementation, in the 'Support' column, each response shall be selected either from the indicated set of responses (for example: Yes / No / NA), or it shall reference additional items that are to be attached (for example, list of traffic signal controllers to be supported by an implementation). For all items, the procurement personnel should circle either .Y. for yes, required in the implementation, or .N. for no, not required for the implementation. Although the procurement personnel may circle an item as .No. not required, it does not preclude a supplier from providing the features to satisfy the user need.

If a conditional requirement is not applicable, use the Not Applicable (NA) choice. If a mandatory requirement is not satisfied, exception information must be supplied by entering a reference Xi, where i is a unique identifier, to an accompanying rationale for the non-conformance. When the status is expressed as a two-character combination (as defined in 3.3.1.1 above), the response shall address each element of the requirement; e.g., for the requirement .mo. the possible compliant responses are .yy. or .yn..

3.3.2.1 Conformance Definition

SAE J2735 SE defines data concepts for the exchange of information between connected vehicles and between a connected vehicle and an RSU. The following defines SAE J2735 SE conformance:

To claim 'Conformance' to SAE **J2735 SE**, the implementation must minimally satisfy all of the user needs identified as .M. (Mandatory) in the PRL table (See Section 3.3.3) under the column named Conformance and all user needs identified as O (Optional) in the PRL table under the column named Conformance that have been circled Yes in the Support column.

1. To claim conformance to a ***user need*** defined in SAE J2735 SE, an implementation shall satisfy all of the requirements that trace to the subject user need that are identified by an M in the PRL column named Conformance and all requirements identified as O in the PRL column named Conformance that have been circled Yes in the Support column.

2. To claim conformance to a ***requirement*** defined in this standard, an implementation shall satisfy the requirement by using all of the data concepts (dialog, messages, data frames, and data elements) traced to the subject requirement in the Requirements Traceability Matrix (RTM) (See Appendix A) and design content in the manner specified by this standard or the referenced standards.

A conformant interface may offer additional (optional) features, as long as they are conformant with the requirements of SAE J2735 SE and the standards it references (e.g., IEEE 1609).

NOTE: The reader and user of SAE J2735 SE are advised that 'conformance' to SAE J2735 SE should not be confused with 'compliance' to a specification. SAE J2735 SE is as broad as possible to allow a very simple implementation to be 'conformant' to SAE J2735 SE. A specification will identify the user needs to be satisfied by a particular project and identify the specific requirements (where options are allowed) to satisfy those user needs. A specification writer is advised to match the needs and requirements of a project with the corresponding standardized requirements defined in SAE J2735 SE to achieve interoperability. Note that some needs and requirements defined as optional in SAE J2735 SE may be necessary for the project and must be selected by the specification writer and included in the project specification (in effect made mandatory). To verify conformance to SAE J2735 SE for a specific project requires that the implementation (as defined in the SAE J2735 SE) satisfy the mandatory and selected optional user needs, and the mandatory and selected optional requirements identified for each user need. To verify compliance to the specification will require verifying the system conforms to SAE J2735 SE and validation of the content of the information exchanged.

NOTE: Off-the-shelf interoperability can only be obtained through well documented features broadly supported by the industry as a whole. Designing a system that uses features not defined in a standard will inhibit the goals of interoperability, especially if the documentation of these features is not available for distribution to system integrators.

3.3.2.2 Extensions

It is recognized that the standard does not define standardized data concepts for every possible user need that can exist in the SAE J2735 SE operating environment. The SAE J2735 SE allows specific project implementations to extend or add new data concepts to the implementation. As a result, there could be special features or requirements in the implementation that are not supported by the standard. If such features are present, then the systems developer or integrator need to determine precisely how these features are to be supported without conflicting with the standardized implementations.

Extensions to a SAE J2735 SE conformant implementation are discouraged because they break interoperability. However, the standards organizations recognize the need to satisfy functional requirements not supported by this standard.

To support these additional requirements, project implementations may need to extend the standard by defining new data elements, data frames, data messages, or dialogs that are not contained in SAE J2735 SE. This implementation will not be compliant to the standard, but can be in conformance to the standard. This allows the systems to maintain interoperability for those data exchanges that are conformant and available. To be consistent with this standard, the rules listed below for extending SAE J2735 SE must be met:

1. **No Substitutions.** All functional requirements already supported by this standard must be implemented as defined by the standard. An implementation may NOT define a new data element, message, or dialog if that functional requirement is already supported by this standard. In other words, the implementation may NOT completely replace a feature of the standard the implementer would like to augment with a complete custom feature.

2. **New data elements.** An implementation may add new data elements beyond those data elements defined by the standard. However, an extension cannot reuse an existing name or identifier already defined by the standard.

3. **Additional enumerations.** Where additional enumerations are required, a new object shall be created for the new enumerations. The new object is to be used only for the new enumerations; where the concepts conveyed are identical to the standard object, the original object shall be used.

4. **Range modification.** Extending the range of an existing data element requires that the data element be renamed.

5. **Meaning of data elements.** If an implementation has a different interpretation of the meaning of a data element or how the data element is to be used as defined by this standard, a new data element must be created for that interpretation.

6. **Documentation of extensions.** Any extensions shall be documented by the owning agency(ies) and/or the systems integrator in ASN.1 notation. Further, such extensions shall be documented including user needs being addressed and the specific requirements that are to be satisfied by the extensions and the documentation shall maintain traceability (needs to requirements to design content) in a manner consistent with the presentation in the standard.

7. **New messages.** If extensions are made to a message defined by the standard, whether through the addition of data elements to the message or changes to an existing data element, that message shall be renamed to prevent confusion or ambiguity for the purposes of interoperability.

8. **Message processing.** A conformant receiving center must ignore any attributes or elements in a message that it does not recognize but shall process what it understands.

9. **Naming conventions.** All names, whether new or a renaming, shall conform to the SAE J2735 SE naming conventions.

10. **Dialogs.** Extensions may not modify the dialogs contained in the standard. Where necessary, new dialogs shall be added to support the extensions and such dialogs shall be documented in a manner which is consistent with this standard (See Section 5).

3.3.3 Protocol Requirements List (PRL) Table

In addition to the conformance column and the support column, which were discussed in Section 3.3.1, the additional columns in the PRL table are the User Need ID and User Need columns, FR ID (Functional Requirement ID) and Functional Requirement columns, and the Additional Specifications column.

3.3.3.1 User Need ID and User Needs Column

The user needs are defined within the Section 2.5 of this document and the PRL is based upon the user need within that Section. The section number and user need name are indicated within these columns.

3.3.3.2 FR ID and Requirements Columns

The requirements are defined within Section 3.4-3.6 and the PRL references the traces from user needs to these requirements. The section number and requirements name are indicated within these columns.

3.3.3.3 Additional Specifications Column

The Additional Specifications column may (and should) be used by a procurement specification to provide additional notes and requirements for the product to be procured or may be used by an implementer to provide any additional details about the implementation. In some cases, default text already exists in this field, which the user should complete in order to fully specify the implementation. However, additional text can be added to this field as needed to fully specify a feature. Performance requirements should also be specified in this column.

TABLE 8 - PROTOCOL REQUIREMENTS LIST (PRL) TABLE

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
2.3	**Reference Physical Architecture**					
2.3.2	SAE J2735 SE Device Characteristics			M	Yes	
2.3.2.1	On-Board Unit **(OBU)**			O.1 (1)	Yes / No	
2.3.2.2	Roadside Unit **(RSU)**			O.1 (1)	Yes / No	
2.3.2.3	Public Safety On-Board Unit **(PSOBU)**			OBU:O.2 (1)	Yes / No / NA	
2.3.2.4	Transit Vehicle On-Board Unit **(TrVOBU)**			OBU:O.2 (1)	Yes / No / NA	
2.3.2.5	Commercial Vehicle On-Board Unit **(CVOBU)**			OBU:O.2 (1)	Yes / No / NA	
2.4	**Architectural Needs**					
2.4.2	Operational Environment			M	Yes	
0		3.4.1	OBU - Broadcast Information	OBU:M	Yes / NA	
		3.4.2	RSU - Broadcast Information	RSU:M	Yes / NA	
		3.4.3	Connected Device Dialogs	M	Yes	
		3.4.4	Forwarded Requests	OBU:M	Yes / NA	
2.5	**Features**					
2.5.2	V2V User Needs					
2.5.2.1	Crash Prevention Safety			OBU:O	Yes / No / NA	
2.5.2.1.1	Forward Collision Prevention			OBU:O	Yes / No / NA	
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.4.2.1	Broadcast Vehicle Information - Front Bumper Height	O	Yes / No	
		3.5.1.1.4.2.2	Broadcast Vehicle Information - Rear Bumper Height	O	Yes / No	
		3.5.1.1.4.2.4	Broadcast Vehicle Information - Vehicle Weight	O	Yes / No	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.3.2	Broadcast Vehicle Information - Applied Pressure on the Vehicle Brakes	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.3.4	Broadcast Vehicle Information - Steering Angle Rate of Change	O	Yes / No	
		3.5.1.1.4.3.5	Broadcast Vehicle Information - Driving Wheel Angle	O	Yes / No	
		3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.4.5	Broadcast Vehicle Information - Coefficient of Friction	O	Yes / No	
		3.5.1.1.4.6.1	Broadcast Vehicle Information - Vehicle Hazard Lights	O	Yes / No	
		3.5.1.1.4.6.2	Broadcast Vehicle Information - Vehicle Stopline Violation	O	Yes / No	
		3.5.1.1.4.6.3	Broadcast Vehicle Information - Anti-Lock Brake System Activation	O	Yes / No	
		3.5.1.1.4.6.4	Broadcast Vehicle Information - Traction Control System Activation	O	Yes / No	
		3.5.1.1.4.6.5	Broadcast Vehicle Information - Stability Control System Activation	O	Yes / No	
		3.5.1.1.4.6.7	Broadcast Vehicle Information - Hard Braking Warning	O	Yes / No	
		3.5.1.1.4.6.8.1	Broadcast Vehicle Information - Change in Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.2	Broadcast Vehicle Information - Change in Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.5	Broadcast Vehicle Information - Change in High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.6.10	Broadcast Vehicle Information - Flat Tire	O	Yes / No	
		3.5.1.1.4.6.11	Broadcast Vehicle Information - Vehicle Is Disabled	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.7	Broadcast Vehicle Information - Trailer Weight	O	Yes / No	
		3.5.1.1.4.8	Broadcast Vehicle Information - Vehicle Path History Requirements **(PathHistory)**	O	Yes / No	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.4.8.1	Broadcast Vehicle Path History - GPS Status	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.2	Broadcast Vehicle Path History - Initial Position	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.3	Broadcast Vehicle Path History - Time Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.4	Broadcast Vehicle Path History - Position Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.5	Broadcast Vehicle Path History - Heading	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.6	Broadcast Vehicle Path History - Transmission	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.7	Broadcast Vehicle Path History - Speed	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.8	Broadcast Vehicle Path History - Positional Accuracy	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.9	Broadcast Vehicle Information - Vehicle Path Projection	O	Yes / No	
		3.5.1.1.4.10	Broadcast Vehicle Information - Location Corrections	O	Yes / No	
		3.5.1.2	Device Information Request **(CSR)**	O	Yes / No	
		3.5.1.2.1	Request Vehicle Information - Message Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.2	Request Vehicle Information - Device Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.3	Request Vehicle Information - Requested Item	CSR:M	Yes / NA	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		3.6.1.4.1	Path History - Data Points	PathHistory:M	Yes / NA	
		3.6.1.4.2	Path History - Position Error Tolerance	PathHistory:M	Yes / NA	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.
		G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	CSR:M	Yes / NA	
		G.2.2.2	Maximum Response Time - Request Vehicle Information	CSR:M	Yes / NA	The maximum response time for a connected vehicle to respond to a request is _____ (default: 200) ms.
2.5.2.1.2	Intersection Movement Assist			OBU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.4.2.1	Broadcast Vehicle Information - Front Bumper Height	O	Yes / No	
		3.5.1.1.4.2.2	Broadcast Vehicle Information - Rear Bumper Height	O	Yes / No	
		3.5.1.1.4.2.4	Broadcast Vehicle Information - Vehicle Weight	O	Yes / No	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.3.2	Broadcast Vehicle Information - Applied Pressure on the Vehicle Brakes	O	Yes / No	
		3.5.1.1.4.3.4	Broadcast Vehicle Information - Steering Angle Rate of Change	O	Yes / No	
		3.5.1.1.4.3.5	Broadcast Vehicle Information - Driving Wheel Angle	O	Yes / No	
		3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.6.2	Broadcast Vehicle Information - Vehicle Stopline Violation	O	Yes / No	
		3.5.1.1.4.6.3	Broadcast Vehicle Information - Anti-Lock Brake System Activation	O	Yes / No	
		3.5.1.1.4.6.4	Broadcast Vehicle Information - Traction Control System Activation	O	Yes / No	
		3.5.1.1.4.6.5	Broadcast Vehicle Information - Stability Control System Activation	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.6.7	Broadcast Vehicle Information - Hard Braking Warning	O	Yes / No	
		3.5.1.1.4.6.8.1	Broadcast Vehicle Information - Change in Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.2	Broadcast Vehicle Information - Change in Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.5	Broadcast Vehicle Information - Change in High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.7	Broadcast Vehicle Information - Trailer Weight	O	Yes / No	
		3.5.1.1.4.8	Broadcast Vehicle Information - Vehicle Path History Requirements **(PathHistory)**	O	Yes / No	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.4.8.1	Broadcast Vehicle Path History - GPS Status	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.2	Broadcast Vehicle Path History - Initial Position	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.3	Broadcast Vehicle Path History - Time Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.4	Broadcast Vehicle Path History - Position Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.5	Broadcast Vehicle Path History - Heading	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.6	Broadcast Vehicle Path History - Transmission	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.7	Broadcast Vehicle Path History - Speed	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.8	Broadcast Vehicle Path History - Positional Accuracy	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.9	Broadcast Vehicle Information - Vehicle Path Projection	O	Yes / No	
		3.5.1.1.4.10	Broadcast Vehicle Information - Location Corrections	O	Yes / No	
		3.5.1.2	Device Information Request **(CSR)**	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.2.1	Request Vehicle Information - Message Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.2	Request Vehicle Information - Device Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.3	Request Vehicle Information - Requested Item	CSR:M	Yes / NA	
		3.5.1.3	Broadcast Intersection Infringement **(ICA)**	O	Yes / No	
		3.5.1.3.1	Broadcast Intersection Infringement - Message Identifier	ICA:M	Yes / NA	
		3.5.1.3.2	Broadcast Intersection Infringement - Device Identifier	ICA:M	Yes / NA	
		3.5.1.3.3	Broadcast Intersection Infringement - Vehicle Time	ICA:M	Yes / NA	
		3.5.1.3.4	Broadcast Intersection Infringement - Path History	ICA:M	Yes / NA	
		3.5.1.3.5	Broadcast Intersection Infringement - Intersection Identifier	ICA:M	Yes / NA	
		3.5.1.3.6	Broadcast Intersection Infringement - Lane Number	ICA:M	Yes / NA	
		3.5.1.3.7	Broadcast Intersection Infringement - Intersection Violation	ICA:M	Yes / NA	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		3.6.1.4.1	Path History - Data Points	PathHistory:M	Yes / NA	
		3.6.1.4.2	Path History - Position Error Tolerance	PathHistory:M	Yes / NA	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.
		G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	CSR:M	Yes / NA	
		G.2.2.2	Maximum Response Time - Request Vehicle Information	CSR:M	Yes / NA	The maximum response time for a connected vehicle to respond to a request is _____ (default: 200) ms.
		G.2.3.1	Minimum Transmission Rate - Broadcast Intersection Infringement	ICA:M	Yes / NA	
		G.2.3.2	Maximum Transmission Rate - Broadcast Intersection Infringement	ICA:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.3.3	Default Transmission Rate - Broadcast Intersection Infringement	ICA:M	Yes / NA	The default message transmission rate for a connected vehicle to broadcast intersection infringement information is once per ___ (default: 100) ms.
2.5.2.1.3	Pre-Crash Actions			OBU:O	Yes / No / NA	
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.4.2.1	Broadcast Vehicle Information - Front Bumper Height	O	Yes / No	
		3.5.1.1.4.2.2	Broadcast Vehicle Information - Rear Bumper Height	O	Yes / No	
		3.5.1.1.4.2.3	Broadcast Vehicle Information - Vehicle Height	O	Yes / No	
		3.5.1.1.4.2.4	Broadcast Vehicle Information - Vehicle Weight	O	Yes / No	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.3.2	Broadcast Vehicle Information - Applied Pressure on the Vehicle Brakes	O	Yes / No	
		3.5.1.1.4.3.4	Broadcast Vehicle Information - Steering Angle Rate of Change	O	Yes / No	
		3.5.1.1.4.3.5	Broadcast Vehicle Information - Driving Wheel Angle	O	Yes / No	
		3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.5	Broadcast Vehicle Information - Obstacle Information	O	Yes / No	
		3.5.1.1.4.6.2	Broadcast Vehicle Information - Vehicle Stopline Violation	O	Yes / No	
		3.5.1.1.4.6.3	Broadcast Vehicle Information - Anti-Lock Brake System Activation	O	Yes / No	
		3.5.1.1.4.6.4	Broadcast Vehicle Information - Traction Control System Activation	O	Yes / No	
		3.5.1.1.4.6.5	Broadcast Vehicle Information - Stability Control System Activation	O	Yes / No	
		3.5.1.1.4.6.7	Broadcast Vehicle Information - Hard Braking Warning	O	Yes / No	
		3.5.1.1.4.6.8.5	Broadcast Vehicle Information - Change in High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.8	Broadcast Vehicle Information - Vehicle Path History Requirements **(PathHistory)**	O	Yes / No	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.4.8.1	Broadcast Vehicle Path History - GPS Status	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.2	Broadcast Vehicle Path History - Initial Position	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.3	Broadcast Vehicle Path History - Time Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.4	Broadcast Vehicle Path History - Position Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.5	Broadcast Vehicle Path History - Heading	PathHistory:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.8.6	Broadcast Vehicle Path History - Transmission	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.7	Broadcast Vehicle Path History - Speed	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.8	Broadcast Vehicle Path History - Positional Accuracy	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.9	Broadcast Vehicle Information - Vehicle Path Projection	O	Yes / No	
		3.5.1.1.4.10	Broadcast Vehicle Information - Location Corrections	O	Yes / No	
		3.5.1.2	Device Information Request **(CSR)**	O	Yes / No	
		3.5.1.2.1	Request Vehicle Information - Message Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.2	Request Vehicle Information - Device Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.3	Request Vehicle Information - Requested Item	CSR:M	Yes / NA	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		3.6.1.4.1	Path History - Data Points	PathHistory:M	Yes / NA	
		3.6.1.4.2	Path History - Position Error Tolerance	PathHistory:M	Yes / NA	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.
		G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	CSR:M	Yes / NA	
		G.2.2.2	Maximum Response Time - Request Vehicle Information	CSR:M	Yes / NA	The maximum response time for a connected vehicle to respond to a request is _____ (default: 200) ms.
2.5.2.1.4	Control Loss Warning			OBU:O	Yes / No / NA	
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.3.2	Broadcast Vehicle Information - Applied Pressure on the Vehicle Brakes	O	Yes / No	
		3.5.1.1.4.3.4	Broadcast Vehicle Information - Steering Angle Rate of Change	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.3.5	Broadcast Vehicle Information - Driving Wheel Angle	O	Yes / No	
		3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.4.5	Broadcast Vehicle Information - Coefficient of Friction	O	Yes / No	
		3.5.1.1.4.6.3	Broadcast Vehicle Information - Anti-Lock Brake System Activation	O	Yes / No	
		3.5.1.1.4.6.4	Broadcast Vehicle Information - Traction Control System Activation	O	Yes / No	
		3.5.1.1.4.6.5	Broadcast Vehicle Information - Stability Control System Activation	O	Yes / No	
		3.5.1.1.4.6.7	Broadcast Vehicle Information - Hard Braking Warning	O	Yes / No	
		3.5.1.1.4.6.8.5	Broadcast Vehicle Information - Change in High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.8	Broadcast Vehicle Information - Vehicle Path History Requirements **(PathHistory)**	O	Yes / No	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.4.8.1	Broadcast Vehicle Path History - GPS Status	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.2	Broadcast Vehicle Path History - Initial Position	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.3	Broadcast Vehicle Path History - Time Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.4	Broadcast Vehicle Path History - Position Offset	PathHistory:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.8.5	Broadcast Vehicle Path History - Heading	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.6	Broadcast Vehicle Path History - Transmission	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.7	Broadcast Vehicle Path History - Speed	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.8	Broadcast Vehicle Path History - Positional Accuracy	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.9	Broadcast Vehicle Information - Vehicle Path Projection	O	Yes / No	
		3.5.1.1.4.10	Broadcast Vehicle Information - Location Corrections	O	Yes / No	
		3.5.1.2	Device Information Request **(CSR)**	O	Yes / No	
		3.5.1.2.1	Request Vehicle Information - Message Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.2	Request Vehicle Information - Device Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.3	Request Vehicle Information - Requested Item	CSR:M	Yes / NA	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		3.6.1.4.1	Path History - Data Points	PathHistory:M	Yes / NA	
		3.6.1.4.2	Path History - Position Error Tolerance	PathHistory:M	Yes / NA	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for the mandatory elements is once per ___ (default: 100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.
		G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	CSR:M	Yes / NA	
		G.2.2.2	Maximum Response Time - Request Vehicle Information	CSR:M	Yes / NA	The maximum response time for a connected vehicle to respond to a request is _____ (default: 200) ms.
2.5.2.1.5	Lane Change Warning			OBU:O	Yes / No / NA	
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.3.4	Broadcast Vehicle Information - Steering Angle Rate of Change	O	Yes / No	
		3.5.1.1.4.3.5	Broadcast Vehicle Information - Driving Wheel Angle	O	Yes / No	
		3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.6.8.1	Broadcast Vehicle Information - Change in Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.2	Broadcast Vehicle Information - Change in Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.5	Broadcast Vehicle Information - Change in High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.8	Broadcast Vehicle Information - Vehicle Path History Requirements **(PathHistory)**	O	Yes / No	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.4.8.1	Broadcast Vehicle Path History - GPS Status	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.2	Broadcast Vehicle Path History - Initial Position	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.3	Broadcast Vehicle Path History - Time Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.4	Broadcast Vehicle Path History - Position Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.5	Broadcast Vehicle Path History - Heading	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.6	Broadcast Vehicle Path History - Transmission	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.7	Broadcast Vehicle Path History - Speed	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.8	Broadcast Vehicle Path History - Positional Accuracy	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.9	Broadcast Vehicle Information - Vehicle Path Projection	O	Yes / No	
		3.5.1.1.4.10	Broadcast Vehicle Information - Location Corrections	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.2	Device Information Request **(CSR)**	O	Yes / No	
		3.5.1.2.1	Request Vehicle Information - Message Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.2	Request Vehicle Information - Device Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.3	Request Vehicle Information - Requested Item	CSR:M	Yes / NA	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		3.6.1.4.1	Path History - Data Points	PathHistory:M	Yes / NA	
		3.6.1.4.2	Path History - Position Error Tolerance	PathHistory:M	Yes / NA	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.
		G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	CSR:M	Yes / NA	
		G.2.2.2	Maximum Response Time - Request Vehicle Information	CSR:M	Yes / NA	The maximum response time for a connected vehicle to respond to a request is _____ (default: 200) ms.
2.5.2.1.6	Do Not Pass Warning			OBU:O	Yes / No / NA	
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.3.4	Broadcast Vehicle Information - Steering Angle Rate of Change	O	Yes / No	
		3.5.1.1.4.3.5	Broadcast Vehicle Information - Driving Wheel Angle	O	Yes / No	
		3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.6.8.1	Broadcast Vehicle Information - Change in Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.2	Broadcast Vehicle Information - Change in Right Turn Signal State	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.6.8.5	Broadcast Vehicle Information - Change in High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.8	Broadcast Vehicle Information - Vehicle Path History Requirements **(PathHistory)**	O	Yes / No	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.4.8.1	Broadcast Vehicle Path History - GPS Status	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.2	Broadcast Vehicle Path History - Initial Position	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.3	Broadcast Vehicle Path History - Time Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.4	Broadcast Vehicle Path History - Position Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.5	Broadcast Vehicle Path History - Heading	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.6	Broadcast Vehicle Path History - Transmission	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.7	Broadcast Vehicle Path History - Speed	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.8	Broadcast Vehicle Path History - Positional Accuracy	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.9	Broadcast Vehicle Information - Vehicle Path Projection	O	Yes / No	
		3.5.1.1.4.10	Broadcast Vehicle Information - Location Corrections	O	Yes / No	
		3.5.1.2	Device Information Request **(CSR)**	O	Yes / No	
		3.5.1.2.1	Request Vehicle Information - Message Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.2	Request Vehicle Information - Device Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.3	Request Vehicle Information - Requested Item	CSR:M	Yes / NA	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		3.6.1.4.1	Path History - Data Points	PathHistory:M	Yes / NA	
		3.6.1.4.2	Path History - Position Error Tolerance	PathHistory:M	Yes / NA	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.
		G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	CSR:M	Yes / NA	
		G.2.2.2	Maximum Response Time - Request Vehicle Information	CSR:M	Yes / NA	The maximum response time for a connected vehicle to respond to a request is _____ (default: 200) ms.
2.5.2.1.7	Blind Spot Warning			OBU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.3.4	Broadcast Vehicle Information - Steering Angle Rate of Change	O	Yes / No	
		3.5.1.1.4.3.5	Broadcast Vehicle Information - Driving Wheel Angle	O	Yes / No	
		3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.6.8.1	Broadcast Vehicle Information - Change in Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.2	Broadcast Vehicle Information - Change in Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.5	Broadcast Vehicle Information - Change in High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.8	Broadcast Vehicle Information - Vehicle Path History Requirements **(PathHistory)**	O	Yes / No	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.4.8.1	Broadcast Vehicle Path History - GPS Status	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.2	Broadcast Vehicle Path History - Initial Position	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.3	Broadcast Vehicle Path History - Time Offset	PathHistory:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.8.4	Broadcast Vehicle Path History - Position Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.5	Broadcast Vehicle Path History - Heading	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.6	Broadcast Vehicle Path History - Transmission	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.7	Broadcast Vehicle Path History - Speed	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.8	Broadcast Vehicle Path History - Positional Accuracy	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.9	Broadcast Vehicle Information - Vehicle Path Projection	O	Yes / No	
		3.5.1.1.4.10	Broadcast Vehicle Information - Location Corrections	O	Yes / No	
		3.5.1.2	Device Information Request **(CSR)**	O	Yes / No	
		3.5.1.2.1	Request Vehicle Information - Message Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.2	Request Vehicle Information - Device Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.3	Request Vehicle Information - Requested Item	CSR:M	Yes / NA	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		3.6.1.4.1	Path History - Data Points	PathHistory:M	Yes / NA	
		3.6.1.4.2	Path History - Position Error Tolerance	PathHistory:M	Yes / NA	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.
		G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	CSR:M	Yes / NA	
		G.2.2.2	Maximum Response Time - Request Vehicle Information	CSR:M	Yes / NA	The maximum response time for a connected vehicle to respond to a request is _____ (default: 200) ms.
2.5.2.1.8	Facilitate Development and Testing			OBU:O	Yes / No / NA	
		3.5.1.1.2	Broadcast Vehicle Information - Critical Information - Verbose	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.4.1	Broadcast Vehicle Information - Vehicle Type	O	Yes / No	
		3.5.1.1.4.2.1	Broadcast Vehicle Information - Front Bumper Height	O	Yes / No	
		3.5.1.1.4.2.2	Broadcast Vehicle Information - Rear Bumper Height	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.2.4	Broadcast Vehicle Information - Vehicle Weight	O	Yes / No	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.3.2	Broadcast Vehicle Information - Applied Pressure on the Vehicle Brakes	O	Yes / No	
		3.5.1.1.4.3.3	Broadcast Vehicle Information - Wheel Vertical Acceleration	O	Yes / No	
		3.5.1.1.4.3.4	Broadcast Vehicle Information - Steering Angle Rate of Change	O	Yes / No	
		3.5.1.1.4.3.5	Broadcast Vehicle Information - Driving Wheel Angle	O	Yes / No	
		3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.3	Broadcast Vehicle Information - Daytime Running Lights State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.5	Broadcast Vehicle Information - Fog Lamps State	O	Yes / No	
		3.5.1.1.4.4.1.6	Broadcast Vehicle Information - Low Beam Headlights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.4.1.8	Broadcast Vehicle Information - Parking Lights State	O	Yes / No	
		3.5.1.1.4.4.1.9	Broadcast Vehicle Information - Automatic Light Controls State	O	Yes / No	
		3.5.1.1.4.4.2	Broadcast Vehicle Information - Vehicle Front Wiper Status	O	Yes / No	
		3.5.1.1.4.4.3	Broadcast Vehicle Information - Vehicle Front Wiper Sweeping Rate	O	Yes / No	
		3.5.1.1.4.4.4	Broadcast Vehicle Information - Vehicle Rear Wiper Status	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.4.5	Broadcast Vehicle Information - Coefficient of Friction	O	Yes / No	
		3.5.1.1.4.4.6	Broadcast Vehicle Information - Solar Radiation	O	Yes / No	
		3.5.1.1.4.4.7	Broadcast Vehicle Information - Ambient Air Temperature	O	Yes / No	
		3.5.1.1.4.4.8	Broadcast Vehicle Information - Ambient Air Pressure	O	Yes / No	
		3.5.1.1.4.4.9	Broadcast Vehicle Information - Precipitation Type	O	Yes / No	
		3.5.1.1.4.4.10	Broadcast Vehicle Information - Precipitation Rate	O	Yes / No	
		3.5.1.1.4.5	Broadcast Vehicle Information - Obstacle Information	O	Yes / No	
		3.5.1.1.4.6.1	Broadcast Vehicle Information - Vehicle Hazard Lights	O	Yes / No	
		3.5.1.1.4.6.2	Broadcast Vehicle Information - Vehicle Stopline Violation	O	Yes / No	
		3.5.1.1.4.6.3	Broadcast Vehicle Information - Anti-Lock Brake System Activation	O	Yes / No	
		3.5.1.1.4.6.4	Broadcast Vehicle Information - Traction Control System Activation	O	Yes / No	
		3.5.1.1.4.6.5	Broadcast Vehicle Information - Stability Control System Activation	O	Yes / No	
		3.5.1.1.4.6.6	Broadcast Vehicle Information - Hazardous Materials Present	O	Yes / No	
		3.5.1.1.4.6.7	Broadcast Vehicle Information - Hard Braking Warning	O	Yes / No	
		3.5.1.1.4.6.8.1	Broadcast Vehicle Information - Change in Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.2	Broadcast Vehicle Information - Change in Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.3	Broadcast Vehicle Information - Change in Fog Lamps State	O	Yes / No	
		3.5.1.1.4.6.8.4	Broadcast Vehicle Information - Change in Low Beam Headlights State	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.6.8.5	Broadcast Vehicle Information - Change in High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.6.8.6	Broadcast Vehicle Information - Change in Parking Lights State	O	Yes / No	
		3.5.1.1.4.6.8	Broadcast Vehicle Information - Change in Vehicle Light Status	O	Yes / No	
		3.5.1.1.4.6.9	Broadcast Vehicle Information - Change in Wiper Status	O	Yes / No	
		3.5.1.1.4.6.10	Broadcast Vehicle Information - Flat Tire	O	Yes / No	
		3.5.1.1.4.6.11	Broadcast Vehicle Information - Vehicle Is Disabled	O	Yes / No	
		3.5.1.1.4.6.12	Broadcast Vehicle Information - Air Bag Deployment	O	Yes / No	
		3.5.1.1.4.7	Broadcast Vehicle Information - Trailer Weight	O	Yes / No	
		3.5.1.1.4.8	Broadcast Vehicle Information - Vehicle Path History Requirements **(PathHistory)**	O	Yes / No	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.4.8.1	Broadcast Vehicle Path History - GPS Status	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.2	Broadcast Vehicle Path History - Initial Position	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.3	Broadcast Vehicle Path History - Time Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.4	Broadcast Vehicle Path History - Position Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.5	Broadcast Vehicle Path History - Heading	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.6	Broadcast Vehicle Path History - Transmission	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.7	Broadcast Vehicle Path History - Speed	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.8	Broadcast Vehicle Path History - Positional Accuracy	PathHistory:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.9	Broadcast Vehicle Information - Vehicle Path Projection	O	Yes / No	
		3.5.1.1.4.10	Broadcast Vehicle Information - Location Corrections	O	Yes / No	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		3.6.1.4.1	Path History - Data Points	PathHistory:M	Yes / NA	
		3.6.1.4.2	Path History - Position Error Tolerance	PathHistory:M	Yes / NA	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.
2.5.2.2	Situational Awareness			OBU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.3.3	Broadcast Vehicle Information - Wheel Vertical Acceleration	O	Yes / No	
		3.5.1.1.4.4.1.3	Broadcast Vehicle Information - Daytime Running Lights State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.5	Broadcast Vehicle Information - Fog Lamps State	O	Yes / No	
		3.5.1.1.4.4.1.6	Broadcast Vehicle Information - Low Beam Headlights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.4.1.8	Broadcast Vehicle Information - Parking Lights State	O	Yes / No	
		3.5.1.1.4.4.1.9	Broadcast Vehicle Information - Automatic Light Controls State	O	Yes / No	
		3.5.1.1.4.4.2	Broadcast Vehicle Information - Vehicle Front Wiper Status	O	Yes / No	
		3.5.1.1.4.4.3	Broadcast Vehicle Information - Vehicle Front Wiper Sweeping Rate	O	Yes / No	
		3.5.1.1.4.4.4	Broadcast Vehicle Information - Vehicle Rear Wiper Status	O	Yes / No	
		3.5.1.1.4.4.5	Broadcast Vehicle Information - Coefficient of Friction	O	Yes / No	
		3.5.1.1.4.4.6	Broadcast Vehicle Information - Solar Radiation	O	Yes / No	
		3.5.1.1.4.4.7	Broadcast Vehicle Information - Ambient Air Temperature	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.4.8	Broadcast Vehicle Information - Ambient Air Pressure	O	Yes / No	
		3.5.1.1.4.4.9	Broadcast Vehicle Information - Precipitation Type	O	Yes / No	
		3.5.1.1.4.4.10	Broadcast Vehicle Information - Precipitation Rate	O	Yes / No	
		3.5.1.1.4.5	Broadcast Vehicle Information - Obstacle Information	O	Yes / No	
		3.5.1.1.4.6.3	Broadcast Vehicle Information - Anti-Lock Brake System Activation	O	Yes / No	
		3.5.1.1.4.6.4	Broadcast Vehicle Information - Traction Control System Activation	O	Yes / No	
		3.5.1.1.4.6.5	Broadcast Vehicle Information - Stability Control System Activation	O	Yes / No	
		3.5.1.1.4.6.7	Broadcast Vehicle Information - Hard Braking Warning	O	Yes / No	
		3.5.1.1.4.6.8.3	Broadcast Vehicle Information - Change in Fog Lamps State	O	Yes / No	
		3.5.1.1.4.6.8.4	Broadcast Vehicle Information - Change in Low Beam Headlights State	O	Yes / No	
		3.5.1.1.4.6.8.5	Broadcast Vehicle Information - Change in High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.6.8.6	Broadcast Vehicle Information - Change in Parking Lights State	O	Yes / No	
		3.5.1.1.4.6.9	Broadcast Vehicle Information - Change in Wiper Status	O	Yes / No	
		3.5.1.2	Device Information Request **(CSR)**	O	Yes / No	
		3.5.1.2.1	Request Vehicle Information - Message Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.2	Request Vehicle Information - Device Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.3	Request Vehicle Information - Requested Item	CSR:M	Yes / NA	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.
		G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	CSR:M	Yes / NA	
		G.2.2.2	Maximum Response Time - Request Vehicle Information	CSR:M	Yes / NA	The maximum response time for a connected vehicle to respond to a request is ______ (default: 200) ms.
2.5.2.3	Emergency Vehicle Alert			PSOBU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.3	Broadcast Vehicle Information - Daytime Running Lights State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.5	Broadcast Vehicle Information - Fog Lamps State	O	Yes / No	
		3.5.1.1.4.4.1.6	Broadcast Vehicle Information - Low Beam Headlights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.4.1.8	Broadcast Vehicle Information - Parking Lights State	O	Yes / No	
		3.5.1.1.4.4.1.9	Broadcast Vehicle Information - Automatic Light Controls State	O	Yes / No	
		3.5.1.1.4.6.13	Broadcast Emergency Response Indication	M	Yes	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.
2.5.2.4	Vehicle Emergency Response			OBU:O	Yes / No / NA	
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.4.1	Broadcast Vehicle Information - Vehicle Type	O	Yes / No	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.6.6	Broadcast Vehicle Information - Hazardous Materials Present	O	Yes / No	
		3.5.1.1.4.6.10	Broadcast Vehicle Information - Flat Tire	O	Yes / No	
		3.5.1.1.4.6.11	Broadcast Vehicle Information - Vehicle Is Disabled	M	Yes	
		3.5.1.1.4.6.12	Broadcast Vehicle Information - Air Bag Deployment	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.2	Device Information Request **(CSR)**	O; PSOBU:M	Yes / No	
		3.5.1.2.1	Request Vehicle Information - Message Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.2	Request Vehicle Information - Device Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.3	Request Vehicle Information - Requested Item	CSR:M	Yes / NA	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	CSR:M	Yes / NA	
		G.2.2.2	Maximum Response Time - Request Vehicle Information	CSR:M	Yes / NA	The maximum response time for a connected vehicle to respond to a request is _____ (default: 200) ms.
2.5.2.5	Mayday Request			OBU:O	Yes / No /NA	
		3.5.9.1	Broadcast Mayday Message	M	Yes	
		3.5.9.1.1.1	Broadcast Mayday - Vehicle Location	M	Yes	
		3.5.9.1.1.2	Broadcast Mayday - Timestamp	M	Yes	
		3.5.9.1.1.3	Broadcast Mayday - Event	M	Yes	
		3.5.9.1.2.1	Broadcast Mayday - Number of Airbags	O	Yes / No	
		3.5.9.1.2.2	Broadcast Mayday - Vehicle Make Model and Fuel Type	O	Yes / No	
		3.5.9.1.2.3	Broadcast Mayday - Hazmat Codes	O	Yes / No	
		3.5.9.1.2.4	Broadcast Mayday - Placards	O	Yes / No	
		G.2.12.1	Minimum Transmission Rate - Broadcast Mayday	M	Yes	
		G.2.12.2	Maximum Transmission Rate - Broadcast Mayday	M	Yes	
		G.2.12.3	Default Transmission Rate - Broadcast Mayday	M	Yes	The default message transmission rate for a connected vehicle to broadcast mayday information is once per ___ (default: 1000) ms.
2.5.2.6	Transit Vehicle Crash Warning			TrVOBU:O	Yes / No /NA	
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.3.2	Broadcast Vehicle Information - Applied Pressure on the Vehicle Brakes	O	Yes / No	
		3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.6.8.1	Broadcast Vehicle Information - Change in Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.2	Broadcast Vehicle Information - Change in Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.6.8.5	Broadcast Vehicle Information - Change in High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.8	Broadcast Vehicle Information - Vehicle Path History Requirements **(PathHistory)**	O	Yes / No	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.4.8.1	Broadcast Vehicle Path History - GPS Status	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.2	Broadcast Vehicle Path History - Initial Position	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.3	Broadcast Vehicle Path History - Time Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.4	Broadcast Vehicle Path History - Position Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.5	Broadcast Vehicle Path History - Heading	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.6	Broadcast Vehicle Path History - Transmission	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.7	Broadcast Vehicle Path History - Speed	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.8	Broadcast Vehicle Path History - Positional Accuracy	PathHistory:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.9	Broadcast Vehicle Information - Vehicle Path Projection	O	Yes / No	
		3.5.1.1.4.10	Broadcast Vehicle Information - Location Corrections	O	Yes / No	
		3.5.1.2	Device Information Request **(CSR)**	O	Yes / No	
		3.5.1.2.1	Request Vehicle Information - Message Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.2	Request Vehicle Information - Device Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.3	Request Vehicle Information - Requested Item	CSR:M	Yes / NA	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		3.6.1.4.1	Path History - Data Points	PathHistory:M	Yes / NA	
		3.6.1.4.2	Path History - Position Error Tolerance	PathHistory:M	Yes / NA	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.
		G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	CSR:M	Yes / NA	
		G.2.2.2	Maximum Response Time - Request Vehicle Information	CSR:M	Yes / NA	The maximum response time for a connected vehicle to respond to a request is ______ (default: 200) ms.
2.5.3.1.1	Data to Determine Stopline Violations at Unsignalized Intersections			RSU:O	Yes / No / NA	
		3.5.6.1	Broadcast Roadway Geometrics	M	Yes	
		3.5.6.1.1	Broadcast Roadway Geometrics - Message Identifier	M	Yes	
		3.5.6.2.1.1	Broadcast Intersection - Identifier	M	Yes	
		3.5.6.2.1.2	Broadcast Intersection - Reference Point	M	Yes	
		3.5.6.2.1.3	Broadcast Intersection - Lane Default Width	M	Yes	
		3.5.6.2.1.4.1	Broadcast Intersection - Egress Lanes	M	Yes	
		3.5.6.2.1.4.2	Broadcast Intersection - Approach Lanes	M	Yes	
		3.5.6.2.1.4.3	Broadcast Intersection - Lane Number	M	Yes	
		3.5.6.2.1.4.4	Broadcast Intersection - Lane Centerline Coordinates	M	Yes	
		3.5.6.2.1.5.1	Broadcast Intersection - Vehicle Lane Movements	M	Yes	
		3.5.6.2.1.5.2	Broadcast Intersection - Pedestrian Lane Movements	O	Yes / No	
		3.5.6.2.1.5.3	Broadcast Intersection - Special Lane Movements	O	Yes / No	
		3.5.6.2.2.1	Broadcast Intersection - Version Identifier	O	Yes / No	
		3.5.6.2.2.2	Broadcast Intersection - Computed Lane	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.6.2.2.3	Broadcast Intersection - Crossings	O	Yes / No	
		3.5.6.2.2.4	Broadcast Intersection - Lane Width	O	Yes / No	
		3.5.6.2.2.5	Broadcast Intersection - Node Lane Width	O	Yes / No	
		3.5.6.2.2.6	Broadcast Intersection - Egress Connection	O	Yes / No	
		3.5.6.2.2.7	Broadcast Intersection - Computed Intersection	O	Yes / No	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.6.1.3	Message Identifier	M	Yes	
		G.2.8.1	Minimum Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	
		G.2.8.2	Maximum Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	
		G.2.8.3	Default Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	The default message transmission rate to broadcast roadway geometrics information is once per ___ (default: 1000) ms.
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1/60) seconds.
2.5.3.1.2	Data to Determine Stopline Violations at Signalized Intersections and Grade Crossings			RSU:O	Yes / No / NA	
		3.5.6.1	Broadcast Roadway Geometrics	M	Yes	
		3.5.6.1.1	Broadcast Roadway Geometrics - Message Identifier	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.6.2.1.1	Broadcast Intersection - Identifier	M	Yes	
		3.5.6.2.1.2	Broadcast Intersection - Reference Point	M	Yes	
		3.5.6.2.1.3	Broadcast Intersection - Lane Default Width	M	Yes	
		3.5.6.2.1.4.1	Broadcast Intersection - Egress Lanes	M	Yes	
		3.5.6.2.1.4.2	Broadcast Intersection - Approach Lanes	M	Yes	
		3.5.6.2.1.4.3	Broadcast Intersection - Lane Number	M	Yes	
		3.5.6.2.1.4.4	Broadcast Intersection - Lane Centerline Coordinates	M	Yes	
		3.5.6.2.1.5.1	Broadcast Intersection - Vehicle Lane Movements	M	Yes	
		3.5.6.2.1.5.2	Broadcast Intersection - Pedestrian Lane Movements	O	Yes / No	
		3.5.6.2.1.5.3	Broadcast Intersection - Special Lane Movements	O	Yes / No	
		3.5.6.2.2.1	Broadcast Intersection - Version Identifier	O	Yes / No	
		3.5.6.2.2.2	Broadcast Intersection - Computed Lane	O	Yes / No	
		3.5.6.2.2.3	Broadcast Intersection - Crossings	O	Yes / No	
		3.5.6.2.2.4	Broadcast Intersection - Lane Width	O	Yes / No	
		3.5.6.2.2.5	Broadcast Intersection - Node Lane Width	O	Yes / No	
		3.5.6.2.2.6	Broadcast Intersection - Egress Connection	O	Yes / No	
		3.5.6.2.2.7	Broadcast Intersection - Computed Intersection	O	Yes / No	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.7.1	Broadcast Signal Phase and Timing Information	M	Yes	
		3.5.7.1.1.1	Broadcast Signal Phase and Timing - Message Identifier	M	Yes	
		3.5.7.1.1.2	Broadcast Signal Phase and Timing - Intersection Identifier	M	Yes	
		3.5.7.1.1.3	Broadcast Signal Phase and Timing - Intersection Status	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.7.1.1.4	Broadcast Signal Phase and Timing - Timestamp	M	Yes / No	
		3.5.7.1.2.1	Broadcast Signal Phase and Timing - Preempt State	O	Yes / No	
		3.5.7.1.2.2	Broadcast Signal Phase and Timing - Priority State	O	Yes / No	
		3.5.7.1.3.1.1	Broadcast Movement - Lane Data	M	Yes	
		3.5.7.1.3.1.2.1	Broadcast Movement - Vehicular State	M	Yes	
		3.5.7.1.3.1.2.2	Broadcast Movement - Pedestrian State	O	Yes / No	
		3.5.7.1.3.1.2.3	Broadcast Movement - Special State	O	Yes / No	
		3.5.7.1.3.1.3	Broadcast Movement - Time of Change - Minimum	M	Yes	
		3.5.7.1.3.1.4	Broadcast Movement - Time of Change - Maximum	M	Yes	
		3.5.7.1.3.2.1	Broadcast Movement - Succeeding Signal Indications	O	Yes / No	
		3.5.7.1.3.2.2	Broadcast Movement - Succeeding Signal Indication Time of Change	O	Yes / No	
		3.5.7.1.3.2.3	Broadcast Movement - Pedestrian Detect	O	Yes / No	
		3.5.7.1.3.2.4	Broadcast Movement - Pedestrian Call	O	Yes / No	
		G.2.8.1	Minimum Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	
		G.2.8.2	Maximum Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	
		G.2.8.3	Default Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	The default message transmission rate to broadcast roadway geometrics information is once per ___ (default: 1000) ms.
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1/60) seconds.
		G.2.10.1	Minimum Transmission Rate - Broadcast Signal Phase and Timing Information	M	Yes	
		G.2.10.2	Maximum Transmission Rate - Broadcast Signal Phase and Timing Information	M	Yes	
		G.2.10.3	Default Transmission Rate - Broadcast Signal Phase and Timing Information	M	Yes	The default message transmission rate to broadcast signal phase and timing information is once per ___ (default: 150) ms.
2.5.3.1.3	Signal Movement at Intersections: Eco-Driving			RSU:O	Yes / No / NA	
		3.5.6.1	Broadcast Roadway Geometrics	M	Yes	
		3.5.6.1.1	Broadcast Roadway Geometrics - Message Identifier	M	Yes	
		3.5.6.2.1.1	Broadcast Intersection - Identifier	M	Yes	
		3.5.6.2.1.2	Broadcast Intersection - Reference Point	M	Yes	
		3.5.6.2.1.3	Broadcast Intersection - Lane Default Width	M	Yes	
		3.5.6.2.1.4.1	Broadcast Intersection - Egress Lanes	M	Yes	
		3.5.6.2.1.4.2	Broadcast Intersection - Approach Lanes	M	Yes	
		3.5.6.2.1.4.3	Broadcast Intersection - Lane Number	M	Yes	
		3.5.6.2.1.4.4	Broadcast Intersection - Lane Centerline Coordinates	M	Yes	
		3.5.6.2.1.5.1	Broadcast Intersection - Vehicle Lane Movements	M	Yes	
		3.5.6.2.1.5.2	Broadcast Intersection - Pedestrian Lane Movements	O	Yes / No	
		3.5.6.2.1.5.3	Broadcast Intersection - Special Lane Movements	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.6.2.2.1	Broadcast Intersection - Version Identifier	O	Yes / No	
		3.5.6.2.2.2	Broadcast Intersection - Computed Lane	O	Yes / No	
		3.5.6.2.2.3	Broadcast Intersection - Crossings	O	Yes / No	
		3.5.6.2.2.4	Broadcast Intersection - Lane Width	O	Yes / No	
		3.5.6.2.2.5	Broadcast Intersection - Node Lane Width	O	Yes / No	
		3.5.6.2.2.6	Broadcast Intersection - Egress Connection	O	Yes / No	
		3.5.6.2.2.7	Broadcast Intersection - Computed Intersection	O	Yes / No	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.7.1	Broadcast Signal Phase and Timing Information	M	Yes	
		3.5.7.1.1.1	Broadcast Signal Phase and Timing - Message Identifier	M	Yes	
		3.5.7.1.1.2	Broadcast Signal Phase and Timing - Intersection Identifier	M	Yes	
		3.5.7.1.1.3	Broadcast Signal Phase and Timing - Intersection Status	M	Yes	
		3.5.7.1.1.4	Broadcast Signal Phase and Timing - Timestamp	O	Yes / No	
		3.5.7.1.2.1	Broadcast Signal Phase and Timing - Preempt State	O	Yes / No	
		3.5.7.1.2.2	Broadcast Signal Phase and Timing - Priority State	O	Yes / No	
		3.5.7.1.3.1.1	Broadcast Movement - Lane Data	M	Yes	
		3.5.7.1.3.1.2.1	Broadcast Movement - Vehicular State	M	Yes	
		3.5.7.1.3.1.2.2	Broadcast Movement - Pedestrian State	O	Yes / No	
		3.5.7.1.3.1.2.3	Broadcast Movement - Special State	O	Yes / No	
		3.5.7.1.3.1.3	Broadcast Movement - Time of Change - Minimum	M	Yes	
		3.5.7.1.3.1.4	Broadcast Movement - Time of Change - Maximum	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.7.1.3.2.1	Broadcast Movement - Succeeding Signal Indications	O	Yes / No	
		3.5.7.1.3.2.2	Broadcast Movement - Succeeding Signal Indication Time of Change	O	Yes / No	
		3.5.7.1.3.2.3	Broadcast Movement - Pedestrian Detect	O	Yes / No	
		3.5.7.1.3.2.4	Broadcast Movement - Pedestrian Call	O	Yes / No	
		3.6.1.3	Message Identifier	M	Yes	
		G.2.8.1	Minimum Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	
		G.2.8.2	Maximum Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	
		G.2.8.3	Default Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	The default message transmission rate to broadcast roadway geometrics information is once per ___ (default: 1000) ms.
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1/60) seconds.
		G.2.10.1	Minimum Transmission Rate - Broadcast Signal Phase and Timing Information	M	Yes	
		G.2.10.2	Maximum Transmission Rate - Broadcast Signal Phase and Timing Information	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.10.3	Default Transmission Rate - Broadcast Signal Phase and Timing Information	M	Yes	The default message transmission rate to broadcast signal phase and timing information is once per ___ (default: 150) ms.
2.5.3.1.4	Infrastructure Restriction Warnings			RSU:O	Yes / No / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.8.1	Broadcast Traveler Information	M	Yes	
		3.5.8.2.1	Broadcast Traveler Information - Packet Identifier	M	Yes	
		3.5.8.2.2.1	Broadcast Traveler Advisories - Message Identifier **(Advisory)**	O.3 (1..*)	Yes / No	
		3.5.8.2.2.2	Broadcast Road Sign - Message Identifier **(Roadsign)**	O.3 (1..*)	Yes / No	
		3.5.8.3.1	Broadcast Road Sign - MUTCD Type	Roadsign:O	Yes / No / NA	
		3.5.8.3.2	Broadcast Traveler Information - Start Time **(ValidTime)**	O	Yes / No	
		3.5.8.3.3	Broadcast Traveler Information - Start Year	ValidTime:O	Yes / No / NA	
		3.5.8.3.4	Broadcast Traveler Information - Validity Duration	ValidTime:M	Yes / NA	
		3.5.8.3.5	Broadcast Traveler Information - Importance	O	Yes / No	
		3.5.8.3.6	Broadcast Traveler Information - Presentation Requirements **(Presentation)**	O	Yes / No	
		3.5.8.3.6.1	Broadcast Traveler Information - Default Anchor Point Position	Presentation:M	Yes / NA	
		3.5.8.3.6.2	Broadcast Traveler Information - Heading Slice	Presentation:O	Yes / No / NA	
		3.5.8.3.6.3.1	Broadcast Traveler Information - Circular Region - Radius **(Circular)**	Presentation:O.4(1..*)	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.8.3.6.3.2	Broadcast Traveler Information - Circular Region - Anchor Point	Circular:O	Yes / No / NA	
		3.5.8.3.6.4.1	Broadcast Traveler Information - Polygon Region - Offsets **(Polygon)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.4.2	Broadcast Traveler Information - Polygon Region - Anchor Point	Polygon:O	Yes / No / NA	
		3.5.8.3.6.5.1	Broadcast Traveler Information - Shape Point Set - Default Direction **(Shape)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.5.2	Broadcast Traveler Information - Shape Point Set - Default Width	Shape:M	Yes / NA	
		3.5.8.3.6.5.3	Broadcast Traveler Information - Shape Point Set - Offsets	Shape:M	Yes / NA	
		3.5.8.3.6.5.4	Broadcast Traveler Information - Shape Point Set - Direction	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.5	Broadcast Traveler Information - Shape Point Set - Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.6	Broadcast Traveler Information - Shape Point Set - Node Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.7	Broadcast Traveler Information - Shape Point Set - Anchor Point	Shape:O	Yes / No / NA	
		3.5.8.3.7	Broadcast Traveler Advisories - Content	Advisory:M	Yes / NA	
		3.5.8.3.8	Broadcast Road Sign - Content	Roadsign:M	Yes / NA	
		3.5.8.3.9	Broadcast Traveler Information - Uniform Resource Locator	O	Yes / No	
		3.5.8.3.10	Broadcast Traveler Information - Valid Vehicle Type	O	Yes / No	
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.11.1	Maximum Transmission Rate - Broadcast Traveler Information	M	Yes	
		G.2.11.2	Default Transmission Rate - Broadcast Traveler Information	M	Yes	The default message transmission rate to broadcast traveler information messages is once per ___ (default: 1000) ms.
2.5.3.1.5	Warnings about Hazards in a Work Zone			RSU:O	Yes / No / NA	
		3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	M	Yes	
		3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier	M	Yes	
		3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier	M	Yes	
		3.5.1.1.3.3	Broadcast Vehicle Information - Position Time	M	Yes	
		3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position	M	Yes	
		3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy	M	Yes	
		3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State	M	Yes	
		3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed	M	Yes	
		3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading	M	Yes	
		3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle	M	Yes	
		3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration	M	Yes	
		3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration	M	Yes	
		3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate	M	Yes	
		3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status	M	Yes	
		3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status	M	Yes	
		3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status	M	Yes	
		3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status	M	Yes	
		3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status	M	Yes	
		3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width	M	Yes	
		3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length	M	Yes	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.4.1	Broadcast Vehicle Information - Vehicle Type	O	Yes / No	
		3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status	O	Yes / No	
		3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State	O	Yes / No	
		3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State	O	Yes / No	
		3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State	O	Yes / No	
		3.5.1.1.4.6	Broadcast Vehicle Information - Vehicle Status Change	M	Yes	
		3.5.1.1.4.6.1	Broadcast Vehicle Information - Vehicle Hazard Lights	M	Yes	
		3.5.1.1.4.6.3	Broadcast Vehicle Information - Anti-Lock Brake System Activation	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.1.4.6.4	Broadcast Vehicle Information - Traction Control System Activation	M	Yes	
		3.5.1.1.4.6.5	Broadcast Vehicle Information - Stability Control System Activation	M	Yes	
		3.5.1.1.4.6.7	Broadcast Vehicle Information - Hard Braking Warning	M	Yes	
		3.5.1.1.4.6.8	Broadcast Vehicle Information - Change in Vehicle Light Status	M	Yes	
		3.5.1.1.4.8	Broadcast Vehicle Information - Vehicle Path History Requirements **(PathHistory)**	O	Yes / No	A connected vehicle shall have a sufficient size buffer to support at least ___ (minimum/default: 10) data points for the vehicle's path history.
		3.5.1.1.4.8.1	Broadcast Vehicle Path History - GPS Status	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.2	Broadcast Vehicle Path History - Initial Position	PathHistory:M	Yes / NA	
		3.5.1.1.4.8.3	Broadcast Vehicle Path History - Time Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.4	Broadcast Vehicle Path History - Position Offset	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.5	Broadcast Vehicle Path History - Heading	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.6	Broadcast Vehicle Path History - Transmission	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.7	Broadcast Vehicle Path History - Speed	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.8.8	Broadcast Vehicle Path History - Positional Accuracy	PathHistory:O	Yes / No / NA	
		3.5.1.1.4.9	Broadcast Vehicle Information - Vehicle Path Projection	O	Yes / No	
		3.5.1.1.4.10	Broadcast Vehicle Information - Location Corrections	O	Yes / No	
		3.5.1.2	Device Information Request **(CSR)**	O	Yes / No	
		3.5.1.2.1	Request Vehicle Information - Message Identifier	CSR:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.1.2.2	Request Vehicle Information - Device Identifier	CSR:O	Yes / No / NA	
		3.5.1.2.3	Request Vehicle Information - Requested Item	CSR:M	Yes / NA	
		3.6.1.2.1	Change Device Identifier on Security Certificate	M	Yes	
		3.6.1.2.2	Change Device Identifier on Identifier Conflict	M	Yes	
		3.6.1.2.3	Randomized Change - Device Identifier	M	Yes	
		3.6.1.3	Message Identifier	M	Yes	
		3.6.1.4.1	Path History - Data Points	PathHistory:M	Yes / NA	
		3.6.1.4.2	Path History - Position Error Tolerance	PathHistory:M	Yes / NA	
		G.2.1.1	Requirements to Broadcast Vehicle Information	M	Yes	
		G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	
		G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)	M	Yes	The default message transmission rate for a connected vehicle to broadcast its mandatory elements is once per ____ (default:100) ms.
		G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information	M	Yes	
		G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information	M	Yes	The default message transmission rate for a connected vehicle to broadcast information about itself is once per ___ (default: 1000) ms.

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	CSR:M	Yes / NA	
		G.2.2.2	Maximum Response Time - Request Vehicle Information	CSR:M	Yes / NA	The maximum response time for a connected vehicle to respond to a request is _____ (default: 200) ms.
2.5.3.1.6	Warnings about Upcoming Work Zone			RSU:O	Yes / No / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.8.1	Broadcast Traveler Information	M	Yes	
		3.5.8.1	Broadcast Traveler Information	M	Yes	
		3.5.8.2.1	Broadcast Traveler Information - Packet Identifier	M	Yes	
		3.5.8.2.2.1	Broadcast Traveler Advisories - Message Identifier **(Advisory)**	O.3 (1..*)	Yes / No	
		3.5.8.2.2.2	Broadcast Road Sign - Message Identifier **(Roadsign)**	O.3 (1..*)	Yes / No	
		3.5.8.3.1	Broadcast Road Sign - MUTCD Type	Roadsign:O	Yes / No / NA	
		3.5.8.3.2	Broadcast Traveler Information - Start Time **(ValidTime)**	O	Yes / No	
		3.5.8.3.3	Broadcast Traveler Information - Start Year	ValidTime:O	Yes / No / NA	
		3.5.8.3.4	Broadcast Traveler Information - Validity Duration	ValidTime:M	Yes / NA	
		3.5.8.3.5	Broadcast Traveler Information - Importance	O	Yes / No	
		3.5.8.3.6	Broadcast Traveler Information - Presentation Requirements **(Presentation)**	O	Yes / No	
		3.5.8.3.6.1	Broadcast Traveler Information - Default Anchor Point Position	Presentation:M	Yes / NA	
		3.5.8.3.6.2	Broadcast Traveler Information - Heading Slice	Presentation:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.8.3.6.3.1	Broadcast Traveler Information - Circular Region - Radius **(Circular)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.3.2	Broadcast Traveler Information - Circular Region - Anchor Point	Circular:O	Yes / No / NA	
		3.5.8.3.6.4.1	Broadcast Traveler Information - Polygon Region - Offsets **(Polygon)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.4.2	Broadcast Traveler Information - Polygon Region - Anchor Point	Polygon:O	Yes / No / NA	
		3.5.8.3.6.5.1	Broadcast Traveler Information - Shape Point Set - Default Direction **(Shape)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.5.2	Broadcast Traveler Information - Shape Point Set - Default Width	Shape:M	Yes / NA	
		3.5.8.3.6.5.3	Broadcast Traveler Information - Shape Point Set - Offsets	Shape:M	Yes / NA	
		3.5.8.3.6.5.4	Broadcast Traveler Information - Shape Point Set - Direction	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.5	Broadcast Traveler Information - Shape Point Set - Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.6	Broadcast Traveler Information - Shape Point Set - Node Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.7	Broadcast Traveler Information - Shape Point Set - Anchor Point	Shape:O	Yes / No / NA	
		3.5.8.3.7	Broadcast Traveler Advisories - Content	Advisory:M	Yes / NA	
		3.5.8.3.8	Broadcast Road Sign - Content	Roadsign:M	Yes / NA	
		3.5.8.3.9	Broadcast Traveler Information - Uniform Resource Locator	O	Yes / No	
		3.5.8.3.10	Broadcast Traveler Information - Valid Vehicle Type	O	Yes / No	
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
		G.2.11.1	Maximum Transmission Rate - Broadcast Traveler Information	M	Yes	
		G.2.11.2	Default Transmission Rate - Broadcast Traveler Information	M	Yes	The default message transmission rate to broadcast traveler information messages is once per ___ (default: 1000) ms.
2.5.3.1.7	Restricted Lane Warnings			RSU:O	Yes / No / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.8.1	Broadcast Traveler Information	M	Yes	
		3.5.8.2.1	Broadcast Traveler Information - Packet Identifier	M	Yes	
		3.5.8.2.2.1	Broadcast Traveler Advisories - Message Identifier **(Advisory)**	O.3 (1..*)	Yes / No	
		3.5.8.2.2.2	Broadcast Road Sign - Message Identifier **(Roadsign)**	O.3 (1..*)	Yes / No	
		3.5.8.3.1	Broadcast Road Sign - MUTCD Type	Roadsign:O	Yes / No / NA	
		3.5.8.3.2	Broadcast Traveler Information - Start Time **(ValidTime)**	O	Yes / No	
		3.5.8.3.3	Broadcast Traveler Information - Start Year	ValidTime:O	Yes / No / NA	
		3.5.8.3.4	Broadcast Traveler Information - Validity Duration	ValidTime:M	Yes / NA	
		3.5.8.3.5	Broadcast Traveler Information - Importance	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.8.3.6	Broadcast Traveler Information - Presentation Requirements **(Presentation)**	O	Yes / No	
		3.5.8.3.6.1	Broadcast Traveler Information - Default Anchor Point Position	Presentation:M	Yes / NA	
		3.5.8.3.6.2	Broadcast Traveler Information - Heading Slice	Presentation:O	Yes / No / NA	
		3.5.8.3.6.3.1	Broadcast Traveler Information - Circular Region - Radius **(Circular)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.3.2	Broadcast Traveler Information - Circular Region - Anchor Point	Circular:O	Yes / No / NA	
		3.5.8.3.6.4.1	Broadcast Traveler Information - Polygon Region - Offsets **(Polygon)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.4.2	Broadcast Traveler Information - Polygon Region - Anchor Point	Polygon:O	Yes / No / NA	
		3.5.8.3.6.5.1	Broadcast Traveler Information - Shape Point Set - Default Direction **(Shape)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.5.2	Broadcast Traveler Information - Shape Point Set - Default Width	Shape:M	Yes / NA	
		3.5.8.3.6.5.3	Broadcast Traveler Information - Shape Point Set - Offsets	Shape:M	Yes / NA	
		3.5.8.3.6.5.4	Broadcast Traveler Information - Shape Point Set - Direction	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.5	Broadcast Traveler Information - Shape Point Set - Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.6	Broadcast Traveler Information - Shape Point Set - Node Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.7	Broadcast Traveler Information - Shape Point Set - Anchor Point	Shape:O	Yes / No / NA	
		3.5.8.3.7	Broadcast Traveler Advisories - Content	Advisory:M	Yes / NA	
		3.5.8.3.8	Broadcast Road Sign - Content	Roadsign:M	Yes / NA	
		3.5.8.3.9	Broadcast Traveler Information - Uniform Resource Locator	O	Yes / No	
		3.5.8.3.10	Broadcast Traveler Information - Valid Vehicle Type	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
		G.2.11.1	Maximum Transmission Rate - Broadcast Traveler Information	M	Yes	
		G.2.11.2	Default Transmission Rate - Broadcast Traveler Information	M	Yes	The default message transmission rate to broadcast traveler information messages is once per ___ (default: 1000) ms.
2.5.3.1.8	Roadway Hazards Information			RSU:O	Yes / No / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.8.1	Broadcast Traveler Information	M	Yes	
		3.5.8.1	Broadcast Traveler Information	M	Yes	
		3.5.8.2.1	Broadcast Traveler Information - Packet Identifier	M	Yes	
		3.5.8.2.2.1	Broadcast Traveler Advisories - Message Identifier	M	Yes	
		3.5.8.3.2	Broadcast Traveler Information - Start Time **(ValidTime)**	O	Yes / No	
		3.5.8.3.3	Broadcast Traveler Information - Start Year	ValidTime:O	Yes / No / NA	
		3.5.8.3.4	Broadcast Traveler Information - Validity Duration	ValidTime:M	Yes / NA	
		3.5.8.3.5	Broadcast Traveler Information - Importance	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.8.3.6	Broadcast Traveler Information - Presentation Requirements **(Presentation)**	O	Yes / No	
		3.5.8.3.6.1	Broadcast Traveler Information - Default Anchor Point Position	Presentation:M	Yes / NA	
		3.5.8.3.6.2	Broadcast Traveler Information - Heading Slice	Presentation:O	Yes / No / NA	
		3.5.8.3.6.3.1	Broadcast Traveler Information - Circular Region - Radius **(Circular)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.3.2	Broadcast Traveler Information - Circular Region - Anchor Point	Circular:O	Yes / No / NA	
		3.5.8.3.6.4.1	Broadcast Traveler Information - Polygon Region - Offsets **(Polygon)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.4.2	Broadcast Traveler Information - Polygon Region - Anchor Point	Polygon:O	Yes / No / NA	
		3.5.8.3.6.5.1	Broadcast Traveler Information - Shape Point Set - Default Direction **(Shape)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.5.2	Broadcast Traveler Information - Shape Point Set - Default Width	Shape:M	Yes / NA	
		3.5.8.3.6.5.3	Broadcast Traveler Information - Shape Point Set - Offsets	Shape:M	Yes / NA	
		3.5.8.3.6.5.4	Broadcast Traveler Information - Shape Point Set - Direction	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.5	Broadcast Traveler Information - Shape Point Set - Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.6	Broadcast Traveler Information - Shape Point Set - Node Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.7	Broadcast Traveler Information - Shape Point Set - Anchor Point	Shape:O	Yes / No / NA	
		3.5.8.3.7	Broadcast Traveler Advisories - Content	M	Yes	
		3.5.8.3.9	Broadcast Traveler Information - Uniform Resource Locator	O	Yes / No	
		3.5.8.3.10	Broadcast Traveler Information - Valid Vehicle Type	O	Yes / No	
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
		G.2.11.1	Maximum Transmission Rate - Broadcast Traveler Information	M	Yes	
		G.2.11.2	Default Transmission Rate - Broadcast Traveler Information	M	Yes	The default message transmission rate to broadcast traveler information messages is once per ___ (default: 1000) ms.
2.5.3.1.9	Pedestrian and Turning Transit Vehicle Crash Warning			RSU:O	Yes / No / NA	
		3.5.6.1	Broadcast Roadway Geometrics	M	Yes	
		3.5.6.1.1	Broadcast Roadway Geometrics - Message Identifier	M	Yes	
		3.5.6.2.1.1	Broadcast Intersection - Identifier	M	Yes	
		3.5.6.2.1.2	Broadcast Intersection - Reference Point	M	Yes	
		3.5.6.2.1.3	Broadcast Intersection - Lane Default Width	M	Yes	
		3.5.6.2.1.4.1	Broadcast Intersection - Egress Lanes	M	Yes	
		3.5.6.2.1.4.2	Broadcast Intersection - Approach Lanes	M	Yes	
		3.5.6.2.1.4.3	Broadcast Intersection - Lane Number	M	Yes	
		3.5.6.2.1.4.4	Broadcast Intersection - Lane Centerline Coordinates	M	Yes	
		3.5.6.2.1.5.1	Broadcast Intersection - Vehicle Lane Movements	M	Yes	
		3.5.6.2.1.5.2	Broadcast Intersection - Pedestrian Lane Movements	M	Yes	
		3.5.6.2.1.5.3	Broadcast Intersection - Special Lane Movements	O	Yes / No	
		3.5.6.2.2.1	Broadcast Intersection - Version Identifier	O	Yes / No	
		3.5.6.2.2.2	Broadcast Intersection - Computed Lane	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.6.2.2.3	Broadcast Intersection - Crossings	M	Yes	
		3.5.6.2.2.4	Broadcast Intersection - Lane Width	O	Yes / No	
		3.5.6.2.2.5	Broadcast Intersection - Node Lane Width	O	Yes / No	
		3.5.6.2.2.6	Broadcast Intersection - Egress Connection	O	Yes / No	
		3.5.6.2.2.7	Broadcast Intersection - Computed Intersection	O	Yes / No	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.7.1	Broadcast Signal Phase and Timing Information	M	Yes	
		3.5.7.1.1.1	Broadcast Signal Phase and Timing - Message Identifier	M	Yes	
		3.5.7.1.1.2	Broadcast Signal Phase and Timing - Intersection Identifier	M	Yes	
		3.5.7.1.1.3	Broadcast Signal Phase and Timing - Intersection Status	M	Yes	
		3.5.7.1.1.4	Broadcast Signal Phase and Timing - Timestamp	M	Yes	
		3.5.7.1.2.1	Broadcast Signal Phase and Timing - Preempt State	O	Yes / No	
		3.5.7.1.2.2	Broadcast Signal Phase and Timing - Priority State	O	Yes / No	
		3.5.7.1.3.1.1	Broadcast Movement - Lane Data	M	Yes	
		3.5.7.1.3.1.2.1	Broadcast Movement - Vehicular State	M	Yes	
		3.5.7.1.3.1.2.2	Broadcast Movement - Pedestrian State	M	Yes	
		3.5.7.1.3.1.2.3	Broadcast Movement - Special State	O	Yes / No	
		3.5.7.1.3.1.3	Broadcast Movement - Time of Change - Minimum	M	Yes	
		3.5.7.1.3.1.4	Broadcast Movement - Time of Change - Maximum	M	Yes	
		3.5.7.1.3.2.1	Broadcast Movement - Succeeding Signal Indications	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.7.1.3.2.2	Broadcast Movement - Succeeding Signal Indication Time of Change	O	Yes / No	
		3.5.7.1.3.2.3	Broadcast Movement - Pedestrian Detect	M	Yes	
		3.5.7.1.3.2.4	Broadcast Movement - Pedestrian Call	O	Yes / No	
		G.2.8.1	Minimum Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	
		G.2.8.2	Maximum Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	
		G.2.8.3	Default Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	The default message transmission rate to broadcast roadway geometrics information is once per ___ (default: 1000) ms.
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1/60) seconds.
		G.2.10.1	Minimum Transmission Rate - Broadcast Signal Phase and Timing Information	M	Yes	
		G.2.10.2	Maximum Transmission Rate - Broadcast Signal Phase and Timing Information	M	Yes	
		G.2.10.3	Default Transmission Rate - Broadcast Signal Phase and Timing Information	M	Yes	The default message transmission rate to broadcast signal phase and timing information is once per ___ (default: 150) ms.

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
2.5.3.2	Mayday Forward			OBU:O	Yes / No / NA	A connected vehicle shall have a sufficient size buffer to forward a mayday transmission from __ (default = 1) vehicle.
		3.5.9.2.1	Receive Mayday Broadcasts	M	Yes	
		3.5.9.2.2	Forward Mayday Broadcasts	M	Yes	
2.5.3.3	Mayday Request to Infrastructure			OBU:O	Yes / No / NA	
		3.5.9.1	Broadcast Mayday Message	M	Yes	
		3.5.9.1.1.1	Broadcast Mayday - Vehicle Location	M	Yes	
		3.5.9.1.1.2	Broadcast Mayday - Timestamp	M	Yes	
		3.5.9.1.1.3	Broadcast Mayday - Event	M	Yes	
		3.5.9.1.2.1	Broadcast Mayday - Number of Airbags	O	Yes / No	
		3.5.9.1.2.2	Broadcast Mayday - Vehicle Make Model and Fuel Type	O	Yes / No	
		3.5.9.1.2.3	Broadcast Mayday - Hazmat Codes	O	Yes / No	
		3.5.9.1.2.4	Broadcast Mayday - Placards	O	Yes / No	
		G.2.12.1	Minimum Transmission Rate - Broadcast Mayday	M	Yes	
		G.2.12.2	Maximum Transmission Rate - Broadcast Mayday	M	Yes	
		G.2.12.3	Default Transmission Rate - Broadcast Mayday	M	Yes	The default message transmission rate for a connected vehicle to broadcast mayday information is once per ___ (default: 1000) ms.
2.5.3.4.1	Commercial Vehicle Credentialing and Permitting			O	Yes / No	
		3.5.3.1.1	Commercial Vehicle Information Request	RSU:M	Yes / NA	
		3.5.3.1.1.1.1	Request Commercial Vehicle Information - Vehicle Identification	RSU:M	Yes / NA	
		3.5.3.1.1.2.1	Request Commercial Vehicle Information - Driver Identification	RSU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.3.1.1.2.3	Request Commercial Vehicle Information - Trailer Data	RSU:O	Yes / No / NA	
		3.5.3.1.1.2.4	Request Commercial Vehicle Information - Cargo Data	RSU:O	Yes / No / NA	
		3.5.3.1.1.2.5	Request Commercial Vehicle Information - Specific Vehicles	RSU:O	Yes / No / NA	
		3.5.3.1.1.3	Request Commercial Vehicle Information - Presentation Requirements **(CMVPresentation)**	RSU:O	Yes / No / NA	
		3.5.3.1.1.3.1	Request Commercial Vehicle Information - Default Anchor Point Position	CMVPresentation :M	Yes / NA	
		3.5.3.1.1.3.2	Request Commercial Vehicle Information - Heading Slice	CMVPresentation :O	Yes / No / NA	
		3.5.3.1.1.3.3	Request Commercial Vehicle Information - Circular Region - Radius **(CMVCircle)**	CMVPresentation :O.6(1..*)	Yes / No / NA	
		3.5.3.1.1.3.4	Request Commercial Vehicle Information - Circular Region - Anchor Point	CMVCircle:M	Yes / NA	
		3.5.3.1.1.3.5	Request Commercial Vehicle Information - Polygon Region - Offsets **(CMVPolygon)**	CMVPresentation :O.6(1..*)	Yes / No / NA	
		3.5.3.1.1.3.6	Request Commercial Vehicle Information - Polygon Region - Anchor Point	CMVPolygon:O	Yes / No / NA	
		3.5.3.1.1.3.7	Request Commercial Vehicle Information - Shape Point Set - Default Direction **(CMVShape)**	CMVPresentation :O.6(1..*)	Yes / No / NA	
		3.5.3.1.1.3.8	Request Commercial Vehicle Information - Shape Point Set - Default Width	CMVShape:M	Yes / NA	
		3.5.3.1.1.3.9	Request Commercial Vehicle Information - Shape Point Set - Offsets	CMVShape:M	Yes / NA	
		3.5.3.1.1.3.10	Request Commercial Vehicle Information - Shape Point Set - Direction	CMVShape:O	Yes / No / NA	
		3.5.3.1.1.3.11	Request Commercial Vehicle Information - Shape Point Set - Width	CMVShape:O	Yes / No / NA	
		3.5.3.1.1.3.12	Request Commercial Vehicle Information - Shape Point Set - Node Width	CMVShape:O	Yes / No / NA	
		3.5.3.1.1.3.13	Request Commercial Vehicle Information - Shape Point Set - Anchor Point	CMVShape:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.3.1.2	Transmit Commercial Vehicle Information	CVOBU:M	Yes / NA	
		3.5.3.1.2.1.1	Transmit Commercial Vehicle Power Unit - License Plate Data	CVOBU:M	Yes / NA	
		3.5.3.1.2.1.2	Transmit Commercial Vehicle Power Unit - VIN	CVOBU:M	Yes / NA	
		3.5.3.1.2.1.3	Transmit Commercial Vehicle Power Unit - Owner Carrier Name	CVOBU:M	Yes / NA	
		3.5.3.1.2.2.1.1	Transmit Commercial Vehicle Power Unit - VIN Source	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.1.2	Transmit Commercial Vehicle Power Unit - Owner Registration Number	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.1.3	Transmit Commercial Vehicle Power Unit - Lessee Registration Number	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.2	Transmit Commercial Vehicle Power Unit - Lessee Carrier Name	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.3.1	Transmit Commercial Vehicle Driver - Name	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.3.2	Transmit Commercial Vehicle Driver - License Number	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.3.3	Transmit Commercial Vehicle Driver - Date of Birth	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.3.4	Transmit Commercial Vehicle Driver - PIN	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.4.1	Transmit Trailer Information - VIN	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.4.2	Transmit Trailer Information - License Plate Data	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.4.3	Transmit Trailer Information - Number of Axles	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.4.4	Transmit Trailer Information - Number of Trailer Tires	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.4.5	Transmit Trailer Information - Weight	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.5.1	Transmit Cargo Information - Shipment ID	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.5.2	Transmit Cargo Information - Hazmat Codes	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.5.3	Transmit Cargo Information - Placards	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.6.1	Transmit Commercial Vehicle Information - Device Time	CVOBU:M	Yes / NA	

This SAE Information Report is a compilation of engineering reference data and educational material from various sources deemed useful to the technical community. Normative language contained herein should not be considered as an SAE Recommended Practice or SAE Standard.

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.3.1.2.2.6.2	Transmit Commercial Vehicle Information - Vehicle Position	CVOBU:M	Yes / NA	
		3.5.3.1.2.2.6.3	Transmit Commercial Vehicle Information - Positional Accuracy	CVOBU:M	Yes / NA	
		3.5.3.1.2.2.6.4	Transmit Commercial Vehicle Information - Vehicle Speed	CVOBU:M	Yes / NA	
		3.5.3.1.2.2.6.5	Transmit Commercial Vehicle Information - Vehicle Heading	CVOBU:M	Yes / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	RSU:O	Yes / No /NA	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	RSU:O	Yes / No /NA	
		G.2.5.1	Maximum Broadcast Rate - Commercial Vehicle Information	RSU:M	Yes / NA	
		G.2.5.2	Default Broadcast Rate - Commercial Vehicle Information	RSU:M	Yes / NA	The default message transmission rate for an RSU to request credentials from a commercial connected vehicle is once per ___ (default: 1000) ms.
		G.2.5.3	Maximum Response Time - Commercial Vehicle Information Requests	CVOBU:M	Yes / NA	The maximum response time for a commercial connected vehicle to respond to a request is _____ (default: 1000) ms.
		G.2.5.4	Default Re-Transmission Time - Commercial Vehicle Information (RSU)	RSU:M	Yes / NA	
		G.2.5.5	Default Re-Transmission Time - Commercial Vehicle Information (CMV)	CVOBU:M	Yes / NA	
		G.2.5.6	Maximum Re-Transmission Time - Commercial Vehicle Information	M	Yes	
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
2.5.3.4.2	Safety Inspection Data			O	Yes / No	
		3.5.3.1.1	Commercial Vehicle Information Request	RSU:M	Yes / NA	
		3.5.3.1.1.1.1	Request Commercial Vehicle Information - Vehicle Identification	RSU:M	Yes / NA	
		3.5.3.1.1.2.1	Request Commercial Vehicle Information - Driver Identification	RSU:O	Yes / No / NA	
		3.5.3.1.1.2.2	Request Commercial Vehicle Information - Driver Hours of Service Data	RSU:O	Yes / No / NA	
		3.5.3.1.1.2.3	Request Commercial Vehicle Information - Trailer Data	RSU:O	Yes / No / NA	
		3.5.3.1.1.2.4	Request Commercial Vehicle Information - Cargo Data	RSU:O	Yes / No / NA	
		3.5.3.1.1.2.5	Request Commercial Vehicle Information - Specific Vehicles	RSU:M	Yes / NA	
		3.5.3.1.1.3	Request Commercial Vehicle Information - Presentation Requirements **(CMVPresentation)**	RSU:O	Yes / No / NA	
		3.5.3.1.1.3.1	Request Commercial Vehicle Information - Default Anchor Point Position	CMVPresentation :M	Yes / NA	
		3.5.3.1.1.3.2	Request Commercial Vehicle Information - Heading Slice	CMVPresentation :O	Yes / No / NA	
		3.5.3.1.1.3.3	Request Commercial Vehicle Information - Circular Region - Radius **(CMVCircle)**	CMVPresentation :O.6(1..*)	Yes / No / NA	
		3.5.3.1.1.3.4	Request Commercial Vehicle Information - Circular Region - Anchor Point	CMVCircle:M	Yes / NA	
		3.5.3.1.1.3.5	Request Commercial Vehicle Information - Polygon Region - Offsets **(CMVPolygon)**	CMVPresentation :O.6(1..*)	Yes / No / NA	
		3.5.3.1.1.3.6	Request Commercial Vehicle Information - Polygon Region - Anchor Point	CMVPolygon:O	Yes / No / NA	

This SAE Information Report is a compilation of engineering reference data and educational material from various sources deemed useful to the technical community. Normative language contained herein should not be considered as an SAE Recommended Practice or SAE Standard.

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.3.1.1.3.7	Request Commercial Vehicle Information - Shape Point Set - Default Direction **(CMVShape)**	CMVPresentation :O.6(1..*)	Yes / No / NA	
		3.5.3.1.1.3.8	Request Commercial Vehicle Information - Shape Point Set - Default Width	CMVShape:M	Yes / NA	
		3.5.3.1.1.3.9	Request Commercial Vehicle Information - Shape Point Set - Offsets	CMVShape:M	Yes / NA	
		3.5.3.1.1.3.10	Request Commercial Vehicle Information - Shape Point Set - Direction	CMVShape:O	Yes / No / NA	
		3.5.3.1.1.3.11	Request Commercial Vehicle Information - Shape Point Set - Width	CMVShape:O	Yes / No / NA	
		3.5.3.1.1.3.12	Request Commercial Vehicle Information - Shape Point Set - Node Width	CMVShape:O	Yes / No / NA	
		3.5.3.1.1.3.13	Request Commercial Vehicle Information - Shape Point Set - Anchor Point	CMVShape:O	Yes / No / NA	
		3.5.3.1.2	Transmit Commercial Vehicle Information	CVOBU:M	Yes / NA	
		3.5.3.1.2.1.1	Transmit Commercial Vehicle Power Unit - License Plate Data	CVOBU:M	Yes / NA	
		3.5.3.1.2.1.2	Transmit Commercial Vehicle Power Unit - VIN	CVOBU:M	Yes / NA	
		3.5.3.1.2.1.3	Transmit Commercial Vehicle Power Unit - Owner Carrier Name	CVOBU:M	Yes / NA	
		3.5.3.1.2.2.1.1	Transmit Commercial Vehicle Power Unit - VIN Source	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.1.2	Transmit Commercial Vehicle Power Unit - Owner Registration Number	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.1.3	Transmit Commercial Vehicle Power Unit - Lessee Registration Number	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.2	Transmit Commercial Vehicle Power Unit - Lessee Carrier Name	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.3.1	Transmit Commercial Vehicle Driver - Name	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.3.2	Transmit Commercial Vehicle Driver - License Number	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.3.3	Transmit Commercial Vehicle Driver - Date of Birth	CVOBU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.3.1.2.2.3.4	Transmit Commercial Vehicle Driver - PIN	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.4.1	Transmit Trailer Information - VIN	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.4.2	Transmit Trailer Information - License Plate Data	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.4.3	Transmit Trailer Information - Number of Axles	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.4.4	Transmit Trailer Information - Number of Trailer Tires	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.4.5	Transmit Trailer Information - Weight	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.5.1	Transmit Cargo Information - Shipment ID	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.5.2	Transmit Cargo Information - Hazmat Codes	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.5.3	Transmit Cargo Information - Placards	CVOBU:O	Yes / No / NA	
		3.5.3.1.2.2.6.1	Transmit Commercial Vehicle Information - Device Time	CVOBU:M	Yes / NA	
		3.5.3.1.2.2.6.2	Transmit Commercial Vehicle Information - Vehicle Position	CVOBU:M	Yes / NA	
		3.5.3.1.2.2.6.3	Transmit Commercial Vehicle Information - Positional Accuracy	CVOBU:M	Yes / NA	
		3.5.3.1.2.2.6.4	Transmit Commercial Vehicle Information - Vehicle Speed	CVOBU:M	Yes / NA	
		3.5.3.1.2.2.6.5	Transmit Commercial Vehicle Information - Vehicle Heading	CVOBU:M	Yes / NA	
		3.5.3.2.1	Transmit Screening Activity Result **(RSUScreening)**	RSU:O	Yes / No / NA	
		3.5.3.2.1.1.1	Transmit Screening Activity Result - VIN	RSUScreening:M ; CMVScreen:M	Yes / NA	
		3.5.3.2.1.1.2	Transmit Screening Activity Result - Encounter ID	RSUScreening:M ; CMVScreen:M	Yes / NA	
		3.5.3.2.1.1.3	Transmit Screening Activity Result - Encounter Date and Time	RSUScreening:M ; CMVScreen:M	Yes / NA	
		3.5.3.2.1.1.4	Transmit Screening Activity Result - Encounter Location	RSUScreening:M ; CMVScreen:M	Yes / NA	
		3.5.3.2.1.1.5	Transmit Screening Activity Result - Check Type	RSUScreening:M ; CMVScreen:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.3.2.1.1.6	Transmit Screening Activity Result - Check Value	RSUScreening:M ; CMVScreen:M	Yes / NA	
		3.5.3.2.1.2.1	Transmit Screening Activity Result - Vehicle Polling Date and Time	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.2	Transmit Screening Activity Result - Encounter Station	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.3.1	Transmit Screening Activity Result - Vehicle Weight	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.3.2	Transmit Screening Activity Result - Vehicle Height	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.3.3	Transmit Screening Activity Result - Vehicle Width	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.3.4	Transmit Screening Activity Result - Vehicle Length	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.4.1	Transmit Screening Activity Result - Tire Pressure	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.4.2	Transmit Screening Activity Result - Tire Temperature	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.4.3	Transmit Screening Activity Result - Tire Pressure Threshold	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.5.1	Transmit Screening Activity Result - Vehicle Weight on the Axle	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.5.2	Transmit Screening Activity Result - Distance Between Vehicle Axles	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.6.1	Transmit Screening Activity Result - Left Brake Measure	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.6.2	Transmit Screening Activity Result - Right Brake Measure	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.6.3	Transmit Screening Activity Result - Brake Actuator	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.6.4	Transmit Screening Activity Result - Brake Lining Thickness	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.6.5	Transmit Screening Activity Result - Brake Temperature	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.1.2.7	Transmit Screening Activity Result - Safety Belt	RSUScreening:O ; CMVScreen:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.3.2.1.2.8	Transmit Commercial Vehicle Driver Hours of Service Data	RSUScreening:O ; CMVScreen:O	Yes / No / NA	
		3.5.3.2.2	Screening Activity Results Acknowledgement **(CMVScreenAck)**	CVOBU:O	Yes / No / NA	
		3.5.3.2.2.1.1	Transmit Screening Activity Result - VIN	CMVScreenAck: CVOBU:M	Yes / NA	
		3.5.3.2.2.1.2	Transmit Screening Activity Result - Encounter ID	CMVScreenAck: CVOBU:M	Yes / NA	
		3.5.3.2.2.1.3	Transmit Screening Activity Result - Encounter Date and Time	CMVScreenAck: CVOBU:M	Yes / NA	
		3.5.3.2.2.1.4	Transmit Screening Activity Result - Check Value	CMVScreenAck: CVOBU:M	Yes / NA	
		3.5.3.2.3	Commercial Screening Information Request **(RSUScreenRequest)**	RSU:O	Yes / No / NA	
		3.5.3.2.3.1.1	Commercial Screening Information Request - Vehicle Identification	RSUScreenRequest:M	Yes / NA	
		3.5.3.2.3.2.1	Request Commercial Screening Information - Encounter ID	RSUScreenRequest:O	Yes / No / NA	
		3.5.3.2.4	Transmit Previous Screening Activity Result **(CMVScreen)**	CVOBU:O	Yes / No / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	RSU:O	Yes / No/NA	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	RSU:O	Yes / No/NA	
		G.2.5.1	Maximum Broadcast Rate - Commercial Vehicle Information	RSU:M	Yes / NA	
		G.2.5.2	Default Broadcast Rate - Commercial Vehicle Information	RSU:M	Yes / NA	The default message transmission rate for an RSU to transmit commercial screening information is once per ___ (default: 1000) ms.

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.5.3	Maximum Response Time - Commercial Vehicle Information Requests	CVOBU:M	Yes / NA	The maximum response time for a commercial connected vehicle to respond to a request is _____ (default: 1000) ms.
		G.2.5.4	Default Re-Transmission Time - Commercial Vehicle Information (RSU)	RSU:M	Yes / NA	
		G.2.5.5	Default Re-Transmission Time - Commercial Vehicle Information (CMV)	CVOBU:M	Yes / NA	
		G.2.5.6	Maximum Re-Transmission Time - Commercial Vehicle Information	M	Yes	
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
2.5.3.4.3	Vehicle Clearance			RSU:O	Yes / No / NA	
		3.5.3.3.1	Transmit Instructions	RSU:M	Yes / NA	
		3.5.3.3.1.1	Transmit Instructions - VIN	RSU:M	Yes / NA	
		3.5.3.3.1.2.1	Transmit Instructions - Bypass	RSU:M	Yes / NA	
		3.5.3.3.1.2.2	Transmit Instructions - Pull-In Location	RSU:M	Yes / NA	
		3.5.3.3.1.3.1	Transmit Instructions - Pull-In Location Name	RSU:O	Yes / No / NA	
		3.5.3.3.1.3.2	Transmit Instructions - Pull-In Location Description	RSU:O	Yes / No / NA	
		3.5.3.3.2	Transmit Instructions Acknowledgement	CVOBU:M	Yes / NA	
		3.5.3.3.2.1.1	Transmit Instructions Acknowledgement - VIN	CVOBU:M	Yes / NA	
		3.5.3.3.2.2.1	Transmit Instructions Acknowledgement - Pull-In Location	CVOBU:O	Yes / No / NA	
		3.5.3.3.2.2.2	Transmit Instructions Acknowledgement - Pull-In Location Name	CVOBU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	RSU:O	Yes / No / NA	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	RSU:O	Yes / No / NA	
		G.2.5.1	Maximum Broadcast Rate - Commercial Vehicle Information	RSU:M	Yes / NA	
		G.2.5.2	Default Broadcast Rate - Commercial Vehicle Information	RSU:M	Yes / NA	The default message transmission rate to broadcast instructions is once per ___ (default: 1000) ms.
		G.2.5.3	Maximum Response Time - Commercial Vehicle Information Requests	CVOBU:M	Yes / NA	The maximum response time for a commercial connected vehicle to respond to a request is ______ (default: 1000) ms.
		G.2.5.4	Default Re-Transmission Time - Commercial Vehicle Information (RSU)	RSU:M	Yes / NA	
		G.2.5.5	Default Re-Transmission Time - Commercial Vehicle Information (CMV)	CVOBU:M	Yes / NA	
		G.2.5.6	Maximum Re-Transmission Time - Commercial Vehicle Information	M	Yes	
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
2.5.3.4.4	Receive Parking Space Availability and Service Information			RSU:O	Yes / No / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.8.1	Broadcast Traveler Information	M	Yes	
		3.5.8.2.1	Broadcast Traveler Information - Packet Identifier	M	Yes	
		3.5.8.2.2.1	Broadcast Traveler Advisories - Message Identifier	M	Yes	
		3.5.8.3.2	Broadcast Traveler Information - Start Time **(ValidTime)**	O	Yes / No	
		3.5.8.3.3	Broadcast Traveler Information - Start Year	ValidTime:O	Yes / No / NA	
		3.5.8.3.4	Broadcast Traveler Information - Validity Duration	ValidTime:M	Yes / NA	
		3.5.8.3.5	Broadcast Traveler Information - Importance	O	Yes / No	
		3.5.8.3.6	Broadcast Traveler Information - Presentation Requirements **(Presentation)**	O	Yes / No	
		3.5.8.3.6.1	Broadcast Traveler Information - Default Anchor Point Position	Presentation:M	Yes / NA	
		3.5.8.3.6.2	Broadcast Traveler Information - Heading Slice	Presentation:O	Yes / No / NA	
		3.5.8.3.6.3.1	Broadcast Traveler Information - Circular Region - Radius **(Circular)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.3.2	Broadcast Traveler Information - Circular Region - Anchor Point	Circular:O	Yes / No / NA	
		3.5.8.3.6.4.1	Broadcast Traveler Information - Polygon Region - Offsets **(Polygon)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.4.2	Broadcast Traveler Information - Polygon Region - Anchor Point	Polygon:O	Yes / No / NA	
		3.5.8.3.6.5.1	Broadcast Traveler Information - Shape Point Set - Default Direction **(Shape)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.5.2	Broadcast Traveler Information - Shape Point Set - Default Width	Shape:M	Yes / NA	
		3.5.8.3.6.5.3	Broadcast Traveler Information - Shape Point Set - Offsets	Shape:M	Yes / NA	
		3.5.8.3.6.5.4	Broadcast Traveler Information - Shape Point Set - Direction	Shape:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.8.3.6.5.5	Broadcast Traveler Information - Shape Point Set - Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.6	Broadcast Traveler Information - Shape Point Set - Node Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.7	Broadcast Traveler Information - Shape Point Set - Anchor Point	Shape:O	Yes / No / NA	
		3.5.8.3.7	Broadcast Traveler Advisories - Content	M	Yes	
		3.5.8.3.9	Broadcast Traveler Information - Uniform Resource Locator	O	Yes / No	
		3.5.8.3.10	Broadcast Traveler Information - Valid Vehicle Type	O	Yes / No	
		3.5.8.3.11.1	Broadcast Parking Availability - Mandatory Requirements	M	Yes	
		3.5.8.3.11.2.1	Broadcast Parking Availability - Location Description	O	Yes / No	
		3.5.8.3.11.2.2	Broadcast Parking Availability - Availability Time	O	Yes / No	
		3.5.8.3.11.2.3	Broadcast Parking Availability - Availability End Time	O	Yes / No	
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
		G.2.11.1	Maximum Transmission Rate - Broadcast Traveler Information	M	Yes	
		G.2.11.2	Default Transmission Rate - Broadcast Traveler Information	M	Yes	The default message transmission rate to broadcast traveler information messages is once per ___ (default: 1000) ms.

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
2.5.3.5.1.1	Vehicle Data for Traffic Data Collection			O	Yes / No	
		3.5.5.1	Probe Data Request	RSU:M	Yes / NA	
		3.5.5.2	Transmit Probe Data Message	OBU:M	Yes / NA	
		3.5.5.2.1.1	Transmit Probe Data - Probe Segment Number	OBU:M	Yes / NA	
		3.5.5.2.1.2	Transmit Probe Data - Position	OBU:M	Yes / NA	
		3.5.5.2.1.3	Transmit Probe Data - Snapshots	OBU:M	Yes / NA	A connected device shall support at least ___ (minimum / default: 30) snapshots.
		3.5.5.2.2.1	Transmit Probe Data - Vehicle Type	OBU:O	Yes / No / NA	
		3.5.5.2.2.2	Transmit Probe Data - Identifier	OBU:O	Yes / No / NA	
		3.5.5.3	Broadcast Probe Management Information **(Probe)**	RSU:O	Yes / No / NA	
		3.5.5.3.1.1	Manage Probe - Sample Size	Probe:M	Yes / NA	
		3.5.5.3.1.2.1	Manage Probe - Termination Time	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.2.2	Manage Probe - Termination Distance	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.1	Manage Probe - Generation by Time	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.2	Manage Probe - Generation by Distance	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.2.1	Manage Probe - Heading Slice	Probe:O	Yes / No / NA	
		3.5.5.3.2.2	Manage Probe - Interval Between Transmissions	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.1	Manage Probe - Stop Time Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.2	Manage Probe - Last Stop Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.3	Manage Probe - Start Speed Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.1	Manage Probe - Support Reading	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.2	Manage Probe - Support Greater Than Event	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.3	Manage Probe - Support Less Than Event	Probe:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.5.1.1	Initial Snapshot	OBU:M	Yes / NA	A connected device shall not generate a snapshot until it has traveled ____ (default and minimum: 500 meters) since its ignition was turned on
		3.6.1.5.1.2.1	Periodic Snapshot - Default	OBU:M	Yes / NA	A connected device shall generate periodic intervals no less than ____ (default: 4 seconds) when traveling at or less than ____ (default: 8.9 meters per second); and no more than ____ (default: 20 seconds) when traveling at or more than ____ (default: 26.8 meters per second)
		3.6.1.5.1.2.2	Periodic Snapshot - Stops	OBU:M	Yes / NA	Stop time threshold is ____ (default: 5.0 seconds), last stop threshold is ____ (default: 15.0 seconds), start speed threshold is ____ (default: 4.5 meters per second).
		3.6.1.5.1.3	Event Snapshot	OBU:M	Yes / NA	
		3.6.1.5.1.4.1	Snapshot - Vehicle Stop	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default stop time threshold and last stop threshold.

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.5.1.4.2	Snapshot - Vehicle Start	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default start speed threshold.
		3.6.1.5.2.1	Delete Snapshot - Transmission	OBU:M	Yes / NA	
		3.6.1.5.2.2	Delete Snapshot - Expiration	OBU:M	Yes / NA	Default expiration time is ___ (default: 360) seconds and default expiration distance is ___ (default: 4000) meters.
		3.6.1.5.2.3	Delete Snapshot - Vehicle Turned Off	OBU:M	Yes / NA	
		3.6.1.5.3.1	Change PSN	OBU:M	Yes / NA	Default PSN time is ___ (default: 120) seconds and default PSN distance is ___ (default: 1000) meters.
		3.6.1.5.3.2	PSN - Gap	OBU:M	Yes / NA	
		G.2.6.1	Maximum Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	
		G.2.6.2	Default Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	The default message transmission rate for an RSU to advertise service for the collection of probe data is once per ___ (default: 1000) ms.
		G.2.7.1	Maximum Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.7.2	Default Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	The default message transmission rate for an RSU to broadcast a message to change the data collection policy of a connected vehicle is once per ___ (default: 1000) ms.
2.5.3.5.1.2	Vehicle Data for Incident Detection			O	Yes / No	
		3.5.5.1	Probe Data Request	RSU:M	Yes / NA	
		3.5.5.2	Transmit Probe Data Message	OBU:M	Yes / NA	
		3.5.5.2.1.1	Transmit Probe Data - Probe Segment Number	OBU:M	Yes / NA	
		3.5.5.2.1.2	Transmit Probe Data - Position	OBU:M	Yes / NA	
		3.5.5.2.1.3	Transmit Probe Data - Snapshots	OBU:M	Yes / NA	A connected device shall have a buffer size to store at least ___ (minimum / default: 30) snapshots.
		3.5.5.2.2.1	Transmit Probe Data - Vehicle Type	OBU:O	Yes / No / NA	
		3.5.5.2.2.2	Transmit Probe Data - Identifier	OBU:O	Yes / No / NA	
		3.5.5.3	Broadcast Probe Management Information **(Probe)**	RSU:O	Yes / No / NA	
		3.5.5.3.1.1	Manage Probe - Sample Size	Probe:M	Yes / NA	
		3.5.5.3.1.2.1	Manage Probe - Termination Time	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.2.2	Manage Probe - Termination Distance	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.1	Manage Probe - Generation by Time	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.2	Manage Probe - Generation by Distance	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.2.1	Manage Probe - Heading Slice	Probe:O	Yes / No / NA	
		3.5.5.3.2.2	Manage Probe - Interval Between Transmissions	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.1	Manage Probe - Stop Time Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.2	Manage Probe - Last Stop Threshold	Probe:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.5.3.2.3.3	Manage Probe - Start Speed Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.1	Manage Probe - Support Reading	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.2	Manage Probe - Support Greater Than Event	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.3	Manage Probe - Support Less Than Event	Probe:O	Yes / No / NA	
		3.6.1.5.1.1	Initial Snapshot	OBU:M	Yes / NA	A connected device shall not generate a snapshot until it has traveled ____ (default and minimum: 500 meters) since its ignition was turned on
		3.6.1.5.1.2.1	Periodic Snapshot - Default	OBU:M	Yes / NA	A connected device shall generate periodic intervals no less than ____ (default: 4 seconds) when traveling at or less than ____ (default: 8.9 meters per second); and no more than ____ (default: 20 seconds) when traveling at or more than ____ (default: 26.8 meters per second)
		3.6.1.5.1.2.2	Periodic Snapshot - Stops	OBU:M	Yes / NA	Stop time threshold is ____ (default: 5.0 seconds), last stop threshold is ____ (default: 15.0 seconds), start speed threshold is ____ (default: 4.5 meters per second).
		3.6.1.5.1.3	Event Snapshot	OBU:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.5.1.4.1	Snapshot - Vehicle Stop	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default stop time threshold and last stop threshold.
		3.6.1.5.1.4.2	Snapshot - Vehicle Start	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default start speed threshold.
		3.6.1.5.2.1	Delete Snapshot - Transmission	OBU:M	Yes / NA	
		3.6.1.5.2.2	Delete Snapshot - Expiration	OBU:M	Yes / NA	Default expiration time is ___ (default: 360) seconds and default expiration distance is ___ (default: 4000) meters.
		3.6.1.5.2.3	Delete Snapshot - Vehicle Turned Off	OBU:M	Yes / NA	
		3.6.1.5.3.1	Change PSN	OBU:M	Yes / NA	Default PSN time is ___ (default: 120) seconds and default PSN distance is ___ (default: 1000) meters.
		3.6.1.5.3.2	PSN - Gap	OBU:M	Yes / NA	
		G.2.6.1	Maximum Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	
		G.2.6.2	Default Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	The default message transmission rate for an RSU to advertise service for the collection of probe data is once per ___ (default: 1000) ms.
		G.2.7.1	Maximum Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.7.2	Default Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	The default message transmission rate for an RSU to broadcast a message to change the data collection policy of a connected vehicle is once per ___ (default: 1000) ms.
2.5.3.5.1.3	Vehicle Data for Traffic Operations Strategies			O	Yes / No	
		3.5.5.1	Probe Data Request	RSU:M	Yes / NA	
		3.5.5.2	Transmit Probe Data Message	OBU:M	Yes / NA	
		3.5.5.2.1.1	Transmit Probe Data - Probe Segment Number	OBU:M	Yes / NA	
		3.5.5.2.1.2	Transmit Probe Data - Position	OBU:M	Yes / NA	
		3.5.5.2.1.3	Transmit Probe Data - Snapshots	OBU:M	Yes / NA	A connected device shall have a buffer size to store at least ___ (minimum / default: 30) snapshots.
		3.5.5.2.2.1	Transmit Probe Data - Vehicle Type	OBU:O	Yes / No / NA	
		3.5.5.2.2.2	Transmit Probe Data - Identifier	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.1	Transmit Probe Data - Wind Direction	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.2	Transmit Probe Data - Wind Speed	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.3	Transmit Probe Data - Dewpoint Temperature	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.4	Transmit Probe Data - Total Radiation	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.5	Transmit Probe Data - Visibility	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.6	Transmit Probe Data - Surface Temperature	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.7	Transmit Probe Data - Roadway Water/Ice Depth	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.8	Transmit Probe Data - Roadway Snow Depth	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.9	Transmit Probe Data - Adjacent Snow Depth	OBU:O	Yes / No / NA	
		3.5.5.2.2.4.1	Transmit Probe Data - Fuel Type	OBU:O	Yes / No / NA	
		3.5.5.2.2.4.2	Transmit Probe Data - Fuel Economy	OBU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.5.2.2.4.3	Transmit Probe Data - Fuel Remaining	OBU:O	Yes / No / NA	
		3.5.5.2.2.4.4	Transmit Probe Data - Charge Remaining	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.1	Transmit Probe Data - CO Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.2	Transmit Probe Data - CO Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.3	Transmit Probe Data - NOx Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.4	Transmit Probe Data - NOx Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.5	Transmit Probe Data - SO2 Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.6	Transmit Probe Data - SO2 Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.7	Transmit Probe Data - CO2 Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.8	Transmit Probe Data - CO2 Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.9	Transmit Probe Data - PM10 Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.10	Transmit Probe Data - PM10 Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.11	Transmit Probe Data - PM2.5 Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.12	Transmit Probe Data - PM2.5 Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.13	Transmit Probe Data - VOC Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.14	Transmit Probe Data - VOC Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.3	Broadcast Probe Management Information **(Probe)**	RSU:O	Yes / No / NA	
		3.5.5.3.1.1	Manage Probe - Sample Size	Probe:M	Yes / NA	
		3.5.5.3.1.2.1	Manage Probe - Termination Time	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.2.2	Manage Probe - Termination Distance	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.1	Manage Probe - Generation by Time	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.2	Manage Probe - Generation by Distance	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.2.1	Manage Probe - Heading Slice	Probe:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.5.3.2.2	Manage Probe - Interval Between Transmissions	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.1	Manage Probe - Stop Time Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.2	Manage Probe - Last Stop Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.3	Manage Probe - Start Speed Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.1	Manage Probe - Support Reading	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.2	Manage Probe - Support Greater Than Event	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.3	Manage Probe - Support Less Than Event	Probe:O	Yes / No / NA	
		3.6.1.5.1.1	Initial Snapshot	OBU:M	Yes / NA	A connected device shall not generate a snapshot until it has traveled ____ (default and minimum: 500 meters) since its ignition was turned on
		3.6.1.5.1.2.1	Periodic Snapshot - Default	OBU:M	Yes / NA	A connected device shall generate periodic intervals no less than ____ (default: 4 seconds) when traveling at or less than ____ (default: 8.9 meters per second); and no more than ____ (default: 20 seconds) when traveling at or more than ____ (default: 26.8 meters per second)

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.5.1.2.2	Periodic Snapshot - Stops	OBU:M	Yes / NA	Stop time threshold is ____ (default: 5.0 seconds), last stop threshold is ____ (default: 15.0 seconds), start speed threshold is ____ (default: 4.5 meters per second).
		3.6.1.5.1.3	Event Snapshot	OBU:M	Yes / NA	
		3.6.1.5.1.4.1	Snapshot - Vehicle Stop	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default stop time threshold and last stop threshold.
		3.6.1.5.1.4.2	Snapshot - Vehicle Start	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default start speed threshold.
		3.6.1.5.2.1	Delete Snapshot - Transmission	OBU:M	Yes / NA	
		3.6.1.5.2.2	Delete Snapshot - Expiration	OBU:M	Yes / NA	Default expiration time is ___ (default: 360) seconds and default expiration distance is ___ (default: 4000) meters.
		3.6.1.5.2.3	Delete Snapshot - Vehicle Turned Off	OBU:M	Yes / NA	
		3.6.1.5.3.1	Change PSN	OBU:M	Yes / NA	Default PSN time is ___ (default: 120) seconds and default PSN distance is ___ (default: 1000) meters.
		3.6.1.5.3.2	PSN - Gap	OBU:M	Yes / NA	
		G.2.6.1	Maximum Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.6.2	Default Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	The default message transmission rate for an RSU to advertise service for the collection of probe data is once per ___ (default: 1000) ms.
		G.2.7.1	Maximum Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	
		G.2.7.2	Default Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	The default message transmission rate for an RSU to broadcast a message to change the data collection policy of a connected vehicle is once per ___ (default: 1000) ms.
2.5.3.5.2	Vehicle Data for Highway Maintenance and Design			O	Yes / No	
		3.5.5.1	Probe Data Request	RSU:M	Yes / NA	
		3.5.5.2	Transmit Probe Data Message	OBU:M	Yes / NA	
		3.5.5.2.1.1	Transmit Probe Data - Probe Segment Number	OBU:M	Yes / NA	
		3.5.5.2.1.2	Transmit Probe Data - Position	OBU:M	Yes / NA	
		3.5.5.2.1.3	Transmit Probe Data - Snapshots	OBU:M	Yes / NA	A connected device shall have a buffer size to store at least ___ (minimum / default: 30) snapshots.
		3.5.5.2.2.1	Transmit Probe Data - Vehicle Type	OBU:O	Yes / No / NA	
		3.5.5.2.2.2	Transmit Probe Data - Identifier	OBU:O	Yes / No / NA	
		3.5.5.3	Broadcast Probe Management Information **(Probe)**	RSU:O	Yes / No / NA	
		3.5.5.3.1.1	Manage Probe - Sample Size	Probe:M	Yes / NA	
		3.5.5.3.1.2.1	Manage Probe - Termination Time	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.2.2	Manage Probe - Termination Distance	Probe:O.4 (1..*)	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.5.3.1.3.1	Manage Probe - Generation by Time	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.2	Manage Probe - Generation by Distance	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.2.1	Manage Probe - Heading Slice	Probe:O	Yes / No / NA	
		3.5.5.3.2.2	Manage Probe - Interval Between Transmissions	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.1	Manage Probe - Stop Time Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.2	Manage Probe - Last Stop Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.3	Manage Probe - Start Speed Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.1	Manage Probe - Support Reading	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.2	Manage Probe - Support Greater Than Event	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.3	Manage Probe - Support Less Than Event	Probe:O	Yes / No / NA	
		3.6.1.5.1.1	Initial Snapshot	OBU:M	Yes / NA	A connected device shall not generate a snapshot until it has traveled ____ (default and minimum: 500 meters) since its ignition was turned on
		3.6.1.5.1.2.1	Periodic Snapshot - Default	OBU:M	Yes / NA	A connected device shall generate periodic intervals no less than ____ (default: 4 seconds) when traveling at or less than ____ (default: 8.9 meters per second); and no more than ____ (default: 20 seconds) when traveling at or more than ____ (default: 26.8 meters per second)

This SAE Information Report is a compilation of engineering reference data and educational material from various sources deemed useful to the technical community. Normative language contained herein should not be considered as an SAE Recommended Practice or SAE Standard.

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.5.1.2.2	Periodic Snapshot - Stops	OBU:M	Yes / NA	Stop time threshold is ____ (default: 5.0 seconds), last stop threshold is ____ (default: 15.0 seconds), start speed threshold is ____ (default: 4.5 meters per second).
		3.6.1.5.1.3	Event Snapshot	OBU:M	Yes / NA	
		3.6.1.5.1.4.1	Snapshot - Vehicle Stop	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default stop time threshold and last stop threshold.
		3.6.1.5.1.4.2	Snapshot - Vehicle Start	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default start speed threshold.
		3.6.1.5.2.1	Delete Snapshot - Transmission	OBU:M	Yes / NA	
		3.6.1.5.2.2	Delete Snapshot - Expiration	OBU:M	Yes / NA	Default expiration time is ___ (default: 360) seconds and default expiration distance is ___ (default: 4000) meters.
		3.6.1.5.2.3	Delete Snapshot - Vehicle Turned Off	OBU:M	Yes / NA	
		3.6.1.5.3.1	Change PSN	OBU:M	Yes / NA	Default PSN time is ___ (default: 120) seconds and default PSN distance is ___ (default: 1000) meters.
		3.6.1.5.3.2	PSN - Gap	OBU:M	Yes / NA	
		G.2.6.1	Maximum Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.6.2	Default Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	The default message transmission rate for an RSU to advertise service for the collection of probe data is once per ___ (default: 1000) ms.
		G.2.7.1	Maximum Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	
		G.2.7.2	Default Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	The default message transmission rate for an RSU to broadcast a message to change the data collection policy of a connected vehicle is once per ___ (default: 1000) ms.
2.5.3.5.3	Vehicle Data for Environmental Monitoring			O	Yes / No	
		3.5.5.1	Probe Data Request	RSU:M	Yes / NA	
		3.5.5.2	Transmit Probe Data Message	OBU:M	Yes / NA	
		3.5.5.2.1.1	Transmit Probe Data - Probe Segment Number	OBU:M	Yes / NA	
		3.5.5.2.1.2	Transmit Probe Data - Position	OBU:M	Yes / NA	
		3.5.5.2.1.3	Transmit Probe Data - Snapshots	OBU:M	Yes / NA	
		3.5.5.2.2.1	Transmit Probe Data - Vehicle Type	OBU:O	Yes / No / NA	
		3.5.5.2.2.2	Transmit Probe Data - Identifier	OBU:O	Yes / No / NA	A connected device shall have a buffer size to store at least ___ (minimum / default: 30) snapshots.
		3.5.5.2.2.4.1	Transmit Probe Data - Fuel Type	OBU:O	Yes / No / NA	
		3.5.5.2.2.4.2	Transmit Probe Data - Fuel Economy	OBU:O	Yes / No / NA	
		3.5.5.2.2.4.3	Transmit Probe Data - Fuel Remaining	OBU:O	Yes / No / NA	
		3.5.5.2.2.4.4	Transmit Probe Data - Charge Remaining	OBU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.5.2.2.5.1	Transmit Probe Data - CO Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.2	Transmit Probe Data - CO Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.3	Transmit Probe Data - NOx Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.4	Transmit Probe Data - NOx Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.5	Transmit Probe Data - SO2 Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.6	Transmit Probe Data - SO2 Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.7	Transmit Probe Data - CO2 Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.8	Transmit Probe Data - CO2 Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.9	Transmit Probe Data - PM10 Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.10	Transmit Probe Data - PM10 Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.11	Transmit Probe Data - PM2.5 Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.12	Transmit Probe Data - PM2.5 Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.13	Transmit Probe Data - VOC Emissions (Running)	OBU:O	Yes / No / NA	
		3.5.5.2.2.5.14	Transmit Probe Data - VOC Emissions (Idling)	OBU:O	Yes / No / NA	
		3.5.5.3	Broadcast Probe Management Information **(Probe)**	RSU:O	Yes / No / NA	
		3.5.5.3.1.1	Manage Probe - Sample Size	Probe:M	Yes / NA	
		3.5.5.3.1.2.1	Manage Probe - Termination Time	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.2.2	Manage Probe - Termination Distance	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.1	Manage Probe - Generation by Time	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.2	Manage Probe - Generation by Distance	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.2.1	Manage Probe - Heading Slice	Probe:O	Yes / No / NA	
		3.5.5.3.2.2	Manage Probe - Interval Between Transmissions	Probe:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.5.3.2.3.1	Manage Probe - Stop Time Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.2	Manage Probe - Last Stop Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.3	Manage Probe - Start Speed Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.1	Manage Probe - Support Reading	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.2	Manage Probe - Support Greater Than Event	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.3	Manage Probe - Support Less Than Event	Probe:O	Yes / No / NA	
		3.6.1.5.1.1	Initial Snapshot	OBU:M	Yes / NA	A connected device shall not generate a snapshot until it has traveled ____ (default and minimum: 500 meters) since its ignition was turned on
		3.6.1.5.1.2.1	Periodic Snapshot - Default	OBU:M	Yes / NA	A connected device shall generate periodic intervals no less than ____ (default: 4 seconds) when traveling at or less than ____ (default: 8.9 meters per second); and no more than ____ (default: 20 seconds) when traveling at or more than ____ (default: 26.8 meters per second)
		3.6.1.5.1.2.2	Periodic Snapshot - Stops	OBU:M	Yes / NA	Stop time threshold is ____ (default: 5.0 seconds), last stop threshold is ____ (default: 15.0 seconds), start speed threshold is ____ (default: 4.5 meters per second).

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.5.1.3	Event Snapshot	OBU:M	Yes / NA	
		3.6.1.5.1.4.1	Snapshot - Vehicle Stop	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default stop time threshold and last stop threshold.
		3.6.1.5.1.4.2	Snapshot - Vehicle Start	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default start speed threshold.
		3.6.1.5.2.1	Delete Snapshot - Transmission	OBU:M	Yes / NA	
		3.6.1.5.2.2	Delete Snapshot - Expiration	OBU:M	Yes / NA	Default expiration time is ___ (default: 360) seconds and default expiration distance is ___ (default: 4000) meters.
		3.6.1.5.2.3	Delete Snapshot - Vehicle Turned Off	OBU:M	Yes / NA	
		3.6.1.5.3.1	Change PSN	OBU:M	Yes / NA	Default PSN time is ___ (default: 120) seconds and default PSN distance is ___ (default: 1000) meters.
		3.6.1.5.3.2	PSN - Gap	OBU:M	Yes / NA	
		G.2.6.1	Maximum Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	
		G.2.6.2	Default Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	The default message transmission rate for an RSU to advertise service for the collection of probe data is once per ___ (default: 1000) ms.
		G.2.7.1	Maximum Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.7.2	Default Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	The default message transmission rate for an RSU to broadcast a message to change the data collection policy of a connected vehicle is once per ___ (default: 1000) ms.
2.5.3.5.4	Vehicle Data to Determine Hazardous Road Conditions			O	Yes / No	
		3.5.5.1	Probe Data Request	RSU:M	Yes / NA	
		3.5.5.2	Transmit Probe Data Message	OBU:M	Yes / NA	
		3.5.5.2.1.1	Transmit Probe Data - Probe Segment Number	OBU:M	Yes / NA	
		3.5.5.2.1.2	Transmit Probe Data - Position	OBU:M	Yes / NA	
		3.5.5.2.1.3	Transmit Probe Data - Snapshots	OBU:M	Yes / NA	A connected device shall have a buffer size to store at least ___ (minimum / default: 30) snapshots.
		3.5.5.2.2.1	Transmit Probe Data - Vehicle Type	OBU:O	Yes / No / NA	
		3.5.5.2.2.2	Transmit Probe Data - Identifier	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.1	Transmit Probe Data - Wind Direction	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.2	Transmit Probe Data - Wind Speed	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.3	Transmit Probe Data - Dewpoint Temperature	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.4	Transmit Probe Data - Total Radiation	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.5	Transmit Probe Data - Visibility	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.6	Transmit Probe Data - Surface Temperature	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.7	Transmit Probe Data - Roadway Water/Ice Depth	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.8	Transmit Probe Data - Roadway Snow Depth	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.9	Transmit Probe Data - Adjacent Snow Depth	OBU:O	Yes / No / NA	
		3.5.5.3	Broadcast Probe Management Information **(Probe)**	RSU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.5.3.1.1	Manage Probe - Sample Size	Probe:M	Yes / NA	
		3.5.5.3.1.2.1	Manage Probe - Termination Time	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.2.2	Manage Probe - Termination Distance	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.1	Manage Probe - Generation by Time	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.2	Manage Probe - Generation by Distance	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.2.1	Manage Probe - Heading Slice	Probe:O	Yes / No / NA	
		3.5.5.3.2.2	Manage Probe - Interval Between Transmissions	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.1	Manage Probe - Stop Time Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.2	Manage Probe - Last Stop Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.3	Manage Probe - Start Speed Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.1	Manage Probe - Support Reading	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.2	Manage Probe - Support Greater Than Event	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.3	Manage Probe - Support Less Than Event	Probe:O	Yes / No / NA	
		3.6.1.5.1.1	Initial Snapshot	OBU:M	Yes / NA	A connected device shall not generate a snapshot until it has traveled ____ (default and minimum: 500 meters) since its ignition was turned on
		3.6.1.5.1.2.1	Periodic Snapshot - Default	OBU:M	Yes / NA	A connected device shall generate periodic intervals no less than ____ (default: 4 seconds) when traveling at or less than ____ (default: 8.9 meters per second); and no more than ____ (default: 20 seconds) when traveling at or more than ____ (default: 26.8 meters per second)

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.5.1.2.2	Periodic Snapshot - Stops	OBU:M	Yes / NA	Stop time threshold is ____ (default: 5.0 seconds), last stop threshold is ____ (default: 15.0 seconds), start speed threshold is ____ (default: 4.5 meters per second).
		3.6.1.5.1.3	Event Snapshot	OBU:M	Yes / NA	
		3.6.1.5.1.4.1	Snapshot - Vehicle Stop	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default stop time threshold and last stop threshold.
		3.6.1.5.1.4.2	Snapshot - Vehicle Start	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default start speed threshold.
		3.6.1.5.2.1	Delete Snapshot - Transmission	OBU:M	Yes / NA	
		3.6.1.5.2.2	Delete Snapshot - Expiration	OBU:M	Yes / NA	Default expiration time is ___ (default: 360) seconds and default expiration distance is ___ (default: 4000) meters.
		3.6.1.5.2.3	Delete Snapshot - Vehicle Turned Off	OBU:M	Yes / NA	
		3.6.1.5.3.1	Change PSN	OBU:M	Yes / NA	Default PSN time is ___ (default: 120) seconds and default PSN distance is ___ (default: 1000) meters.
		3.6.1.5.3.2	PSN - Gap	OBU:M	Yes / NA	
		G.2.6.1	Maximum Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.6.2	Default Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	The default message transmission rate for an RSU to advertise service for the collection of probe data is once per ___ (default: 1000) ms.
		G.2.7.1	Maximum Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	
		G.2.7.2	Default Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	The default message transmission rate for an RSU to broadcast a message to change the data collection policy of a connected vehicle is once per ___ (default: 1000) ms.
2.5.3.5.5	Vehicle Data for Weather Forecasting			O	Yes / No	
		3.5.5.1	Probe Data Request	RSU:M	Yes / NA	
		3.5.5.2	Transmit Probe Data Message	OBU:M	Yes / NA	
		3.5.5.2.1.1	Transmit Probe Data - Probe Segment Number	OBU:M	Yes / NA	
		3.5.5.2.1.2	Transmit Probe Data - Position	OBU:M	Yes / NA	
		3.5.5.2.1.3	Transmit Probe Data - Snapshots	OBU:M	Yes / NA	A connected device shall have a buffer size to store at least ___ (minimum / default: 30) snapshots.
		3.5.5.2.2.1	Transmit Probe Data - Vehicle Type	OBU:O	Yes / No / NA	
		3.5.5.2.2.2	Transmit Probe Data - Identifier	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.1	Transmit Probe Data - Wind Direction	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.2	Transmit Probe Data - Wind Speed	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.3	Transmit Probe Data - Dewpoint Temperature	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.4	Transmit Probe Data - Total Radiation	OBU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.5.2.2.3.5	Transmit Probe Data - Visibility	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.6	Transmit Probe Data - Surface Temperature	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.7	Transmit Probe Data - Roadway Water/Ice Depth	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.8	Transmit Probe Data - Roadway Snow Depth	OBU:O	Yes / No / NA	
		3.5.5.2.2.3.9	Transmit Probe Data - Adjacent Snow Depth	OBU:O	Yes / No / NA	
		3.5.5.3	Broadcast Probe Management Information **(Probe)**	RSU:O	Yes / No / NA	
		3.5.5.3.1.1	Manage Probe - Sample Size	Probe:M	Yes / NA	
		3.5.5.3.1.2.1	Manage Probe - Termination Time	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.2.2	Manage Probe - Termination Distance	Probe:O.4 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.1	Manage Probe - Generation by Time	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.1.3.2	Manage Probe - Generation by Distance	Probe:O.5 (1..*)	Yes / No / NA	
		3.5.5.3.2.1	Manage Probe - Heading Slice	Probe:O	Yes / No / NA	
		3.5.5.3.2.2	Manage Probe - Interval Between Transmissions	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.1	Manage Probe - Stop Time Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.2	Manage Probe - Last Stop Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.3.3	Manage Probe - Start Speed Threshold	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.1	Manage Probe - Support Reading	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.2	Manage Probe - Support Greater Than Event	Probe:O	Yes / No / NA	
		3.5.5.3.2.4.3	Manage Probe - Support Less Than Event	Probe:O	Yes / No / NA	
		3.6.1.5.1.1	Initial Snapshot	OBU:M	Yes / NA	A connected device shall not generate a snapshot until it has traveled ____ (default and minimum: 500 meters) since its ignition was turned on

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.5.1.2.1	Periodic Snapshot - Default	OBU:M	Yes / NA	A connected device shall generate periodic intervals no less than ____ (default: 4 seconds) when traveling at or less than ____ (default: 8.9 meters per second); and no more than ____ (default: 20 seconds) when traveling at or more than ____ (default: 26.8 meters per second)
		3.6.1.5.1.2.2	Periodic Snapshot - Stops	OBU:M	Yes / NA	Stop time threshold is ____ (default: 5.0 seconds), last stop threshold is ____ (default: 15.0 seconds), start speed threshold is ____ (default: 4.5 meters per second).
		3.6.1.5.1.3	Event Snapshot	OBU:M	Yes / NA	
		3.6.1.5.1.4.1	Snapshot - Vehicle Stop	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default stop time threshold and last stop threshold.
		3.6.1.5.1.4.2	Snapshot - Vehicle Start	OBU:M	Yes / NA	See 3.6.1.5.1.2.2 for the default start speed threshold.
		3.6.1.5.2.1	Delete Snapshot - Transmission	OBU:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.6.1.5.2.2	Delete Snapshot - Expiration	OBU:M	Yes / NA	Default expiration time is ___ (default: 360) seconds and default expiration distance is ___ (default: 4000) meters.
		3.6.1.5.2.3	Delete Snapshot - Vehicle Turned Off	OBU:M	Yes / NA	
		3.6.1.5.3.1	Change PSN	OBU:M	Yes / NA	Default PSN time is ___ (default: 120) seconds and default PSN distance is ___ (default: 1000) meters.
		3.6.1.5.3.2	PSN - Gap	OBU:M	Yes / NA	
		G.2.6.1	Maximum Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	
		G.2.6.2	Default Transmission Rate - Broadcast Probe Data Service	RSU:M	Yes / NA	The default message transmission rate for an RSU to advertise service for the collection of probe data is once per ___ (default: 1000) ms.
		G.2.7.1	Maximum Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	
		G.2.7.2	Default Transmission Rate - Broadcast Probe Data Management	Probe:M	Yes / NA	The default message transmission rate for an RSU to broadcast a message to change the data collection policy of a connected vehicle is once per ___ (default: 1000) ms.
2.5.3.6.1	Speed Advisories			RSU:O	Yes / No / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.8.1	Broadcast Traveler Information	M	Yes	
		3.5.8.2.1	Broadcast Traveler Information - Packet Identifier	M	Yes	
		3.5.8.2.2.1	Broadcast Traveler Advisories - Message Identifier	M	Yes	
		3.5.8.3.2	Broadcast Traveler Information - Start Time **(ValidTime)**	O	Yes / No	
		3.5.8.3.3	Broadcast Traveler Information - Start Year	ValidTime:O	Yes / No / NA	
		3.5.8.3.4	Broadcast Traveler Information - Validity Duration	ValidTime:M	Yes / NA	
		3.5.8.3.5	Broadcast Traveler Information - Importance	O	Yes / No	
		3.5.8.3.6	Broadcast Traveler Information - Presentation Requirements **(Presentation)**	O	Yes / No	
		3.5.8.3.6.1	Broadcast Traveler Information - Default Anchor Point Position	Presentation:M	Yes / NA	
		3.5.8.3.6.2	Broadcast Traveler Information - Heading Slice	Presentation:O	Yes / No / NA	
		3.5.8.3.6.3.1	Broadcast Traveler Information - Circular Region - Radius **(Circular)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.3.2	Broadcast Traveler Information - Circular Region - Anchor Point	Circular:O	Yes / No / NA	
		3.5.8.3.6.4.1	Broadcast Traveler Information - Polygon Region - Offsets **(Polygon)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.4.2	Broadcast Traveler Information - Polygon Region - Anchor Point	Polygon:O	Yes / No / NA	
		3.5.8.3.6.5.1	Broadcast Traveler Information - Shape Point Set - Default Direction **(Shape)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.5.2	Broadcast Traveler Information - Shape Point Set - Default Width	Shape:M	Yes / NA	
		3.5.8.3.6.5.3	Broadcast Traveler Information - Shape Point Set - Offsets	Shape:M	Yes / NA	
		3.5.8.3.6.5.4	Broadcast Traveler Information - Shape Point Set - Direction	Shape:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.8.3.6.5.5	Broadcast Traveler Information - Shape Point Set - Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.6	Broadcast Traveler Information - Shape Point Set - Node Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.7	Broadcast Traveler Information - Shape Point Set - Anchor Point	Shape:O	Yes / No / NA	
		3.5.8.3.7	Broadcast Traveler Advisories - Content	M	Yes	
		3.5.8.3.9	Broadcast Traveler Information - Uniform Resource Locator	O	Yes / No	
		3.5.8.3.10	Broadcast Traveler Information - Valid Vehicle Type	O	Yes / No	
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
		G.2.11.1	Maximum Transmission Rate - Broadcast Traveler Information	M	Yes	
		G.2.11.2	Default Transmission Rate - Broadcast Traveler Information	M	Yes	The default message transmission rate to broadcast traveler information messages is once per ___ (default: 1000) ms.
2.5.3.6.2	Location Based Traveler Information and Advisories			RSU:O	Yes / No / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.8.1	Broadcast Traveler Information	M	Yes	
		3.5.8.2.1	Broadcast Traveler Information - Packet Identifier	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.8.2.2.1	Broadcast Traveler Advisories - Message Identifier **(Advisory)**	O.3 (1..*)	Yes / No	
		3.5.8.2.2.2	Broadcast Road Sign - Message Identifier **(Roadsign)**	O.3 (1..*)	Yes / No	
		3.5.8.3.1	Broadcast Road Sign - MUTCD Type	Roadsign:O	Yes / No / NA	
		3.5.8.3.2	Broadcast Traveler Information - Start Time **(ValidTime)**	O	Yes / No	
		3.5.8.3.3	Broadcast Traveler Information - Start Year	ValidTime:O	Yes / No / NA	
		3.5.8.3.4	Broadcast Traveler Information - Validity Duration	ValidTime:M	Yes / NA	
		3.5.8.3.5	Broadcast Traveler Information - Importance	O	Yes / No	
		3.5.8.3.6	Broadcast Traveler Information - Presentation Requirements **(Presentation)**	O	Yes / No	
		3.5.8.3.6.1	Broadcast Traveler Information - Default Anchor Point Position	Presentation:M	Yes / NA	
		3.5.8.3.6.2	Broadcast Traveler Information - Heading Slice	Presentation:O	Yes / No / NA	
		3.5.8.3.6.3.1	Broadcast Traveler Information - Circular Region - Radius **(Circular)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.3.2	Broadcast Traveler Information - Circular Region - Anchor Point	Circular:O	Yes / No / NA	
		3.5.8.3.6.4.1	Broadcast Traveler Information - Polygon Region - Offsets **(Polygon)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.4.2	Broadcast Traveler Information - Polygon Region - Anchor Point	Polygon:O	Yes / No / NA	
		3.5.8.3.6.5.1	Broadcast Traveler Information - Shape Point Set - Default Direction **(Shape)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.5.2	Broadcast Traveler Information - Shape Point Set - Default Width	Shape:M	Yes / NA	
		3.5.8.3.6.5.3	Broadcast Traveler Information - Shape Point Set - Offsets	Shape:M	Yes / NA	
		3.5.8.3.6.5.4	Broadcast Traveler Information - Shape Point Set - Direction	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.5	Broadcast Traveler Information - Shape Point Set - Width	Shape:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.8.3.6.5.6	Broadcast Traveler Information - Shape Point Set - Node Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.7	Broadcast Traveler Information - Shape Point Set - Anchor Point	Shape:O	Yes / No / NA	
		3.5.8.3.7	Broadcast Traveler Advisories - Content	Advisory:M	Yes / NA	
		3.5.8.3.8	Broadcast Road Sign - Content	Roadsign:M	Yes / NA	
		3.5.8.3.9	Broadcast Traveler Information - Uniform Resource Locator	O	Yes / No	
		3.5.8.3.10	Broadcast Traveler Information - Valid Vehicle Type	O	Yes / No	
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
		G.2.11.1	Maximum Transmission Rate - Broadcast Traveler Information	M	Yes	
		G.2.11.2	Default Transmission Rate - Broadcast Traveler Information	M	Yes	The default message transmission rate to broadcast traveler information messages is once per ___ (default: 1000) ms.
2.5.3.6.3	Vehicle Restrictions			RSU:O	Yes / No / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.8.1	Broadcast Traveler Information	M	Yes	
		3.5.8.2.1	Broadcast Traveler Information - Packet Identifier	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.8.2.2.1	Broadcast Traveler Advisories - Message Identifier **(Advisory)**	O.3 (1..*)	Yes / No	
		3.5.8.2.2.2	Broadcast Road Sign - Message Identifier **(Roadsign)**	O.3 (1..*)	Yes / No	
		3.5.8.3.1	Broadcast Road Sign - MUTCD Type	Roadsign:O	Yes / No / NA	
		3.5.8.3.2	Broadcast Traveler Information - Start Time **(ValidTime)**	O	Yes / No	
		3.5.8.3.3	Broadcast Traveler Information - Start Year	ValidTime:O	Yes / No / NA	
		3.5.8.3.4	Broadcast Traveler Information - Validity Duration	ValidTime:M	Yes / NA	
		3.5.8.3.5	Broadcast Traveler Information - Importance	O	Yes / No	
		3.5.8.3.6	Broadcast Traveler Information - Presentation Requirements **(Presentation)**	O	Yes / No	
		3.5.8.3.6.1	Broadcast Traveler Information - Default Anchor Point Position	Presentation:M	Yes / NA	
		3.5.8.3.6.2	Broadcast Traveler Information - Heading Slice	Presentation:O	Yes / No / NA	
		3.5.8.3.6.3.1	Broadcast Traveler Information - Circular Region - Radius **(Circular)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.3.2	Broadcast Traveler Information - Circular Region - Anchor Point	Circular:O	Yes / No / NA	
		3.5.8.3.6.4.1	Broadcast Traveler Information - Polygon Region - Offsets **(Polygon)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.4.2	Broadcast Traveler Information - Polygon Region - Anchor Point	Polygon:O	Yes / No / NA	
		3.5.8.3.6.5.1	Broadcast Traveler Information - Shape Point Set - Default Direction **(Shape)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.5.2	Broadcast Traveler Information - Shape Point Set - Default Width	Shape:M	Yes / NA	
		3.5.8.3.6.5.3	Broadcast Traveler Information - Shape Point Set - Offsets	Shape:M	Yes / NA	
		3.5.8.3.6.5.4	Broadcast Traveler Information - Shape Point Set - Direction	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.5	Broadcast Traveler Information - Shape Point Set - Width	Shape:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.8.3.6.5.6	Broadcast Traveler Information - Shape Point Set - Node Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.7	Broadcast Traveler Information - Shape Point Set - Anchor Point	Shape:O	Yes / No / NA	
		3.5.8.3.7	Broadcast Traveler Advisories - Content	Advisory:M	Yes / NA	
		3.5.8.3.8	Broadcast Road Sign - Content	Roadsign:M	Yes / NA	
		3.5.8.3.9	Broadcast Traveler Information - Uniform Resource Locator	O	Yes / No	
		3.5.8.3.10	Broadcast Traveler Information - Valid Vehicle Type	O	Yes / No	
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
		G.2.11.1	Maximum Transmission Rate - Broadcast Traveler Information	M	Yes	
		G.2.11.2	Default Transmission Rate - Broadcast Traveler Information	M	Yes	The default message transmission rate to broadcast traveler information messages is once per ___ (default: 1000) ms.
2.5.3.6.5	Curve Speed Warning			RSU:O	Yes / No / NA	
		3.5.6.1	Broadcast Roadway Geometrics	M	Yes	
		3.5.6.1.1	Broadcast Roadway Geometrics - Message Identifier	M	Yes	
		3.5.6.3.1.1	Broadcast Roadway Segment - Identifier	M	Yes	
		3.5.6.3.1.2	Broadcast Roadway Segment - Reference Point	M	Yes	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.6.3.1.3	Broadcast Roadway Segment - Lane Default Width	M	Yes	
		3.5.6.3.1.4.1	Broadcast Roadway Segment - Lane Number	M	Yes	
		3.5.6.3.1.4.2.1	Broadcast Roadway Segment - Lane Centerline Coordinates	M	Yes	
		3.5.6.3.1.4.2.2	Broadcast Roadway Segment - Computed Lane	O	Yes / No	
		3.5.6.3.1.4.3	Broadcast Roadway Segment - Lane Attributes	M	Yes	
		3.5.6.3.2.1	Broadcast Roadway Segment - Version Identifier	O	Yes / No	
		3.5.6.3.2.2	Broadcast Roadway Segment - Lane Width	O	Yes / No	
		3.5.6.3.2.3	Broadcast Roadway Segment - Node Lane Width	O	Yes / No	
		3.5.6.3.2.4	Broadcast Roadway Segment - Superelevation	O	Yes / No	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	O	Yes / No	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	O	Yes / No	
		3.5.8.1	Broadcast Traveler Information	M	Yes	
		3.5.8.2.1	Broadcast Traveler Information - Packet Identifier	M	Yes	
		3.5.8.2.2.1	Broadcast Traveler Advisories - Message Identifier **(Advisory)**	O.3 (1..*)	Yes / No	
		3.5.8.2.2.2	Broadcast Road Sign - Message Identifier **(Roadsign)**	O.3 (1..*)	Yes / No	
		3.5.8.3.1	Broadcast Road Sign - MUTCD Type	Roadsign:O	Yes / No / NA	
		3.5.8.3.2	Broadcast Traveler Information - Start Time **(ValidTime)**	O	Yes / No	
		3.5.8.3.3	Broadcast Traveler Information - Start Year	ValidTime:O	Yes / No / NA	
		3.5.8.3.4	Broadcast Traveler Information - Validity Duration	ValidTime:M	Yes / NA	
		3.5.8.3.5	Broadcast Traveler Information - Importance	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.8.3.6	Broadcast Traveler Information - Presentation Requirements **(Presentation)**	O	Yes / No	
		3.5.8.3.6.1	Broadcast Traveler Information - Default Anchor Point Position	Presentation:M	Yes / NA	
		3.5.8.3.6.2	Broadcast Traveler Information - Heading Slice	Presentation:O	Yes / No / NA	
		3.5.8.3.6.3.1	Broadcast Traveler Information - Circular Region - Radius **(Circular)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.3.2	Broadcast Traveler Information - Circular Region - Anchor Point	Circular:O	Yes / No / NA	
		3.5.8.3.6.4.1	Broadcast Traveler Information - Polygon Region - Offsets **(Polygon)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.4.2	Broadcast Traveler Information - Polygon Region - Anchor Point	Polygon:O	Yes / No / NA	
		3.5.8.3.6.5.1	Broadcast Traveler Information - Shape Point Set - Default Direction **(Shape)**	Presentation:O.4(1..*)	Yes / No / NA	
		3.5.8.3.6.5.2	Broadcast Traveler Information - Shape Point Set - Default Width	Shape:M	Yes / NA	
		3.5.8.3.6.5.3	Broadcast Traveler Information - Shape Point Set - Offsets	Shape:M	Yes / NA	
		3.5.8.3.6.5.4	Broadcast Traveler Information - Shape Point Set - Direction	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.5	Broadcast Traveler Information - Shape Point Set - Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.6	Broadcast Traveler Information - Shape Point Set - Node Width	Shape:O	Yes / No / NA	
		3.5.8.3.6.5.7	Broadcast Traveler Information - Shape Point Set - Anchor Point	Shape:O	Yes / No / NA	
		3.5.8.3.7	Broadcast Traveler Advisories - Content	Advisory:M	Yes / NA	
		3.5.8.3.8	Broadcast Road Sign - Content	Roadsign:M	Yes / NA	
		3.5.8.3.9	Broadcast Traveler Information - Uniform Resource Locator	O	Yes / No	
		3.5.8.3.10	Broadcast Traveler Information - Valid Vehicle Type	O	Yes / No	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.8.1	Minimum Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	
		G.2.8.2	Maximum Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	
		G.2.8.3	Default Transmission Rate - Broadcast Roadway Geometrics Information	M	Yes	The default message transmission rate to broadcast roadway geometrics information is once per ___ (default: 1000) ms.
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
		G.2.11.1	Maximum Transmission Rate - Broadcast Traveler Information	M	Yes	
		G.2.11.2	Default Transmission Rate - Broadcast Traveler Information	M	Yes	The default message transmission rate to broadcast traveler information messages is once per ___ (default: 1000) ms.
2.5.3.7.1	Minimize Delay to Emergency Vehicles at Traffic Signals			O	Yes / No	
		3.5.2.2.1	Transmit Preempt Request	PSOBU:M	Yes / NA	
		3.5.2.2.2.1	Request Signal Preempt - Message Identifier	PSOBU:M	Yes / NA	
		3.5.2.2.2.2	Request Signal Preempt - Intersection Identifier	PSOBU:M	Yes / NA	
		3.5.2.2.2.3	Request Signal Preempt - Operational Strategy	PSOBU:M	Yes / NA	
		3.5.2.2.3.1	Request Signal Preempt - Approach Lane	PSOBU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.2.2.3.2	Request Signal Preempt - Egress Lane	PSOBU:O	Yes / No / NA	
		3.5.2.2.3.3	Request Signal Preempt - Validation	PSOBU:O	Yes / No / NA	
		3.5.2.2.3.4	Request Signal Preempt - Vehicle Class	PSOBU:O	Yes / No / NA	
		3.5.2.2.3.5	Request Signal Preempt - Time of Service	PSOBU:O	Yes / No / NA	
		3.5.2.2.3.6	Request Signal Preempt - End of Service	PSOBU:O	Yes / No / NA	
		3.5.2.2.3.7	Request Signal Preempt - Vehicle Identity	PSOBU:O	Yes / No / NA	
		3.5.2.2.3.8	Request Signal Preempt - Vehicle Location and Speed	PSOBU:O	Yes / No / NA	
		3.5.2.2.3.9	Request Signal Preempt - Vehicle Status	PSOBU:O	Yes / No / NA	
		3.5.2.2.3.10	Request Signal Preempt - Cancellation	PSOBU:O	Yes / No / NA	
		3.5.6.2.2.7.1	Broadcast Preempt or Priority Scheme **(PreferentialZone)**	RSU:O	Yes / No / NA	
		3.5.6.2.2.7.2	Broadcast Preempt or Priority Scheme - Valid Lane	PreferentialZone: O.7(1..*)	Yes / No / NA	
		3.5.6.2.2.7.3	Broadcast Preempt or Priority Scheme - Valid Zone	PreferentialZone: O.7(1..*)	Yes / No / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	RSU:O	Yes / No / NA	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	RSU:O	Yes / No / NA	
		3.5.7.2	Broadcast Signal Preferential Treatment Status	RSU:M	Yes / NA	
		3.5.7.2.1	Broadcast Preferential Treatment - Message Identifier	RSU:M	Yes / NA	
		3.5.7.2.2	Broadcast Preferential Treatment - Intersection Identifier	RSU:M	Yes / NA	
		3.5.7.2.2.1	Broadcast Preferential Treatment - Intersection Status	RSU:M	Yes / NA	
		3.5.7.2.2.2	Broadcast Preferential Treatment - Preempt State	RSU:M	Yes / NA	
		3.5.7.2.2.4	Broadcast Preferential Treatment - Vehicle Source	RSU:M	Yes / NA	
		3.6.1.3	Message Identifier	PSOBU:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.4.1	Maximum Transmission Rate - Request Signal Preferential Treatment	PSOBU:M	Yes / NA	
		G.2.4.2	Maximum Response Time - Request Signal Preferential Treatment	PSOBU:M	Yes / NA	The maximum response time for an RSU to respond to a signal preferential treatment request is ______ (default: 2000) ms.
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
2.5.3.8.1	Transit Signal Priority			O	Yes / No	
		3.5.4.1.1	Transmit Priority Request	TrVOBU:M	Yes / NA	
		3.5.4.1.2.1	Transmit Priority Request - Message Identifier	TrVOBU:M	Yes / NA	
		3.5.4.1.2.2	Transmit Priority Request - Intersection Identifier	TrVOBU:M	Yes / NA	
		3.5.4.1.2.3	Transmit Priority Request - Operational Strategy	TrVOBU:M	Yes / NA	
		3.5.4.1.3.1	Transmit Priority Request - Approach Lane	TrVOBU:O	Yes / No / NA	
		3.5.4.1.3.2	Transmit Priority Request - Egress Lane	TrVOBU:O	Yes / No / NA	
		3.5.4.1.3.3	Transmit Priority Request - Validation	TrVOBU:O	Yes / No / NA	
		3.5.4.1.3.4	Transmit Priority Request - Vehicle Class	TrVOBU:O	Yes / No / NA	
		3.5.4.1.3.5	Transmit Priority Request - Time of Service	TrVOBU:O	Yes / No / NA	
		3.5.4.1.3.6	Transmit Priority Request - End of Service	TrVOBU:O	Yes / No / NA	
		3.5.4.1.3.7	Transmit Priority Request - Vehicle Identity	TrVOBU:O	Yes / No / NA	
		3.5.4.1.3.8	Transmit Priority Request - Vehicle Location and Speed	TrVOBU:O	Yes / No / NA	
		3.5.4.1.3.9	Transmit Priority Request - Service Information	TrVOBU:O	Yes / No / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		3.5.4.1.3.10	Transmit Priority Request Cancellation	TrVOBU:O	Yes / No / NA	
		3.5.6.2.2.7.1	Broadcast Preempt or Priority Scheme **(PreferentialZone)**	RSU:O	Yes / No / NA	
		3.5.6.2.2.7.2	Broadcast Preempt or Priority Scheme - Valid Lane	PreferentialZone: O.7(1..*)	Yes / No / NA	
		3.5.6.2.2.7.3	Broadcast Preempt or Priority Scheme - Valid Zone	PreferentialZone: O.7(1..*)	Yes / No / NA	
		3.5.6.4.1	Broadcast Location Corrections Detail - NMEA **(Location)**	RSU:O	Yes / No / NA	
		3.5.6.4.2	Broadcast Location Corrections Detail - RTCM **(Location)**	RSU:O	Yes / No / NA	
		3.5.7.2	Broadcast Signal Preferential Treatment Status	RSU:M	Yes / NA	
		3.5.7.2.1	Broadcast Preferential Treatment - Message Identifier	RSU:M	Yes / NA	
		3.5.7.2.2	Broadcast Preferential Treatment - Intersection Identifier	RSU:M	Yes / NA	
		3.5.7.2.2.1	Broadcast Preferential Treatment - Intersection Status	RSU:M	Yes / NA	
		3.5.7.2.2.3	Broadcast Preferential Treatment - Priority State	RSU:M	Yes / NA	
		3.5.7.2.2.4	Broadcast Preferential Treatment - Vehicle Source	RSU:M	Yes / NA	
		3.6.1.3	Message Identifier	TrVOBU:M	Yes / NA	
		G.2.4.1	Maximum Transmission Rate - Request Signal Preferential Treatment	PSOBU:M	Yes / NA	
		G.2.4.2	Maximum Response Time - Request Signal Preferential Treatment	PSOBU:M	Yes / NA	The maximum response time for an RSU to respond to a signal preferential treatment request is ______ (default: 2000) ms.
		G.2.9.1	Minimum Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	

User Need ID	User Need	FR ID	Requirements	Conformance	Support	Additional Specifications
		G.2.9.2	Default Transmission Rate - Location Correction Details Broadcasts	Location:M	Yes / NA	The default message transmission rate to broadcast location correction details information is once per ___ (default: 1000) ms.
2.5.3.9.1	Ad Hoc Messages			O	Yes / No	
		3.5.10.1	Transfer Fleet Data to a Connected Vehicle	RSU:M	Yes / NA	
		3.5.10.2	Transfer Fleet Data from a Connected Vehicle	OBU:M	Yes / NA	
		G.2.13	Maximum Response Time - Ad Hoc Message	OBU:M	Yes / NA	The maximum response time for a connected vehicle to respond to an ad hoc message is _____ (default: 2000) ms.
2.6	Security			M	Yes	
		3.6.2.1	Authentication	M	Yes	
		3.6.2.2	Data Integrity	M	Yes	
		3.6.2.3	Uniqueness	M	Yes	

3.4 Architectural Requirements

Requirements for communication capabilities are provided in the following subsections.

3.4.1 OBU - Broadcast Information

An OBU shall wirelessly broadcast information to other connected devices (i.e., another OBU or an RSU).

3.4.2 RSU - Broadcast Information

An RSU shall wirelessly broadcast information to connected devices.

3.4.3 Connected Device Dialogs

A connected device shall be able to establish a private wireless connection with another specific connected device that mutually agrees.

3.4.4 Forwarded Requests

A connected device shall be able to forward information received from one connected device, to the first available connected device authorized to receive the information. This requirement allows one connected device (the messenger) to collect information, such as a mayday request, from a second connected device (the requestor), then forward that information to a third connected device (the recipient) who is expecting or needs that information.

3.5 Data Exchange and Operational Environment Requirements

The operation of a connected vehicle has been categorized into these major areas:

1. Vehicle Requirements (All vehicles regardless of type)
2. Public Safety Vehicle Requirements
3. Commercial Vehicle Requirements
4. Transit Vehicle Requirements
5. Probe Data Requirements
6. Broadcast Roadway Geometrics Requirements
7. Signalized Intersection Requirements
8. Traveler Information Requirements
9. Broadcast Mayday Requirements
10. Vehicle Manufacturers / Fleet Operator Requirements

In the Concept of Operations (Section 2), each of these major areas has been broken down into subsections. The Data Exchange Requirements also follow this structure.

The detailed requirements to share information in a connected environment are as follows.

3.5.1 Vehicle Requirements

Vehicle information is needed to support most of the applications associated with connected vehicles:

- Applications related to safety need the specific kinetic information from individual vehicles to prevent accidents
- Applications related to mobility need meta data of vehicle flow information to optimize the network operations and provide traveler information
- Applications related to traffic operations make use of data from the vehicle bus for monitoring road conditions and use the information from vehicle paths for traffic control systems
- Applications that are designed to decrease pollution and energy usage can use information from the vehicle to determine operational strategies to improve energy usage

3.5.1.1 Broadcast Vehicle Information - Critical Information

A connected vehicle needs to broadcast a message with safety critical information about itself to other connected devices. All safety applications need a minimum set of information from surrounding connected vehicles to prevent accidents. This set of information is called safety critical information and is data that have been deemed to be needed for safety applications, such as pre-crash applications (e.g., to prepare a vehicle for crashes, such as tightening seat belts or pre-arming air bags).

The following are the detailed requirements for a connected vehicle to broadcast its safety critical information to other connected devices.

3.5.1.1.1 Broadcast Vehicle Information - Critical Information - Compact Form

A connected vehicle shall broadcast safety critical information about itself in a compact manner to other connected devices. This requirement allows a connected vehicle to transmit the data concepts needed to fulfill all the mandatory requirements listed in Section 3.5.1.1.3 in a concise manner to conserve bandwidth. By concise, it is meant that all the necessary information be broadcasted using as little bandwidth as possible. It is expected that this message will be used in production, while the message in Section 3.5.1.1.2 will be used for system testing and development.

3.5.1.1.2 Broadcast Vehicle Information - Critical Information - Verbose

A connected vehicle shall broadcast a message with safety critical information about itself to other connected devices. This message contains the same information content as the message in Section 3.5.1.1.1, however this message is to use a different encoding scheme for system testing and development to allow developers to more easily view and interpret the elements that make up the message. This message may not be as efficient as the message in Section 3.5.1.1.1, i.e., larger bandwidth may be required.

3.5.1.1.3 Broadcast Vehicle Information - Mandatory Requirements

All safety applications need a minimum set of information from surrounding connected vehicles. The following are the minimum requirements for a connected vehicle to broadcast information about itself to other connected devices.

3.5.1.1.3.1 Broadcast Vehicle Information - Device Identifier

A connected vehicle shall include a code identifying itself as part of the safety critical information broadcasted to other connected devices. This code allows a receiving connected device to distinguish information broadcasted from different connected vehicles and to distinguish different transmissions from the same connected vehicle. This code may be a random number to ensure the overall anonymity of the connected vehicle - See Section 3.6.1.2.

3.5.1.1.3.2 Broadcast Vehicle Information - Message Identifier

A connected vehicle shall include a sequential message identifier as part of the safety critical information broadcasted to other connected devices. The message identifier is used to identify the relative sequential order of a stream of messages (of the same message type) from a connected vehicle. The message identifier increments by one whenever the contents of the message has changed.

Because of the repetitive un-acknowledged broadcast nature of the safety critical message, this requirement allows a receiving (host) connected device to detect a duplicate or a missing message from a broadcasting (remote) connected vehicle. If non-sequential message identifiers are received from a broadcasting connected vehicle, a message may have been lost. If the same message identifiers are received from a broadcasting connected vehicle, the receiving connected device may ignore (not process) duplicate messages because the content has not changed.

3.5.1.1.3.3 Broadcast Vehicle Information - Position Time

A connected vehicle shall include the time the vehicle's position was last determined as part of the safety critical information broadcasted to other connected devices. This time allows a receiving connected device to accurately position the location of the connected vehicle at a specific point in time. The time is measured in ms within a minute - that is, only the seconds and ms of the connected vehicle’s time is transmitted.

3.5.1.1.3.4 Broadcast Vehicle Information - Vehicle Position

A connected vehicle shall include its position (latitude, longitude, elevation) based on the WGS-84 coordinate system as part of the safety critical information broadcasted to other connected devices. The latitude and longitude are measured in units of 1/10th microdegrees. The latitude and longitude are to be at least within 1.5 meters of the actual value (latitude/longitude) at an HDOP smaller than 5 under open sky conditions within the 1 sigma absolute error. The elevation represents the elevation of the road surface on which the vehicle is driving on, above or below the WGS-84 reference ellipsoid, in units of 1 decimeter. The elevation is to be at least within 3 meters of the actual elevation at an HDOP smaller than 5 under open sky conditions within the 1 sigma absolute error.

3.5.1.1.3.5 Broadcast Vehicle Information - Positional Accuracy

A connected vehicle shall include the accuracy of its positional determination with respect to its longitudinal and lateral axis, as well as the accuracy of the orientation of the front of the vehicle as part of the safety critical information broadcasted to other connected devices. This accuracy is used to measure the quality of the device position with respect to each given axis and is expressed at one standard deviation. The accuracy is measured in 5 cm units along the semi-major and semi-minor axis while the accuracy of the orientation of the semi-major axis relative to true north is measured at units of 0.0054932479 degrees (equal to 360/65535 degrees). This source of the positional accuracy is the GPS receiver.

3.5.1.1.3.6 Broadcast Vehicle Information - Transmission State

A connected vehicle shall include the current state of the vehicle transmission as part of the safety critical information broadcasted to other connected devices. Valid state values for the vehicle transmission state are neutral, park, forwardGears, reverseGears, and unavailable.

3.5.1.1.3.7 Broadcast Vehicle Information - Vehicle Speed

A connected vehicle shall include its point speed, in units of 0.02 meters per second, as part of the safety critical information broadcasted to other connected devices.

3.5.1.1.3.8 Broadcast Vehicle Information - Vehicle

A connected vehicle shall include its direction of motion as part of the safety critical information broadcasted to other connected devices. Its direction of motion, also known as its heading, is measured from 0 degrees, which is North as defined by the WGS-84 coordinate system and its reference ellipsoid, to 359.9875 degrees in unsigned units of 0.0125 degree increments, with headings to the east as the positive direction (i.e., east is +90.0000 degrees).

NOTE: Heading is often determined by means of radio navigation signals (such GPS) and many of these systems experience a severe degradation in quality as the vehicle comes to rest. A vehicle at rest is often incapable of determining its heading until it begins to move again. Thus, the accuracy of the heading is to be less than 2 degrees when the vehicle speed is greater than 12.5 meters per second (m/s); and less that 3 degrees when the vehicle speed is between 0.56 m/s and 12.5 m/s. If the vehicle speed is below 0.56 m/s the heading is to be latched to the last known good heading value above 0.56 m/s. The heading is unlatched after the vehicle speed exceeds 0.83 m/s.

3.5.1.1.3.9 Broadcast Vehicle Information - Steering Wheel Angle

A connected vehicle shall include the angle of the vehicle's steering wheel, measured in 1.5 degree increments, as part of the safety critical information broadcasted to other connected devices. The angle is expressed in signed values with an angle to the right being positive. The accuracy is to be within 5 degrees of the actual heading. A value of 0 degrees represents that the vehicle's steering wheel is positioned so that the vehicle's driving (steering) wheels are pointed along the longitudinal axis (i.e., towards the front of the vehicle).

3.5.1.1.3.10 Broadcast Vehicle Information - Vehicle Acceleration

A connected vehicle shall include the acceleration values along the longitudinal and lateral axis of the vehicle, in units of 0.01 meters per second squared, as part of the safety critical information broadcasted to other connected devices. The accuracy of the acceleration values is to be within 0.1 m/s squared.

3.5.1.1.3.11 Broadcast Vehicle Information - Vehicle Vertical Acceleration

A connected vehicle shall include the acceleration values along the vertical axis of the vehicle, in units of two-tenths of a meter per second squared, as part of the safety critical information broadcasted to other connected devices. The accuracy of the vertical acceleration value is to be within 1 m/s squared.

3.5.1.1.3.12 Broadcast Vehicle Information - Yaw Rate

A connected vehicle shall include its yaw rate, in 0.01 degrees per second, as part of the safety critical information broadcasted to other connected devices. The yaw rate is the rate of change of the vehicle direction along its longitudinal axis. A positive value indicates the vehicle is turning to the right. The accuracy of the yaw rate is to be within 0.3 degrees per second.

3.5.1.1.3.13 Broadcast Vehicle Information - Vehicle Brake Status Requirements

The detailed requirements for a connected vehicle to broadcast the status of its braking system are listed below.

3.5.1.1.3.13.1 Broadcast Vehicle Information - Wheel Braking Activity

A connected vehicle shall include if any braking is currently active for each of the four wheels of the vehicle as part of the safety critical information broadcasted to other connected devices. If a vehicle has only one front wheel, the brake-active status shall be represented by the left front wheel and the right front wheel status is set to inactive. Similarly, if a vehicle has only one rear wheel, the brake-active status shall be represented by the left rear wheel and the right rear wheel status is set to inactive. This braking activity could be used by a traffic management center to determine that an incident has occurred or congestion may be present.

3.5.1.1.3.13.2 Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status

A connected vehicle shall include the status of its anti-lock brake system (ABS) as part of the safety critical information broadcasted to other connected devices. An anti-lock braking system, if available, detects a situation that may indicate loss of control. A report of an engaged anti-lock braking system can be useful in identifying a hazardous situation. Valid status values are unavailable (the vehicle is not equipped with an anti-lock braking system or the status is unavailable), off (the anti-lock braking system is off), on (the anti-lock braking system is on but not engaged), and engaged (the anti-lock braking system is engaged).

3.5.1.1.3.13.3 Broadcast Vehicle Information - Vehicle Traction Control Status

A connected vehicle shall include the status of its traction control system as part of the safety critical information broadcasted to other connected devices. Valid status values are unavailable (the vehicle is not equipped with traction control or the status is unavailable), off (the traction control is off), on (the traction control is on but not engaged), and engaged (the traction control is engaged).

3.5.1.1.3.13.4 Broadcast Vehicle Information - Vehicle Stability Control Status

A connected vehicle shall include the status of its vehicle stability control system as part of the safety critical information broadcasted to other connected devices. Valid status values are unavailable (the vehicle is not equipped with vehicle stability control or is unavailable), off (the vehicle stability control is off), on (the vehicle stability control is on but not engaged), and engaged (the vehicle stability control is engaged).

3.5.1.1.3.13.5 Broadcast Vehicle Information - Braking Boost Status

A connected vehicle shall include the status of its brake boost assist function as part of the safety critical information broadcasted to other connected devices. Brake boost assist is available on some vehicles. It detects the potential of a situation requiring maximum braking and pre-charges the brake system even before the driver presses the brake pedal. If a vehicle's brake boost assist is engaged, it indicates emergency braking. Valid status values are unavailable (the vehicle is not equipped with brake boost or the brake boost status is unavailable), off (brake boost is not engaged), and on (the brake boost is engaged).

3.5.1.1.3.13.6 Broadcast Vehicle Information - Auxiliary Brake Status

A connected vehicle shall include the status of its auxiliary brake, which is often called a parking brake, as part of the safety critical information broadcasted to other connected devices. Valid status values are unavailable (the vehicle is not equipped with auxiliary brakes or the status is unavailable), off (the auxiliary brakes is not-engaged), and on (the auxiliary brakes is engaged). An auxiliary brake may be engaged if the vehicle's primary brakes have failed or overheated.

3.5.1.1.3.13.7 Broadcast Vehicle Information - Vehicle Width

A connected vehicle shall include its width as part of the safety critical information broadcasted to other connected devices. The vehicle width, measured in 1 cm units, is the widest point of the vehicle with all factory installed equipment. The accuracy of the vehicle width shall be less than 20 cm.

3.5.1.1.3.14 Broadcast Vehicle Information - Vehicle Length

A connected vehicle shall include its length as part of the safety critical information broadcasted to other connected devices. The vehicle length, measured in 1 cm units, is the distance measured from the edge of the front bumper to the edge of the rear bumper. The accuracy of the vehicle length shall be less than 20 centimeters. If there are trailers hitched to the vehicle, the vehicle length is the distance from the edge of the front bumper of the vehicle to the edge of the rear bumper of the last trailer.

3.5.1.1.4 Broadcast Vehicle Information - Optional Requirements

The following are the optional requirements for a connected vehicle to broadcast information about itself to other connected devices. However, if the requirement is selected to be supported according to the PRL in Table 8 (Under the Support column), then that requirement is required to be implemented.

3.5.1.1.4.1 Broadcast Vehicle Information - Vehicle Type

A connected vehicle shall include the vehicle type (classification) of the vehicle, as defined by the FHWA 13-Category Classification System, as part of the information broadcasted to other connected devices. This information is used by transportation agencies for planning and analysis purposes.

3.5.1.1.4.2 Broadcast Vehicle Information - Vehicle Dimensions Requirements

Since vehicles are of differing sizes the physical dimensions of the vehicle are needed to provide the boundaries of the vehicle in collision avoidance.

The detailed requirements for a connected vehicle to broadcast its physical dimensions are listed below.

3.5.1.1.4.2.1 Broadcast Vehicle Information - Front Bumper Height

A connected vehicle shall include the height of its front bumper, in 1 cm units, as part of the information broadcasted to other connected devices. In the case of vehicles with complex bumper shapes, the height at the center of the mass of the bumper (where the bumper can best absorb an impact) should be used.

3.5.1.1.4.2.2 Broadcast Vehicle Information - Rear Bumper Height

A connected vehicle shall include the height of its rear bumper, in 1 cm units, as part of the information broadcasted to other connected devices. In the case of vehicles with complex bumper shapes, the height at the center of the mass of the bumper (where the bumper can best absorb an impact) should be used.

3.5.1.1.4.2.3 Broadcast Vehicle Information - Height

A connected vehicle shall include the vehicle height, in 1 cm units, as part of the information broadcasted to other connected devices.

3.5.1.1.4.2.4 Broadcast Vehicle Information - Vehicle Weight

A connected vehicle shall include its weight, in 1 kilogram units, as part of the information broadcasted to other connected devices. The vehicle weight is defined as the current weight of the vehicle and its contents. Vehicle weight may be a factor for safety applications such as determining stopping distances.

3.5.1.1.4.3 Broadcast Vehicle Information - Vehicle Position and Movement Requirements

Vehicle position and its movement are used in many of connected vehicle applications, including vehicle to vehicle safety applications.

The detailed requirements for a connected vehicle to broadcast its current position and motion are listed below.

3.5.1.1.4.3.1 Broadcast Vehicle Information - GPS Status

A connected vehicle shall include the current status of the GPS system as part of the information broadcasted to other connected devices. This status is a measurement of the accuracy that may be assumed by the receiver of the message - as the device is properly receiving GPS signals from more (GPS) satellites, the accuracy of the GPS data, such as position and time, improves. A GPS system may have more than one of the following status values: unavailable or not equipped, is healthy, is unhealthy, is monitored, a dilution of precision greater than 5, in view of under 5 satellites, location corrections present, and network corrections present. The GPS system status value also includes if the base station type is a moving base station or a fixed base station. The GPS system may be integrated into the vehicle, or be an aftermarket device or other mobile device that can perform similar functions when in the vehicle.

3.5.1.1.4.3.2 Broadcast Vehicle Information - Applied Pressure on the Vehicle Brakes

A connected vehicle shall include the applied pressure on the vehicle's brake pedals as part of the information broadcasted to other connected devices. The applied pressure is measured as within a range of percentage of the maximum pressure that can occur when the brake boost is applied. Valid values are unavailable or not equipped, or one of 15 equal ranges of percent pressure with 1 being a range of 0 to 6.67% applied pressure, to 15 indicating 93.3% to 100% applied pressure.

3.5.1.1.4.3.3 Broadcast Vehicle Information - Wheel Vertical Acceleration

A connected vehicle shall include an indication if the vertical acceleration of a wheel has exceeded a preset threshold of a percentage change in vertical acceleration per second at that wheel as part of the information broadcasted to other connected devices. The indication is either the wheel has exceeded the threshold; or it has not. An indication may be sent for each of four wheels: left front wheel, right front wheel, left rear wheel, and right rear wheel. If a vehicle has only one front wheel, the indication shall be represented by the left front wheel. Similarly, if a vehicle has only one rear wheel, the indication shall be represented by the left rear wheel. This information can be used for the detection of potholes or similar road abnormalities.

3.5.1.1.4.3.4 Broadcast Vehicle Information - Steering Angle Rate of Change A connected vehicle shall include the rate of change of the angle of the steering wheel as part of the information broadcasted to other connected devices. The rate of change can be used to predict the future path trajectory of the connected vehicle. The rate of change is expressed in signed units of 3 degrees per second, with an angle to the right being positive.

3.5.1.1.4.3.5 Broadcast Vehicle Information - Driving Wheel Angle

A connected vehicle shall broadcast the angle of the vehicle's front (steering) wheel as part of the information broadcasted to other connected devices. The angle of the driving wheel can be used to predict the future path trajectory of the connected vehicle. Valid values are from -42.33 degrees to 42.33 degrees, in units of 0.3333 degrees, with an angle to the right being a positive value. A value of zero indicates both front wheels are pointed straight ahead or the data is unavailable.

3.5.1.1.4.4 Broadcast Vehicle Information - Environmental Sensor Values Requirements

To help identify potential hazardous driving conditions, the status of vehicle equipment and the sensor readings from vehicle environmental sensors are needed. The environmental sensor values from vehicles also can be used to provide higher geographic resolution data than is currently available from fixed weather stations.

The requirements for a connected vehicle to broadcast the status of its vehicle equipment and its environmental sensor readings are listed below.

3.5.1.1.4.4.1 Broadcast Vehicle Information - Vehicle Lights State Requirements

A connected vehicle's exterior lights can give an indication of the amount of ambient light in the environment, and provide information about the vehicle’s intended speed and direction of travel.

The requirements for a connected vehicle to broadcast the state of its exterior lights are listed below.

3.5.1.1.4.4.2 Broadcast Vehicle Information - Left Turn Signal State

A connected vehicle shall indicate if its left turn signal lights are on or off as part of the information broadcasted to other connected devices.

3.5.1.1.4.4.3 Broadcast Vehicle Information - Right Turn Signal State

A connected vehicle shall indicate if its right turn signal lights are on or off as part of the information broadcasted to other connected devices.

3.5.1.1.4.4.4 Broadcast Vehicle Information - Daytime Running Lights State

A connected vehicle shall indicate if its daytime running lights are on or off as part of the information broadcasted to other connected devices.

3.5.1.1.4.4.5 Broadcast Vehicle Information - Hazard Lights State

A connected vehicle shall indicate if its hazard lights are on or off as part of the information broadcasted to other connected devices.

3.5.1.1.4.4.6 Broadcast Vehicle Information - Fog Lamps State

A connected vehicle shall indicate if its fog lamps are on or off as part of the information broadcasted to other connected devices.

3.5.1.1.4.4.7 Broadcast Vehicle Information - Low Beam Headlights State

A connected vehicle shall indicate if its low beam headlights are on or off as part of the information broadcasted to other connected devices. Also known as dipped-beam or passing beam headlamps, headlights are generally located at the front of the vehicle to provide forward illumination.

3.5.1.1.4.4.8 Broadcast Vehicle Information - High Beam Headlights State

A connected vehicle shall indicate if its high beam headlights are on or off as part of the information broadcasted to other connected devices.

3.5.1.1.4.4.9 Broadcast Vehicle Information - Parking Lights State

A connected vehicle shall indicate if its parking lights are on or off as part of the information broadcasted to other connected devices. Also known as front position lamps or parking lamps, these lights are used to increase the visibility of the vehicle in a variety of situations.

3.5.1.1.4.4.10 Broadcast Vehicle Information - Automatic Light Controls State

A connected vehicle shall indicate if its automatic light controls are on or off as part of the information broadcasted to other connected devices. The automatic light controls switches a vehicle's headlights (headlamp) on or off depending on the ambient light conditions.

3.5.1.1.4.4.11 Broadcast Vehicle Information - Vehicle Front Wiper Status

A connected vehicle shall include the status of its front windshield wipers as part of the information broadcasted to other connected devices. Valid status values are if the front wiper status is unavailable, front wipers are off, the wipers are sweeping at an intermittent rate, sweeping at a low rate, sweeping at a high rate, the washing solution is in use, and if the vehicle is auto wiper equipped. The status of the wipers can give an indication of the amount of precipitation around the vehicle.

3.5.1.1.4.4.12 Broadcast Vehicle Information - Vehicle Front Wiper Sweeping Rate

A connected vehicle shall include the rate the front windshield wipers are sweeping as part of the information broadcasted to other connected devices. The rate is measured in sweeps per minute. A sweep is defined as a to and fro movement starting and ending in the parked position

3.5.1.1.4.4.13 Broadcast Vehicle Information - Vehicle Rear Wiper Status

A connected vehicle shall include the status of its rear windshield wipers as part of the information broadcasted to other connected devices. Valid status values are if the rear wiper status is unavailable, rear wipers are off, the rear wipers are sweeping at an intermittent rate, sweeping at a low rate, sweeping at a high rate, the washing solution is in use, and if the vehicle is auto wiper equipped.

3.5.1.1.4.4.14 Broadcast Vehicle Information - Coefficient of Friction

A connected vehicle shall include the measured coefficient of friction of the roadway beneath the vehicle as part of the information broadcasted to other connected devices. The coefficient of friction is measured in 1 percent units, as defined by the NTCIP 1204 data object, EssMobileFriction, in NTCIP 1204.

3.5.1.1.4.4.15 Broadcast Vehicle Information - Solar Radiation

A connected vehicle shall include the solar radiation as currently measured by the vehicle's sensors as part of the information broadcasted to other connected devices. The solar radiation is a measure of the amount of sunshine and radiant heat (ultraviolet, visible, and near-infrared radiation) experienced by the vehicle and is measured from -2048 to 2048 watts per square meter, in 1 watts per square meter units, as defined by the NTCIP 1204 data object, EssInstantaneousSolarRadiation. This measurement can be used to determine the ambient light and potential icing on the roadway.

3.5.1.1.4.4.16 Broadcast Vehicle Information - Ambient Air Temperature

A connected vehicle shall include the ambient air temperature measured by the vehicle's sensors as part of the information broadcasted to other connected devices. The range of valid values is from -40 degrees celsius to +150 degrees celsius, in units of 1 degrees celsius, inclusively.

3.5.1.1.4.4.17 Broadcast Vehicle Information - Ambient Air Pressure

A connected vehicle shall include the ambient air pressure measured by the vehicle's sensors as part of the information broadcasted to other connected devices. The range of valid values is from 580 hPa to 1090 hPa, in units of 2 hectopascals (hPa), inclusively. The ambient air pressure changes with the weather and with altitude. Since it affects the density of the air entering the engine and ultimately the air/fuel ratio, some computerized emissions control systems use a barometric pressure sensor so that the spark advance and EGR flow can be regulated to control emissions more precisely.

3.5.1.1.4.4.18 Broadcast Vehicle Information - Precipitation Type

A connected vehicle shall include the type of precipitation as measured by the vehicle's sensors as part of the information broadcasted to other connected devices. Valid types of precipitation are defined by the data object, essPrecipSituation, in NTCIP 1204.

3.5.1.1.4.4.19 Broadcast Vehicle Information - Precipitation Rate

A connected vehicle shall include the precipitation rate as measured by the vehicle's sensors as part of the information broadcasted to other connected devices. The precipitation is measured in one tenths of grams per square meter per second.

3.5.1.1.4.5 Broadcast Vehicle Information - Obstacle Information

A connected vehicle shall include information about an obstacle in the roadway detected by the vehicle as part of the information broadcasted to other connected devices. Obstacle information consists of the measured distance from the obstacle to the vehicle (in 1 meter units), the direction of the obstacle from the vehicle, and the date and time the obstacle was detected by the vehicle. The direction of the obstacle from the vehicle is measured in degrees relative to the direction of motion of the vehicle, in 0.0125 degrees units.

3.5.1.1.4.6 Broadcast Vehicle Information - Vehicle Status Change

A connected vehicle needs to indicate any known change in the status of the vehicle that may have safety implications to other connected devices. This status change flag is used to indicate to other connected devices that an event has occurred that may be unusual or have a safety impact and thus connected devices receiving the event flag may wish to process this connected vehicle's information differently (e.g., priority processing). The status change flags to be transmitted are listed below.

3.5.1.1.4.6.1 Broadcast Vehicle Information - Vehicle Hazard Lights

A connected vehicle shall indicate if its hazard lights are on as part of the vehicle status flag information broadcasted to other connected devices.

3.5.1.1.4.6.2 Broadcast Vehicle Information - Vehicle Stopline Violation

A connected vehicle shall indicate if it anticipates that it will have a stopline violation as part of the vehicle status flag information broadcast to other connected devices. A stopline violation occurs if a vehicle enters an intersection crossing without stopping at a stop sign, or if the vehicle enters an intersection and performs an unpermitted movement (e.g., enters the intersection despite a red indication for it). This requirement assumes that the connected vehicle has information on where the stopline is.

3.5.1.1.4.6.3 Broadcast Vehicle Information - Anti-Lock Brake System Activation

A connected vehicle shall indicate if its anti-lock brake system is engaged as part of the vehicle status flag information broadcasted to other connected devices.

3.5.1.1.4.6.4 Broadcast Vehicle Information - Traction Control System Activation

A connected vehicle shall indicate if its traction control system is engaged as part of the vehicle status flag information broadcasted to other connected devices.

3.5.1.1.4.6.5 Broadcast Vehicle Information - Stability Control System Activation

A connected vehicle shall indicate if its stability control system is engaged as part of the vehicle status flag information broadcasted to other connected devices.

3.5.1.1.4.6.6 Broadcast Vehicle Information - Hazardous Materials Present

A connected vehicle shall indicate if it is currently carrying hazardous materials and is placarded as such, as part of the vehicle status flag information broadcasted to other connected devices.

3.5.1.1.4.6.7 Broadcast Vehicle Information - Hard Braking Warning

A connected vehicle shall indicate if it is braking hard as part of the vehicle status flag information broadcasted to other connected devices. A vehicle is considered to be braking hard if it is decelerating at a rate of greater than 0.4g.

3.5.1.1.4.6.8 Broadcast Vehicle Information - Change in Vehicle Light State Requirements

A connected vehicle needs to indicate if the state of its exterior lights has changed recently, defined as within the last 5 seconds, as part of the vehicle status flag information broadcasted to other connected devices. The state of each vehicle's exterior light is either on or off. A change in the state of an exterior light may indicate to other connected devices a change in a vehicle's intended direction of travel or a forthcoming change in the ambient environment.

The exterior lights whose state changes are to be transmitted by a connected vehicle are listed below.

3.5.1.1.4.6.9 Broadcast Vehicle Information - Change in Left Turn Signal State

A connected vehicle shall indicate if the state of its left turn signal has changed recently, defined as within the last 5 seconds, as part of the vehicle status flag information broadcasted to other connected devices. The state of a vehicle's left turn signal is either on or off.

3.5.1.1.4.6.10 Broadcast Vehicle Information - Change in Right Turn Signal State

A connected vehicle shall indicate if the state of its right turn signal has changed recently, defined as within the last 5 seconds, as part of the vehicle status flag information broadcasted to other connected devices. The state of a vehicle's right turn signal is either on or off.

3.5.1.1.4.6.11 Broadcast Vehicle Information - Change in Fog Lamps State

A connected vehicle shall indicate if the state of its fog lamps has changed recently, defined as within the last 5 seconds, as part of the vehicle status flag information broadcasted to other connected devices. The state of a vehicle's fog lamps is either on or off.

3.5.1.1.4.6.12 Broadcast Vehicle Information - Change in Low Beam Headlights State

A connected vehicle shall indicate if the state of its low beam headlights has changed recently, defined as within the last 5 seconds, as part of the vehicle status flag information broadcasted to other connected devices. The state of a vehicle's low beam headlights is either on or off.

3.5.1.1.4.6.13 Broadcast Vehicle Information - Change in High Beam Headlights State

A connected vehicle shall indicate if the state of its high beam headlights has changed recently, defined as within the last 5 seconds, as part of the vehicle status flag information broadcasted to other connected devices. The state of a vehicle's high beam headlights is either on or off.

3.5.1.1.4.6.14 Broadcast Vehicle Information - Change in Parking Lights State

A connected vehicle shall indicate if the state of its parking lights has changed recently, defined as within the last 5 seconds, as part of the vehicle status flag information broadcasted to other connected devices. The state of a vehicle's parking lights is either on or off.

3.5.1.1.4.6.15 Broadcast Vehicle Information - Change in Wiper Status

A connected vehicle shall indicate if the status of its front or rear wipers has changed recently, defined as within the last 5 seconds, as part of the vehicle status flag information broadcasted to other connected devices. The valid status values for the front and rear wiper can be found in Sections 3.5.1.1.4.4.11 and 3.5.1.1.4.4.13.

3.5.1.1.4.6.16 Broadcast Vehicle Information - Flat Tire

A connected vehicle shall indicate if the vehicle determines at least one of its tires has run flat as part of the vehicle status flag information broadcasted to other connected devices.

3.5.1.1.4.6.17 Broadcast Vehicle Information - Vehicle Is Disabled

A connected vehicle shall indicate if the vehicle considers itself disabled, as part of the vehicle status flag information broadcasted to other connected devices. A vehicle will indicate it is disabled when a situation occurs where a vehicle may need assistance, such as a mechanical failure or it is out of fuel.

3.5.1.1.4.6.18 Broadcast Vehicle Information - Air Bag Deployment

A connected vehicle shall indicate if one or more of its air bags has deployed since the most recent time the vehicle has been turned (ignition) on as part of the vehicle status flag information broadcasted to other connected devices.

3.5.1.1.4.6.19 Broadcast Emergency Response Indication

A public safety connected vehicle shall broadcast to connected devices identifying itself as an authorized public safety vehicle traveling to or at the scene of a service call.

3.5.1.1.4.7 Broadcast Vehicle Information - Trailer Weight

Vehicles, in particular commercial vehicles, may also have trailers hitched to the vehicle. Information about the trailers is needed to satisfy numerous needs such as to determine stopping distances.

A connected vehicle shall provide the weight of each trailer hitched to the vehicle as part of the information broadcasted to other connected devices. The trailer weight is the total weight of the freight-carrying vehicle designed to be pulled, including the weight of its contents. The trailer weight is measured at a 2 kilogram (kg) resolution.

3.5.1.1.4.8 Broadcast Vehicle Information - Vehicle Path History Requirements

A connected vehicle shall provide its path history as part of the safety critical information broadcasted to other connected devices. Safety applications sometimes need to know the recent movements (path history) of the vehicle to predict its intended movement. The representation of a vehicle's path history consists of a recent geographic position (the reference data point) of the vehicle, followed by a series of data points, containing the vehicle's previous geographic positions and status.

The detailed requirements for a connected vehicle to broadcast its path history are listed below.

3.5.1.1.4.8.1 Broadcast Vehicle Path History - GPS Status

A connected vehicle shall include the status of the vehicle's GPS system at the initial data point for the vehicle's path history, as part of the path history information broadcasted to other connected devices. This status is a measurement of the accuracy that may be assumed by the receiving connected device - as the vehicle is properly receiving GPS signals from more (GPS) satellites, the accuracy of the GPS data, such as position and time, improves. The valid status values are: unavailable or not equipped, is healthy, is unhealthy, is monitored, a dilution of precision greater than 5, in view of under 5 satellites, location corrections present, and network corrections present. Note: The GPS system may be integrated into the vehicle, or be an aftermarket device or other mobile device that can perform similar functions when in the vehicle.

3.5.1.1.4.8.2 Broadcast Vehicle Path History - Initial Position

A connected vehicle shall include a geographic position (latitude, longitude, elevation) to serve as the reference point for the vehicle's path history, as part of the path history information broadcasted to other connected devices. The geographic position may be the vehicle's current geographic position or a previous geographic position. The latitude and longitude are based on the WGS-84 coordinate system in units of 1/10th micro degree. The elevation represents the position of the road surface above or below the WGS-84 reference ellipsoid at the geographic center of the vehicle in units of 1 decimeter.

3.5.1.1.4.8.3 Broadcast Vehicle Path History - Time Offset

For each data point of a vehicle's path history, a connected vehicle shall include the time offset from when the vehicle collected the data for that data point to the time when the vehicle recorded its reference point, as part of the path history information broadcasted to other connected devices. The time offset is measured in 10 millisecond increments.

3.5.1.1.4.8.4 Broadcast Vehicle Path History - Position Offset

For each data point of a vehicle's path history, a connected vehicle shall include the positional offset (latitude, longitude, elevation) from the vehicle's position at that data point to the vehicle's position at the reference point, as part of the path history information broadcasted to other connected devices. The offset is the perpendicular difference between the vehicle's position at the data point and the vehicle's position at the reference point along its longitudinal, lateral and vertical axes. The latitude and longitude offsets are measured in units of 1/10th micro degree, and is based on the WGS-84 coordinate system. The elevation represents the vehicle's position above or below the WGS-84 reference ellipsoid in units of 1 decimeter.

3.5.1.1.4.8.5 Broadcast Vehicle Path History - Heading

For each data point of a vehicle's path history, a connected vehicle shall include its current direction of travel (motion) at the time that data point was collected, as part of the path history information broadcasted to other connected devices. The heading is measured from -190.5 to +190.5 degrees, in 1.5 degrees segments, with North on the WGS-84 coordinate system equal to 0 degrees, with headings to the east as the positive direction (i.e., east is +90.0 degrees).

"Note: a less precise (1.5 degree increments) is needed for the vehicle heading for the path history information than the vehicle heading provided as part of the safety critical information (0.0125 degrees) (See 3.5.1.1.3.8). A more precise unit of measure (0.0125 degree increments) is needed for Requirement 3.5.1.1.3.8 so safety applications, such as lane change warning, can more accurately determine what direction a vehicle is heading, especially when considering the high speeds that a vehicle may be traveling.

3.5.1.1.4.8.6 Broadcast Vehicle Path History - Transmission

For each data point of a vehicle's path history, a connected vehicle shall include the state of the vehicle transmission at the time that data point was collected, as part of the path history information broadcasted to other connected devices. Valid values of the vehicle transmission state are neutral, park, forwardGears, reverseGears, and unavailable.

3.5.1.1.4.8.7 Broadcast Vehicle Path History - Speed

For each data point of a vehicle's path history, a connected vehicle shall include its point speed at the time that data point was collected, as part of the path history information broadcasted to other connected devices. The vehicle's point speed is measured in 0.02 meters per second units.

3.5.1.1.4.8.8 Broadcast Vehicle Path History - Positional Accuracy

For each data point of a vehicle's path history, a connected vehicle shall include the accuracy of the positional determination with respect to its semi-major and semi-minor axis, as well as the accuracy of the orientation of the front of the vehicle, at the time that data point was collected as part of the path history information broadcasted to other connected devices. This accuracy is used to measure the quality of the vehicle position with respect to each given axis and is expressed at one standard deviation. The accuracy is measured in 5 cm units along the semi-major and semi-minor axis while the accuracy of the orientation of the semi-major axis relative to true north is measured at units of 0.0054932479 degrees. This source of the positional accuracy is the GPS receiver.

3.5.1.1.4.9 Broadcast Vehicle Information - Vehicle Path Projection

A connected vehicle shall provide its predicted path trajectory as part of the information broadcasted to other connected devices. This predicted trajectory provides an indication of the future positions of the vehicle and can significantly enhance in-lane and out-of-lane threat classification for vehicles.

The predicted path trajectory also includes a confidence factor, in units of 0.5 percent, to provide an indication of the accuracy of the projected trajectory. A 100% confidence factor is full confidence that all vehicle data indicate correct operation and there is a good correlation between differing sources (such as GPS and wheel turns). No correlation between sources would indicate a 0% confidence. Limited correlation or partial equipment failure or unavailability would have an intermediate percentage applied.

3.5.1.1.4.10 Broadcast Vehicle Information - Location Corrections

A connected vehicle shall provide location correction information for itself as part of the information broadcasted to other connected devices. This location correction information is used to calculate the differential corrections between two connected devices.

3.5.1.2 Device Information Request

A connected device shall transmit a request for additional status or sensor reading information from another connected device as needed. In a normal operating environment, a connected device may broadcast only a subset of its device information. However, a connected device, such as a connected vehicle (host vehicle), may need additional information from other surrounding connected devices to properly perform any safety applications it may be running.

The detailed requirements for a connected device to request additional information from other connected devices are as follows.

3.5.1.2.1 Request Vehicle Information - Message Identifier

A connected device shall include a sequential message identifier as part of the request for additional information from another connected device. The message identifier is used to identify a sequence number within a stream of requests from the connected device. The message identifier increments by one whenever the contents of the request has changed. This requirement allows a connected device receiving the requests to ignore (not process) the same request from a requesting connected device when the contents has not changed.

3.5.1.2.2 Request Vehicle Information - Device Identifier

A connected device shall include the device identifier of the connected device that it is requesting additional information from as part of its request. This device identifier may be a random number to ensure the overall anonymity of the receiving connected device. This device identifier is necessary for a receiving connected device to determine if the request for additional information is addressed to it.

3.5.1.2.3 Request Vehicle Information - Requested Item

A connected device shall include a list of information items it is seeking as part of the request for additional information from another connected device. Up to 32 pieces of information may be requested from a connected device as part of a request. Valid information items that may be requested from the connected device are any device characteristics or device sensor readings that are supported by this standard.

3.5.1.3 Broadcast Intersection Infringement

A connected vehicle, which anticipates that it will have an intersection infringement, shall broadcast a message to other connected devices containing its path information.

An intersection infringement occurs if a vehicle enters an intersection crossing without stopping at a stop sign, or if the vehicle enters an intersection and performs an unpermitted movement (e.g., enters the intersection despite a red indication for it). If this appears likely to occur, the vehicle needs to warn other travelers at the intersection that it is entering the intersection to allow the other travelers to avoid collisions at the intersection.

The detailed requirements for a connected vehicle to warn other connected devices are as follows. These requirements assume that the connected vehicle has information on where the stopline is.

3.5.1.3.1 Broadcast Intersection Infringement - Message Identifier

A connected vehicle shall include a message identifier as part of its path information broadcasted to connected devices. The message identifier is used to identify a sequence number within a stream of messages (of the same message type) from a connected vehicle. The message identifier increments by one whenever the contents of the message has changed.

This requirement allows a connected device to determine that a message may have been lost if non-sequential message identifiers are received from a connected vehicle. If the message content has not changed, the same message identifier is used by the connected vehicle. This requirement allows a connected device to ignore (not process) messages from a connected vehicle when the content has not changed.

3.5.1.3.2 Broadcast Intersection Infringement - Device Identifier

A connected vehicle shall include a code identifying itself as part of the path information broadcasted to connected devices. This identifier code is necessary for a remote connected vehicle to distinguish information transmitted or broadcasted from different connected vehicles and to distinguish different transmissions from the same connected vehicle. This code is a random number to ensure the overall anonymity of the remote connected vehicle.

3.5.1.3.3 Broadcast Intersection Infringement - Vehicle Time

A connected vehicle shall include the time, accurate to within 1 millisecond, the vehicle determines its position information as part of the path information broadcasted to connected devices. This information allows a connected device to accurately position the location of the broadcasting connected vehicle at a specific point in time. The time is measured in ms within a minute - that is, only the seconds and ms of the connected vehicle's time is transmitted.

3.5.1.3.4 Broadcast Intersection Infringement - Path History

A connected vehicle shall include its path history, as part of the path information broadcasted to connected devices. The recent movements (path history) of the broadcasting connected vehicle is used by the receiving connected devices to predict the connected vehicle's intended movement. See Section 3.5.1.1.4.8.

3.5.1.3.5 Broadcast Intersection Infringement - Intersection Identifier

A connected vehicle shall include the unique identifier of the intersection it is entering (or is in) as part of the path information broadcasted to connected devices. The intersection identifier is assigned as part of a roadway geometric message broadcasted by an RSU at or near the intersection.

3.5.1.3.6 Broadcast Intersection Infringement - Lane Number

A connected vehicle shall include the lane number it is currently in as part of the path information broadcasted to connected devices. Each lane at the intersection has a unique identifier for that intersection, and is assigned as part of a roadway geometric message broadcasted by an RSU at or near the intersection.

3.5.1.3.7 Broadcast Intersection Infringement - Intersection Violation

A connected vehicle shall indicate if the vehicle anticipates that it will have a stopline violation as part of the path information broadcasted to connected devices. A stopline violation occurs if a vehicle enters an intersection crossing without stopping at a stop sign, or if the vehicle enters an intersection and performs an unpermitted movement (e.g., enters the intersection despite a red indication for it).

3.5.2 Public Safety Vehicle Requirements

In addition to the generic vehicle requirements in Section 3.5.1, there are several safety-related requirements specific to public safety vehicles. For example, while traveling to the scene of an incident, public safety connected vehicles need to make other road users aware of their presence and also may need to request preferential priority at signalized intersections.

The detailed requirements for a properly authorized public safety connected vehicle to respond to an incident and broadcast incident response and emergency alert messages are listed below.

3.5.2.1 Broadcast Emergency Response Indication

A public safety connected vehicle needs to identify itself as an authorized public safety vehicle traveling to or at the scene of a service call. This identification is included as part of vehicle information broadcasted to connected devices (See Section 3.5.1.1.4.6.19).

3.5.2.2 Signal Preemption Requirements

While traveling to the location of an incident, a public safety connected vehicle needs to request preferential treatment when approaching a signalized intersection.

The detailed requirements for a properly authorized public safety connected vehicle to request preferential treatment at a signalized intersection are listed below.

3.5.2.2.1 Transmit Preempt Request

A properly authorized public safety connected vehicle shall transmit to an RSU a message with its request for preferential treatment at a signalized intersection.

3.5.2.2.2 Request Signal Preempt - Mandatory Requirements

The following are the minimum requirements for a public safety connected vehicle to transmit a request for preferential treatment at a signalized intersection to an RSU.

3.5.2.2.2.1 Request Signal Preempt - Message Identifier

A public safety connected vehicle shall include a request identifier for each signal service request transmitted to an RSU. The message (request) identifier is used to identify a sequence number within a stream of messages (of the same message type) from a connected vehicle. The message identifier increments by one whenever the contents of the message has changed. This identifier is used by the RSU to distinguish between requests from different connected vehicles and to distinguish different requests from the same connected vehicle.

3.5.2.2.2.2 Request Signal Preempt - Intersection Identifier

A public safety connected vehicle shall include the unique identifier of the intersection that is the target of the signal service request transmitted to an RSU. The intersection identifier is assigned as part of a roadway geometric message broadcasted by an RSU at or near the intersection.

3.5.2.2.2.3 Request Signal Preempt - Operational Strategy

A public safety connected vehicle shall include the identifier of the operational strategy desired as part of the signal service request transmitted to an RSU. Each operational strategy defines the phases being serviced, the phases to be omitted, the maximum green time that can be reduced, or the maximum green time that can be extended to service the priority. For example, operational strategy number 1 may result in a signal preemption for the northbound approach, while operational strategy number 5 may result in a maximum green time for the eastbound approach.

It is assumed that the operational strategies are defined by the transportation agency that operates the traffic signal controller, with input from the public safety agencies.

3.5.2.2.3 Request Signal Preempt - Optional Requirements

The following are the optional requirements for a public safety connected vehicle to include in a request for preferential treatment at a signalized intersection to an RSU. However, if the requirement is selected to be supported according to the PRL in Section 3.3.3 (Under the Support column), then that requirement is required to be implemented.

3.5.2.2.3.1 Request Signal Preempt - Approach Lane

A public safety connected vehicle shall include the identifier of lane to be used to approach the intersection as part of the signal service request transmitted to an RSU. The lane number is assigned as part of a roadway geometrics message broadcasted by the RSU at the signalized intersection.

3.5.2.2.3.2 Request Signal Preempt - Egress Lane

A public safety connected vehicle shall include the lane number to be used to exit the intersection on as part of the signal service request transmitted to an RSU. The lane number is assigned as part of the roadway geometrics information broadcasted by the RSU at the signalized intersection. The egress lane information is needed to determine which preemption strategy may be appropriate for the public safety connected vehicle.

3.5.2.2.3.3 Request Signal Preempt - Validation

A public safety connected vehicle shall include a validation code as part of the signal service request transmitted to an RSU. The validation code is a string of bytes used by authorized connected vehicles to establish the validity of the signal service request and the identity of the vehicle. For example, the transportation agency that owns and operates the traffic signal controller may provide this validation code only to those fire departments it has agreements with. Without a proper validation code, the preferential request will be ignored by the traffic signal controller.

3.5.2.2.3.4 Request Signal Preempt - Vehicle Class

A public safety connected vehicle shall include its vehicle class type and vehicle class level as part of the signal service request transmitted to an RSU. Signalized intersections can use the vehicle class type and vehicle class level to determine which vehicle receives priority in the event multiple conflicting requests are received by the same signalized intersection. Examples of vehicle class types are public safety vehicle, transit vehicles, military vehicles, commercial motor vehicles carrying freight and private vehicles. A signal service request from a higher vehicle class type will take priority over another a signal service request from a lower vehicle class type. In addition, within each vehicle class type, a vehicle may also be assigned a vehicle class level. For example, with a public safety vehicle class type, an emergency services vehicle may have a higher vehicle class level than a law enforcement vehicle. A signal service request with a higher vehicle class level will take priority over another a signal service request from a lower vehicle class level. The order of precedence for the signal service request priority is by signal priority vehicle class type and then class level.

3.5.2.2.3.5 Request Signal Preempt - Time of Service

A public safety connected vehicle shall include the time when the signal service is requested to start as part of the signal service request transmitted to an RSU. This is the estimated time, in hours, minutes and seconds that the connected vehicle arrives at the intersection’s stopping point (e.g., stop bar).

3.5.2.2.3.6 Request Signal Preempt - End of Service

A public safety connected vehicle shall include the time when the signal service is requested to end as part of the signal service request transmitted to an RSU. This is the estimated time, in hours, minutes, and seconds that the connected vehicle expects to have passed through the intersection. This is defined as the time the connected vehicle expects to pass through the intersection’s stopping point (e.g., stop bar) at the downstream side of the intersection.

3.5.2.2.3.7 Request Signal Preempt - Vehicle Identity

A public safety connected vehicle shall include its identifier as part of the signal service request transmitted to an RSU. The vehicle identifier is used to allow the RSU to distinguish requests from different connected vehicles and to distinguish different requests from the same connected vehicle. The identifier may be a permanent identifier assigned by the public safety agency and used by the public safety agency to track the signal service requests for that vehicle.

3.5.2.2.3.8 Request Signal Preempt - Vehicle Location and Speed

A public safety connected vehicle shall include its current location, speed and heading as part of the signal service request transmitted to an RSU. This information may be used by the traffic signal controller to determine what operational strategy it will perform (service) in the event there are more than one conflicting) request for preferential treatment from different connected vehicles.

3.5.2.2.3.9 Request Signal Preempt - Vehicle Status

A public safety connected vehicle shall include its status information as part of the signal service request transmitted to an RSU. This status information includes if the public safety vehicle is braking as it is traveling, if it is responding to a service call, and if its (emergency) light bar is in use. This information may be used by the traffic signal controller to determine what operational strategy it will perform (service) in the event there are more than one conflicting request for preferential treatment from different connected vehicles.

3.5.2.2.3.10 Request Signal Preempt - Cancellation

A public safety connected vehicle shall transmit to an RSU a message to cancel a previously transmitted signal service request.

3.5.3 Commercial Vehicle Requirements

In addition to the generic vehicle requirements in Section 3.5.1, there are a set of requirements related to roadside checks that are specific to commercial motor vehicles (CMV). The roadside checks generally are performed at a roadside check station, and may include credentialing, weight, safety, duty log, and security inspections. These roadside checks are performed as part of an agency's roadside enforcement program. The roadside check station may be a fixed, permanent station, or a mobile station.

3.5.3.1 Commercial Credentials Information Requirements

These requirements define the information that is needed to support credentialing between a CMV and a commercial vehicle agency. Credentials from a commercial vehicle agency includes the proper permits that allow a commercial motor vehicle to transport goods and passengers within the agency's jurisdiction. Note that back office processing will determine if fees and permits are properly in order. Unlike the requirements for generic vehicles, most requirements specific to CMVs are transmitted only upon request from a properly authorized commercial vehicle agency. The request may originate from a fixed RSU or a mobile, connected device onboard a commercial vehicle agency vehicle.

The detailed requirements to share credentials information between connected CMVs and a commercial vehicle agency are as follows.

3.5.3.1.1 Commercial Vehicle Information Request

At commercial vehicle roadside check stations, an RSU shall transmit a request to CMVs for its credentials information. These stations may be fixed locations or mobile stations. These requests may be broadcasted by an RSU so that information is collected from all connected CMVs in the vicinity. These requests may also be transmitted by an RSU for a specific CMV if additional information is needed from that specific CMV.

3.5.3.1.1.1 Request Commercial Vehicle Information - Mandatory Requirements

The following information is included in the request from an RSU to a CMV for its credentials information.

3.5.3.1.1.1.1 Request Commercial Vehicle Information - Vehicle Identification

An RSU shall request for a CMV's vehicle identification information as part of its request for a connected CMV's credentials information. Vehicle identification information includes identification of the vehicle, and identification of the carrier. With this information, a commercial vehicle agency can use back office systems to check if the carrier's fees and permits are in order.

3.5.3.1.1.2 Request Commercial Vehicle Information - Optional Requirements

The following are optional information that a commercial vehicle agency may include in the request from an RSU to a connected CMV for its credentials information.

3.5.3.1.1.2.1 Request Commercial Vehicle Information - Driver Identification

An RSU shall include a request for a CMV's driver identification information as part of its request for a connected CMV's credentials information. Driver identification information includes the CMV driver's (or drivers') license number and personal identification number. This information is used by commercial vehicle agencies to verify the identity of the driver(s).

3.5.3.1.1.2.2 Request Commercial Vehicle Information - Driver Hours of Service Data

An RSU shall include a request for a CMV's driver hours of service data as part of its request for a connected CMV's credentials information. The driver hours of service records (driver duty log) are stored aboard an Electronic On-Board Recorders (EOBR) and records the hours when a driver is driving and when he takes a break. These driver hours of service logs are requested by commercial vehicle agencies as part of its safety inspections to verify that the driver complies with FMCSA's rules for CMV drivers.

3.5.3.1.1.2.3 Request Commercial Vehicle Information - Trailer Data

An RSU shall include a request for a CMV's trailer data as part of its request for a connected CMV's credentials information. The trailer data includes trailer identification information, axle information, and weight. This information is used by commercial vehicle agencies for safety inspections and to verify that the proper permits are in order (e.g., overweight permits). Note that oversize/overweight permits are generally tied to vehicle combination (tractor + trailer), not just a single tractor or trailer.

3.5.3.1.1.2.4 Request Commercial Vehicle Information - Cargo Data

An RSU shall include a request for a CMV's cargo information as part of its request for a connected CMV's credentials information. Cargo information are requested by commercial vehicle agencies to verify the proper permits are in order, the proper fees have been paid, and for security purposes.

3.5.3.1.1.2.5 Request Commercial Vehicle Information - Specific Vehicles

Often, commercial vehicle agencies may be interested in collecting credentials information, such as driver identification or cargo data, from only a specific CMV. In these cases, an RSU shall include the VIN of the connected CMV as part of a request for its credentials information.

3.5.3.1.1.3 Request Commercial Vehicle Information - Presentation Requirements

Commercial vehicle agencies may wish to request commercial vehicle information only for CMVs within specific geographic (spatial) regions or directions of travel. These geographic regions may be constrained to CMVs traveling a specific section of highway, or exclude access roads/surface streets and parking lots, etc…, and CMVs traveling in a specific direction (e.g., towards a border). Multiple regions geographic regions may be defined.

The detailed requirements for defining the conditions when the request for commercial vehicle information should be presented to the driver are as follows.

3.5.3.1.1.3.1 Request Commercial Vehicle Information - Default Anchor Point Position

An RSU shall include the geographic location (latitude, longitude, elevation) of the default anchor point for which the valid region is determined as part of its request for a connected CMV's credentials information. The latitude and longitude are measured in units of 1/10th microdegree. The elevation represents the height above or below the WGS-84 reference ellipsoid in units of 1 decimeter. The default anchor point is included so an anchor point does not have to be transmitted for each valid region defined for a commercial vehicle information request.

3.5.3.1.1.3.2 Request Commercial Vehicle Information - Heading Slice

For each region, an RSU shall include the CMV’s direction of motion that the request is valid for as part of its request for a connected CMV’s credentials information. This requirement allows commercial vehicle requests to be valid for only those CMVs traveling in the specified directions. The CMV's direction of motion is measured by one or more heading slices, with each heading slice 22.5 degrees wide. For example, a commercial vehicle agency with a roadside check station near a border may be only interested in requesting credential information from CMVs entering its jurisdiction.

3.5.3.1.1.3.3 Request Commercial Vehicle Information - Circular Region - Radius

A spatial region for which a request for a connected CMV’s credentials information is valid may be a circular region around an anchor point. The connected CMV should be located within the circular region for the request to be presented to the CMV driver.

An RSU shall include the radius for the circular region defining the geographic area that the request is valid for as part of its request for a connected CMV’s credentials information. The valid circular region is defined by the radius, measured in one meter units, from either the default anchor point defined in Section 3.5.3.1.1.3.1, or the specified anchor point defined in Section 3.5.3.1.1.3.4. The specified anchor point takes precedence over the default anchor point.

3.5.3.1.1.3.4 Request Commercial Vehicle Information - Circular Region - Anchor Point

An RSU shall include the geographic location (latitude, longitude, elevation) of the anchor point for the circular region defining the geographic area that the request is valid for as part of its request for a connected CMV’s credentials information. The latitude and longitude are measured in units of $1/10^{th}$ microdegree. The elevation represents the height above or below the WGS-84 reference ellipsoid in units of 1 decimeter. If this anchor point information is not transmitted, the default anchor point defined in Section 3.5.3.1.1.3.1 is used.

3.5.3.1.1.3.5 Request Commercial Vehicle Information - Polygon Region - Offsets

A spatial region for which a request for a connected CMV’s credentials information is valid may be a polygon, which may represent the jurisdictional boundaries of a specific transportation agency or a work zone. The connected CMV should be located within this polygon region for the request to be presented to the CMV driver.

An RSU shall include the area of travel defining the geographic area that the request is valid for as part of its request for a connected CMV’s credentials information. The valid area of travel (polygon) is defined by a series of offset points (x-axis, y-axis based on the WGS-84 coordinate system), measured in one meter units. These offset points describes the perimeter of the polygon. Each offset point defines the offset from the specified anchor point defined in Section 3.5.3.1.1.3.6, or the default anchor point defined in Section 3.5.3.1.1.3.1. The anchor point in Section 3.5.3.1.1.3.6 takes precedence over the default anchor point.

Optionally, an elevation offset point (z-axis) and an elevation tolerance, both in one meter units, may also be transmitted for each set of offset points. If the elevation offset point is not transmitted, all CMVs within the x-y polygon area are part of the valid area of travel. For example, a node has an elevation offset point of +5 meters with an elevation tolerance of ±2 meters. Thus any CMV located between +3 meters to +7 meters offset from the previous node is within the area of travel, while CMVs outside this range are not. This requirement is necessary in case the commercial vehicle request is only valid for specific overpasses or underpasses in a specific direction.

3.5.3.1.1.3.6 Request Commercial Vehicle Information - Polygon Region - Anchor Point

An RSU shall include the geographic location (latitude, longitude, elevation) of the anchor point for the polygon area defining the geographic area that the request is valid for as part of its request for a connected CMV’s credentials information. The latitude and longitude are measured in units of $1/10^{th}$ microdegree. The elevation represents the height above or below the WGS-84 reference ellipsoid in units of 1 decimeter. If this anchor point is included, it takes precedence over the default anchor point, otherwise the default anchor point defined in Section 3.5.3.1.1.3.1 should be used.

3.5.3.1.1.3.7 Request Commercial Vehicle Information - Shape Point Set - Default Direction

A spatial region for which a request for a connected CMV's credentials information is valid may be a shape point set, which allows a spline-like representation of a geographic area such as a road segment. The connected CMV should be located within the shape point set region for the request to be presented to the CMV driver. Unlike the valid circular region or the valid polygon region, which can be used to define a wide geographic area, the shape point set is used to represent a short segment of a specific roadway.

An RSU shall include the default direction of travel along the shape point set as part of its request for a connected CMV's credentials information. This requirement indicates the direction of travel along the series of offset points defined in Section 3.5.3.1.1.3.9. Valid values are forward (direction of travel follows node ordering), reverse (direction of travel is the reverse of node ordering), or both (direction of travel allowed in both directions). The default direction is included so the direction does not have to be transmitted for each shape point set defined for a request.

3.5.3.1.1.3.8 Request Commercial Vehicle Information - Shape Point Set - Default Width

An RSU shall include the default width for the shape point set as part of its request for a connected CMV's credentials information. The width, measured in one centimeter units, is used to define the width of the valid region of travel at each offset point defined in Section 3.5.3.1.1.3.9, with the offset point located on the centerline path of the geographic area (width). The default width is included so a width does not have to be transmitted for each shape point set defined for a request.

3.5.3.1.1.3.9 Request Commercial Vehicle Information - Shape Point Set - Offsets

An RSU shall transmit the shape point set defining the geographic area that the request is valid for as part of its request for a connected CMV's credentials information. The shape point set is a path defined by a series of offset points (x-axis, y-axis based on the WGS-84 coordinate system and its reference ellipsoid), measured in centimeters. Each offset point represents the center line of the shape point set.

The first offset point is from the default anchor point defined in Section 3.5.3.1.1.3.1, or the specified anchor point defined in Section 3.5.3.1.1.3.13 (the specified anchor point takes precedence over the default anchor point). All successive offsets are from the previous offset point. For example, the first set of offset points (node) describes the offset from the anchor point, the second set of offset points describes the offset from the first node, the third set of offset points describes the offset from the second node, etc…

Optionally, an elevation offset point (z-axis) and an elevation tolerance, both in one meter units, may also be transmitted for each set of offset points. If the elevation offset point is not transmitted, all CMVs within the x-y shape point set are part of the valid area of travel. For example, a node has an elevation offset point of +5 meters with an elevation tolerance of ±2 meters. Thus any CMV located between +3 meters to +7 meters offset from the previous node is within the area of travel, while CMVs outside this range are not. This requirement is necessary in case the commercial vehicle request is only valid for specific overpasses or underpasses in a specific direction.

3.5.3.1.1.3.10 Request Commercial Vehicle Information - Shape Point Set - Direction

An RSU shall transmit the allowed direction of travel along the shape point set as part of its request for a connected CMV's credentials information. This data element is used to indicate the direction of travel along the series of offset points defined in Section 3.5.3.1.1.3.9. Valid values are forward (direction of travel follows node ordering), reverse (direction of travel is the reverse of node ordering), or both (direction of travel allowed in both directions). If no allowed direction of travel is transmitted, the default direction defined in Section 3.5.3.1.1.3.7 is used for the shape point set.

3.5.3.1.1.3.11 Request Commercial Vehicle Information - Shape Point Set - Width

An RSU shall include the width for the shape point set as part of its request for a connected CMV's credentials information. The width, measured in one centimeter units, is used to define the width of the valid region of travel at each offset point defined in Section 3.5.3.1.1.3.9, with the offset point located on the center line of the shape point set. This width takes precedence over the default width defined in Section 3.5.3.1.1.3.8, otherwise the default width is used for the shape point set.

3.5.3.1.1.3.12 Request Commercial Vehicle Information - Shape Point Set - Node Width

For a shape point offset, an RSU shall include the width of the geographic area at that node as part of its request for a connected CMV's credentials information. Each shape point offset (node) defined in Section 3.5.3.1.1.3.9 represents a point along the center line of the shape point set. The width, measured in one centimeter units, represents the width of the geographic area at that node. This width takes precedence over the default width defined in Section 3.5.3.1.1.3.8, and the width of the shape point set defined in Section 3.5.1.1.3.11.

3.5.3.1.1.3.13 Request Commercial Vehicle Information - Shape Point Set - Anchor Point

An RSU shall include the geographic location (latitude, longitude, elevation) of the anchor point for the shape point set defining the geographic area that the request is valid for as part of its request for a connected CMV's credentials information. The latitude and longitude are measured in units of 1/10th microdegree. The elevation represents the height above or below the WGS-84 reference ellipsoid in units of 1 decimeter. If this anchor point is included, it takes precedence over the default anchor point, otherwise the default anchor point defined in Section 3.5.3.1.1.3.1 should be used.

3.5.3.1.2 Transmit Commercial Vehicle Information

A CMV shall transmit its credentials information to an RSU upon receiving a request from an RSU. Credentials are documents or certificates indicating that the owner or operator of the CMV has the proper licenses from the appropriate agencies and has filed the proper taxes. A CMV's credentials are usually based on the owner's, operator's or the vehicle's identification information. Based on this identification information, a commercial vehicle agency, using back office processing systems, can look up and determine if the owner, operator or vehicle has the proper permits and has paid the proper fees.

3.5.3.1.2.1 Transmit Commercial Vehicle Information - Mandatory Requirements

A CMV's identification information is needed by a commercial vehicle agency to determine if the CMV has the proper credentials and permits via back office processing. The following information is included in the credentials information sent from a connected CMV to an RSU.

3.5.3.1.2.1.1 Transmit Commercial Vehicle Power Unit - License Plate Data

A connected CMV shall include its power unit license plate data as part of its credentials information transmitted to an RSU upon request. The license plate data consists of country and regional jurisdiction (state or province) that issued the license plate, and the license plate number.

3.5.3.1.2.1.2 Transmit Commercial Vehicle Power Unit - VIN

A connected CMV shall include its power unit vehicle identification number (VIN) as part of its credentials information transmitted to an RSU upon request.

3.5.3.1.2.1.3 Transmit Commercial Vehicle Power Unit - Owner Carrier Name

A connected CMV shall include the entity's business name that owns the CMV as part of its credentials information transmitted to an RSU upon request.

3.5.3.1.2.2 Transmit Commercial Vehicle Information - Optional Requirements

The following are optional information that a connected CMV may include in the credentials information transmitted from the CMV to an RSU.

3.5.3.1.2.2.1 Transmit Commercial Vehicle Power Unit - Optional Requirements

The following are optional information about the power unit or the carrier that a connected CMV may include in the credentials information transmitted from a connected CMV to an RSU.

3.5.3.1.2.2.1.1 Transmit Commercial Vehicle Power Unit - VIN Source

A connected CMV shall include the source of the power unit's VIN as part of its credentials information transmitted to an RSU upon request. A power unit may have a VIN that is programmed in its engine computer, and a VIN programmed on its vehicle bus. This requirement identifies the source of the VIN that is transmitted as part of its credentials information. Normally, the VIN from the different parts of the power unit should be the same.

3.5.3.1.2.2.1.2 Transmit Commercial Vehicle Power Unit - Owner Registration Number

A connected CMV shall include the registration number assigned to the entity that owns the power unit as part of its credentials information transmitted to an RSU upon request. An entity operating CMVs normally has to be registered with a regulatory agency before it may transport passengers on a commercial basis, or haul cargo. This is the registration number of the entity. The registration information consists of country and optionally, the regional jurisdiction (state or province) that the entity is registered with, and the registration number. Multiple registrations may be included.

3.5.3.1.2.2.1.3 Transmit Commercial Vehicle Power Unit - Lessee Registration Number

A connected CMV shall include the registration number assigned to the entity that is leasing the power unit as part of its credentials information transmitted to an RSU upon request. CMVs are sometimes leased by one company to another company. An entity operating CMVs normally has to be registered with a regulatory agency before it may transport passengers on a commercial basis, or haul cargo. This requirement is for the registration number of the entity currently responsible for the CMV and its contents, which may be a different company than the company that owns the CMV. This is the registration number of the entity. The registration information consists of country and optionally, the regional jurisdiction (state or province) that the entity is registered with, and the registration number. Multiple registrations may be included.

3.5.3.1.2.2.2 Transmit Commercial Vehicle Power Unit - Lessee Carrier Name

A connected CMV shall include the legal business name of the entity that has leased or is responsible for the CMV as part of its credentials information transmitted to an RSU upon request. CMVs are sometimes leased by one company to another company. This requirement is the name or trade number of the motor carrier company currently responsible for the CMV and its contents, which may be a different company than the company that owns the CMV.

3.5.3.1.2.2.3 Transmit Commercial Vehicle Driver Identification Data

To support CMV credentialing and safety inspections, information identifying the CMV driver and any secondary CMV driver, is needed from the connected CMV to the commercial vehicle agency. The detailed requirements for a CMV to transmit CMV driver identification data to an RSU upon request are listed below.

3.5.3.1.2.2.3.1 Transmit Commercial Vehicle Driver - Name

A connected CMV shall include the names of the drivers operating the CMV on its current run as part of its credentials information transmitted to an RSU upon request. Up to 2 driver names can be transmitted. Each driver name consists of a first name and a last name.

3.5.3.1.2.2.3.2 Transmit Commercial Vehicle Driver - License Number

A connected CMV shall include the license number of the drivers operating the CMV on its current run as part of its credentials information transmitted to an RSU upon request. Up to 2 driver license numbers can be transmitted. The driver license number consists of the identification number, the jurisdiction (if applicable) and country that issued the driver's license.

3.5.3.1.2.2.3.3 Transmit Commercial Vehicle Driver - Date of Birth

A connected CMV shall include the date of birth of the drivers operating the CMV on its current run as part of its credentials information transmitted to an RSU upon request. The date of birth of up to 2 drivers can be transmitted.

3.5.3.1.2.2.3.4 Transmit Commercial Vehicle Driver - PIN

A connected CMV shall include the personal identification number (PIN) of the drivers operating the CMV on its current run as part of its credentials information transmitted to an RSU upon request. The PIN, which is a text field but is normally the last 4 digits of a social security number of the driver, is used to verify the identity of the driver. The PIN for up to 2 drivers can be transmitted.

3.5.3.1.2.2.4 Transmit Commercial Vehicle Information - Trailer Requirements

Commercial vehicles may also have trailers hitched to the vehicle. Information about the trailers is needed to satisfy numerous needs such as commercial vehicle credentialing and permitting or safety inspection data.

The detailed requirements for a connected vehicle to transmit information about any trailer hitched to the vehicle are listed below.

3.5.3.1.2.2.4.1 Transmit Trailer Information - VIN

A connected CMV shall include the vehicle identification number (VIN) of each trailer hitched to the CMV as part of its credentials information transmitted to an RSU upon request. Up to 6 trailer VINs can be transmitted.

3.5.3.1.2.2.4.2 Transmit Trailer Information - License Plate Data

A connected CMV shall include the license plate data of each trailer hitched to the CMV as part of its credentials information transmitted to an RSU upon request. The license plate data includes the license plate number and the country and jurisdiction that issued the license. License plates for up to 6 trailers can be transmitted.

3.5.3.1.2.2.4.3 Transmit Trailer Information - Number of Axles

A connected CMV shall include the number of axles on each trailer hitched to the CMV as part of its credentials information transmitted to an RSU upon request. Up to 7 axles per trailer are supported. Axle counts for up to 6 trailers can be transmitted.

3.5.3.1.2.2.4.4 Transmit Trailer Information - Number of Trailer Tires

A connected CMV shall include the number of tires on each trailer hitched to the CMV as part of its credentials information transmitted to an RSU upon request. Up to 31 tires per trailer is supported. Tire counts for up to 6 trailers can be transmitted.

3.5.3.1.2.2.4.5 Transmit Trailer Information - Weight

A connected CMV shall include the trailer weight of each trailer hitched to the CMV as part of its credentials information transmitted to an RSU upon request. The trailer weight is the total weight of the freight-carrying vehicle designed to be pulled, including the weight of its contents. The trailer weight is measured in 1 kilogram (kg) units. Trailer weights for up to 6 trailers can be transmitted.

3.5.3.1.2.2.5 Transmit Commercial Vehicle Information - Cargo Requirements

To support CMV credentialing, cargo information is needed from the connected CMV to the commercial vehicle agency. The requirements for the transmission of information regarding a CMV's cargo contents are listed below.

3.5.3.1.2.2.5.1 Transmit Cargo Information - Shipment ID

A connected CMV shall include the shipment ID as part of its credentials information transmitted to an RSU upon request. The shipment ID, or shipping document number, is the bill of lading number assigned by the carrier.

3.5.3.1.2.2.5.2 Transmit Cargo Information - Hazmat Codes

A connected CMV shall include the hazmat code(s) of all hazardous materials on-board the CMV as part of its credentials information transmitted to an RSU upon request. The hazmat codes are defined in CFR Title 49 hazardous material codes. Up to 8 hazmat codes can be transmitted for each CMV.

3.5.3.1.2.2.5.3 Transmit Cargo Information - Placards

A connected CMV shall include the hazmat placard codes that are displayed on the CMV as part of its credentials information transmitted to an RSU upon request. The placard codes are defined in CFR Title 49, Part 173. Up to 8 hazmat placard codes can be transmitted for each CMV.

3.5.3.1.2.2.6 Transmit Commercial Vehicle Information - Vehicle Requirements

To support CMV credentialing, the location and speed information is needed from the connected CMV to the commercial vehicle agency. The requirements for the transmission of information regarding a CMV's current location and speed are listed below.

3.5.3.1.2.2.6.1 Transmit Commercial Vehicle Information - Device Time

A connected CMV shall include the time, accurate to within 1 millisecond, the CMV determines its position information as part of its credentials information transmitted to an RSU upon request. This information allows an RSU to accurately position the location of the connected CMV at a specific point in time. The time is measured in ms within a minute - that is, only the seconds and ms of the connected CMV's time is transmitted.

3.5.3.1.2.2.6.2 Transmit Commercial Vehicle Information - Vehicle Position

A connected CMV shall include its position (latitude, longitude, elevation) based on the WGS-84 coordinate system as part of its credentials information transmitted to an RSU upon request. The latitude and longitude are measured in units of 1/10th microdegrees. The latitude and longitude are to be at least within 1.5 meters of the actual value (latitude/longitude) at an HDOP smaller than 5 under open sky conditions within the 1 sigma absolute error. The elevation represents the elevation of the road surface, on which the vehicle is driving on, above or below the WGS-84 reference ellipsoid in units of 1 decimeter. The elevation is to be at least within 3 meters of the actual elevation at an HDOP smaller 5 under open sky conditions within the 1 sigma absolute error.

3.5.3.1.2.2.6.3 Transmit Commercial Vehicle Information - Positional Accuracy

A connected CMV shall include the accuracy of its positional determination with respect to its longitudinal and lateral axis as part of its credentials information transmitted to an RSU upon request. This accuracy is used to measure the quality of the CMV's position with respect to each given axis and is expressed at one standard deviation. The resolution is measured in 0.05 meters (5 cm) units along the semi-major and semi-minor axis. The accuracy also includes the orientation of the front of the vehicle relative to true north and is measured at units of 0.0054932479 degrees. This source of the positional accuracy is the GPS receiver.

3.5.3.1.2.2.6.4 Transmit Commercial Vehicle Information - Vehicle Speed

A connected CMV shall include its point speed, in 0.02 meters per second units, as part of its credentials information transmitted to an RSU upon request.

3.5.3.1.2.2.6.5 Transmit Commercial Vehicle Information - Vehicle Heading

A connected CMV shall include its direction of motion as part of its credentials information transmitted to an RSU upon request. The heading is measured from 0 degrees, which is North as defined by the WGS-84 coordinate system and its reference ellipsoid, to 359.9875 degrees in unsigned units of 0.0125 degrees increments, with headings to the east as the positive direction (i.e., east is +90.0000 degrees). The accuracy of the heading is to be less than 2 degrees when the vehicle speed is greater than 12.5 meters per second (m/s); and less that 3 degrees when the vehicle speed is between 0.56 m/s and 12.5 m/s. If the vehicle speed is below 0.56 m/s the heading is to be latched to the last known good heading value above 0.56 m/s. The heading is unlatched after the vehicle speed exceeds 0.83 m/s.

3.5.3.2 Commercial Vehicle Screening Information Requirements

These requirements allow a commercial vehicle agency and a CMV to share the results of screening activities of the CMV. The commercial vehicle agency would transmit the screening activity results from a roadside check station, which can be a fixed RSU or a mobile, connected device onboard a commercial vehicle agency vehicle behaving as an RSU. A CMV can use this screening activity information to compare the roadside check stations' measurements with the CMV's own sensors. The CMV can also share these screening activity results with other roadside check stations downstream, possibly resulting in the commercial vehicle agency allowing the CMV to bypass those stations.

The detailed requirements for the sharing of commercial screening activity information are listed below.

3.5.3.2.1 Transmit Screening Activity Result

Upon completion of a screening activity, an RSU shall transmit the results of a CMV's screening activity to the connected CMV.

3.5.3.2.1.1 Transmit Screening Activity Result - Mandatory Requirements

The following information is included in the screening activity results transmitted from a connected device to another connected device.

3.5.3.2.1.1.1 Transmit Screening Activity Result - VIN

A connected device shall include the VIN of the CMV that the screening activity was performed on as part of the screening activity results transmitted to another connected device. If the transmitting connected device is an RSU, the VIN also identifies the connected CMV that the transmission of the screening activity results is intended for.

3.5.3.2.1.1.2 Transmit Screening Activity Result - Encounter ID

A connected device shall include an identifier for a CMV's screening activity (encounter) as part of the screening activity results transmitted to another connected device. The commercial vehicle agency performing the screening activity determines how to assign this identifier for each screening activity.

3.5.3.2.1.1.3 Transmit Screening Activity Result - Encounter Date and Time

A connected device shall include the date and time of a CMV's screening activity as part of the screening activity results transmitted to another connected device. This is the date and time a screening activity of a CMV begins, such as when the connected CMV pulls into a roadside check station. The date is in the format yyyymmdd and the time is in hhmmss.

3.5.3.2.1.1.4 Transmit Screening Activity Result - Encounter Location

A connected device shall include the geographic location (latitude, longitude) of a CMV's screening activity as part of the screening activity results transmitted to another connected device. This may be a fixed location, such as a fixed roadside check station, or it may be the location of a mobile roadside check station. The latitude and longitude are based on the WGS-84 coordinate system in units of 1/10th micro degree.

3.5.3.2.1.1.5 Transmit Screening Activity Result - Check Type

A connected device shall include the types of roadside checks that were performed during the screening activity on the CMV as part of the screening activity results transmitted to another connected device. The valid types of roadside checks include: vehicle identification (for credentialing/permitting), driver identification, safety check, trailer data, cargo data, and driver duty logs.

3.5.3.2.1.1.6 Transmit Screening Activity Result - Check Value

A connected device shall include a check value as part of the screening activity results transmitted to another connected device. The check value is used by the connected CMV to verify the integrity of the screening results (i.e., no errors were introduced during the transmission) and is also used by the connected CMV to acknowledge the proper receipt of the screening results back to the transmitting RSU (See Section 3.5.3.2.2.1.4).

3.5.3.2.1.2 Transmit Screening Activity Result - Optional Requirements

The following are the optional requirements for an RSU to transmit the results of a CMV's screening activity to the connected CMV. However, if the requirement is selected to be supported according to the PRL in Section 3.3.3 (Under the Support column), then that requirement is required to be implemented.

3.5.3.2.1.2.1 Transmit Screening Activity Result - Vehicle Polling Date and Time

A connected device shall include the date and time of a CMV's screening activity as part of the screening activity results transmitted to another connected device. This is the date and time the measurements of the CMV were taken, which may be a different date and time than the encounter date and time.

3.5.3.2.1.2.2 Transmit Screening Activity Result - Encounter Station

A connected device shall include the identifier of the roadside check station where the CMV's screening activity occurred as part of the screening activity results transmitted to another connected device. The identifier will consist of a text name of the station.

3.5.3.2.1.2.3 Transmit Screening Activity Result - Vehicle Measurements Requirements

A connected device needs to transmit the vehicle measurements collected by the equipment at the roadside check station to another connected device.

The detailed requirements for the transmission of measurements collected by the equipment at the roadside check station from a connected device to another connected device are listed below.

3.5.3.2.1.2.3.1 Transmit Screening Activity Result - Vehicle Weight

A connected device shall include the measured weight of a CMV during a screening activity as part of the screening activity results transmitted to another connected device. The vehicle weight, in one kilogram units, is defined as the current weight of the vehicle and its contents, including all trailers that are hitched to the power unit.

3.5.3.2.1.2.3.2 Transmit Screening Activity Result - Vehicle Height

A connected device shall include the measured height of a CMV during a screening activity as part of the screening activity results transmitted to another connected device. The height of the vehicle, measured in one centimeter units, is the distance measured from the ground to the highest surface of the vehicle, including trailers but not including any antenna(s).

3.5.3.2.1.2.3.3 Transmit Screening Activity Result - Vehicle Width

A connected device shall include the measured width of a CMV during a screening activity as part of the screening activity results transmitted to another connected device. The width of the vehicle, measured in one centimeter units, is the widest point of the power unit and its trailers with all factory installed equipment, and any aftermarket equipment, i.e., fairings, mirrors, etc...

3.5.3.2.1.2.3.4 Transmit Screening Activity Result - Vehicle Length

A connected device shall include the measured length of a CMV during a screening activity as part of the screening activity results transmitted to another connected device. The length of the vehicle, measured in one centimeter units, is the distance measured from the edge of the front bumper to the edge of the rear bumper. If there are trailers hitched to the vehicle, the vehicle length is the distance from the edge of the front bumper to the edge of the rear bumper of the last trailer.

3.5.3.2.1.2.4 Transmit Screening Activity Result - Tire Information Requirements

A connected device needs to transmit the tire measurements collected by the equipment at the roadside check station to another connected device. The tire information may be measured as part of a safety inspection of a CMV. Up to 64 tires per CMV is supported.

The detailed requirements for a connected device to transmit tire information about a CMV's tires to another connected device are listed below.

3.5.3.2.1.2.4.1 Transmit Screening Activity Result - Tire Pressure

A connected device shall include the tire pressure for each tire on a CMV as measured during a screening activity as part of the screening activity results transmitted to another connected device. Valid values are from 0 to 1000 kPa, in four kPa units.

3.5.3.2.1.2.4.2 Transmit Screening Activity Result - Tire Temperature

A connected device shall include the temperature for each tire on a CMV as measured during a screening activity as part of the screening activity results transmitted to another connected device. The temperature is measured at the surface of the tire sidewall, with a valid range from -273 to 1735 degrees celsius, in .03125 degrees celsius units.

3.5.3.2.1.2.4.3 Transmit Screening Activity Result - Tire Pressure Threshold

A connected device shall include the relative tire pressure threshold for each vehicle tire on a CMV as measured during a screening activity as part of the screening activity results transmitted to another connected device. The threshold indicates the relative pressure level of each tire. The valid values are defined in SAE J1939.

3.5.3.2.1.2.5 Transmit Screening Activity Result - Axle Information Requirements

A connected device needs to transmit the axle measurements collected by the equipment at the roadside check station to another connected device. Up to 20 axles are supported for each CMV.

The detailed requirements for an RSU to transmit information about a CMV's axles to the connected CMV are listed below.

3.5.3.2.1.2.5.1 Transmit Screening Activity Result - Vehicle Weight on the Axle

A connected device shall include the axle weight for each axle of the CMV as measured during a screening activity as part of the screening activity results transmitted to another connected device. The axle weight, in units of 0.5 kilograms, is the total weight placed on the road by all wheels of one axle.

3.5.3.2.1.2.5.2 Transmit Screening Activity Result - Distance Between Vehicle Axles

A connected device shall include the distance between the axles of the CMV as measured during a screening activity as part of the screening activity results transmitted to another connected device. The distance is measured, in one centimeter units, from the center axis to center axis of each axle. The axle spacing is needed for bridge formula weight limit compliance calculations.

3.5.3.2.1.2.6 Transmit Screening Activity Result - Vehicle Brake Requirements

A connected device needs to transmit the status of a CMV's brakes collected by the equipment at the roadside check station to another connected device. The status of a CMV's brakes may be measured as part of a safety inspection for a CMV.

The detailed requirements for a connected CMV to transmit information about the CMV's brakes are listed below.

3.5.3.2.1.2.6.1 Transmit Screening Activity Result - Left Brake Measure

A connected device shall include the braking capability of the left brake for each axle of the CMV as part of the screening activity results transmitted to another connected device. The braking capability is a quantitative measure of individual wheel brake forces or overall vehicle brake performance, and is irrespective of the brake type, energy supply, or the application method. The capability is the ratio of the measured brake force divided by the wheel load, and is measured to the hundredths of a decimal place.

3.5.3.2.1.2.6.2 Transmit Screening Activity Result - Right Brake Measure

A connected device shall include the braking capability of the right brake for each axle of the CMV as part of the screening activity results transmitted to another connected device. The braking capability is a quantitative measure of individual wheel brake forces or overall vehicle brake performance, and is irrespective of the brake type, energy supply, or the application method. The capability is the ratio of the measured brake force divided by the wheel load, and is measured to the hundredths of a decimal place.

3.5.3.2.1.2.6.3 Transmit Screening Activity Result - Brake Actuator

A connected device shall include the actuator stroke conditions for each wheel end of each CMV (power unit and trailers) axle as measured during a screening activity as part of the screening activity results transmitted to another connected device. Valid brake actuator stroke conditions are: normaloperation, nonfunctioning, overstroke, draggingbrake, and sensorerror.

3.5.3.2.1.2.6.4 Transmit Screening Activity Result - Brake Lining Thickness

A connected device shall include the thickness of the brake linings or pad for each axle on the CMV, as measured during a screening activity as part of the screening activity results transmitted to another connected device. The thickness is measured in one tenth of a millimeter units.

3.5.3.2.1.2.6.5 Transmit Screening Activity Result - Brake Temperature

A connected device shall include the brake temperature for each axle on the CMV, as measured during a screening activity as part of the screening activity results transmitted to another connected device. The brake temperature is measured in one degree Celsius units.

3.5.3.2.1.2.7 Transmit Screening Activity Result - Safety Belt

A connected device shall include the state of the safety belt of the driver on the CMV, as measured during a screening activity as part of the screening activity results transmitted to another connected device. The valid states for the safety (seat) belt are notbuckled, buckled, undetermined, and unavailable.

3.5.3.2.1.2.8 Transmit Commercial Vehicle Driver Hours of Service Data

A connected CMV shall include the data contents of the Electronic On-Board Recorders (EOBR) for its current run as part of its credentials information transmitted to an RSU upon request. One of the key aspects of a safety inspection is to review the CMV driver's hours of service data to check if the driver(s) has not violated any regulations regarding driving times, such as exceeding the number of hours driven allowed without a break.

3.5.3.2.2 Screening Activity Results Acknowledgement

A connected CMV, upon receiving its screening activity results, shall transmit a receipt to an RSU acknowledging the results of its screening activity.

3.5.3.2.2.1 Transmit Screening Activity Acknowledgement - Mandatory Requirements

The following information is included in the acknowledgement of its screening activity results transmitted from a connected CMV to an RSU.

3.5.3.2.2.1.1 Transmit Screening Activity Result - VIN

A connected CMV shall include its VIN as part of its acknowledgement of its screening activity results to the RSU. This allows an RSU to verify which connected CMV is transmitting the acknowledgement.

3.5.3.2.2.1.2 Transmit Screening Activity Result - Encounter ID

A connected CMV shall include the identifier of the screening activity it is acknowledging as part of its acknowledgement of its screening activity results to the RSU.

3.5.3.2.2.1.3 Transmit Screening Activity Result - Encounter Date and Time

A connected CMV shall include the date and time of the screening activity it is acknowledging as part of its acknowledgement of its screening activity results to the RSU. This is the date and time a screening activity of a CMV begins, such as when the connected CMV pulls into a roadside check station. The date is in the format yyyymmdd and the time is in hhmmss.

3.5.3.2.2.1.4 Transmit Screening Activity Result - Check Value

A connected CMV shall include the check value of the screening activity it is acknowledging as part of its acknowledgement of its screening activity results to the RSU. The check value was transmitted by the RSU to verify the integrity of the screening results (i.e., no errors were introduced during the transmission), but is used by the connected CMV here to indicate to the RSU it has properly received the screening results.

3.5.3.2.3 Commercial Screening Information Request

A connected CMV shall provide a commercial vehicle agency with the results of its previous screening activities upon request. A commercial vehicle agency may request the results of a CMV's previous screening activities to determine if another screening activity is needed. If the results of a previous screening activity is satisfactory, the commercial vehicle agency may waive additional screening activities. However, a screening activity may be desired if there are inconsistencies in a previous screening activity or a previous screening activity was incomplete.

Thus, at commercial vehicle roadside check stations, an RSU shall transmit a request to CMVs for the results of a previous screening activity. These stations may be at fixed locations or mobile stations.

3.5.3.2.3.1 Commercial Screening Information Request - Mandatory Requirements

The following information is included in the request from an RSU to a CMV for its screening activity information.

3.5.3.2.3.1.1 Commercial Screening Information Request - Vehicle Identification

Each request for screening activity information is directed at a specific CMV. An RSU shall transmit the CMV's VIN as part of its request for a connected CMV's screening activity information.

3.5.3.2.3.2 Commercial Screening Information Request - Optional Requirements

The following are optional information that an RSU may include in its request to a CMV for its screening activity information.

3.5.3.2.3.2.1 Request Commercial Screening Information - Encounter ID

A commercial vehicle agency may be interested in only the results of a specific screening activity. Each screening activity is assigned an identifier. An RSU shall include the identifier of the screening activity it is requesting, as part of its request for a connected CMV's screening activity information.

3.5.3.2.4 Transmit Previous Screening Activity Result

A connected CMV shall transmit, upon request, the results of a previous screening activity, including the date and time of the activity, to a connected device. The CMV may share these results with other roadside check stations downstream, possibly resulting in those stations allowing the CMV to bypass further checks. Up to 4 previous screening activity results may be sent in the same message.

3.5.3.2.4.1 Transmit Previous Screening Activity Result - Mandatory Requirements

The information that is included in the previous screening activity results transmitted from a connected CMV to an RSU can be found in Section 3.5.3.2.1.1.

3.5.3.2.4.2 Transmit Previous Screening Activity Result - Optional Requirements

The optional requirements for a connected CMV to transmit its previous screening activity results to an RSU can be found in Section 3.5.3.2.1.2.

3.5.3.3 Commercial Vehicle Clearance Requirements

These requirements allow a commercial vehicle agency to either provide electronic clearance to a CMV, or provide further instructions to a CMV. The commercial vehicle agency may allow a CMV to bypass a roadside check station after all the safety inspections, weight inspections and credentials have been checked and verified. This allows CMVs to bypass roadside check stations, saving time for the driver.

The detailed requirements for sharing commercial vehicle clearance information between a commercial vehicle agency and a connected CMV are listed below.

3.5.3.3.1 Transmit Instructions

An RSU shall transmit instructions to a connected CMV about potential roadside checks at upcoming roadside check stations.

3.5.3.3.1.1 Transmit Instructions - VIN

An RSU shall include the VIN of the connected CMV that the instructions are intended for as part of the instructions transmitted to a connected CMV.

3.5.3.3.1.2 Transmit Instructions - Instructions

The following are the detailed requirements for the possible instructions that may be transmitted from an RSU to a connected CMV. Only one of the below instructions may be transmitted at any one time.

3.5.3.3.1.2.1 Transmit Instructions - Bypass

An RSU shall instruct a connected CMV to bypass a roadside check station as part of the instructions transmitted to a connected CMV. For example, a commercial vehicle agency may instruct a connected CMV to bypass a roadside check station because the station is closed, the CMV's credentials are in order, or a CMV's previous screening activity information was satisfactory.

3.5.3.3.1.2.2 Transmit Instructions - Pull-In Location

An RSU shall include the geographic location (longitude, latitude) of the roadside check station where a CMV should pull-into as part of the instructions transmitted to a connected CMV. The latitude and longitude are based on the WGS-84 coordinate system in units of $1/10^{th}$ micro degree. The roadside check station may be at a fixed, permanent location or a mobile station.

3.5.3.3.1.3 Transmit Instructions - Optional Requirements

If an RSU transmits the geographic location of the roadside check station where a CMV should pull-into as part of the instructions transmitted to a connected CMV, the following are the optional information that may be included.

3.5.3.3.1.3.1 Transmit Instructions - Pull-In Location Name

An RSU shall include the name of the roadside check station where a CMV should pull into as part of the instructions transmitted to a connected CMV. The name is a text name of the station.

3.5.3.3.1.3.2 Transmit Instructions - Pull-In Location Description

An RSU shall include a description of the roadside check station where a CMV should pull into as part of the instructions transmitted to a connected CMV. The textual description may include additional information about the roadside check station, such as what exit to use to get to the roadside check station (e.g., Exit xx).

3.5.3.3.2 Transmit Instructions Acknowledgement

A connected CMV shall transmit an acknowledgement to an RSU acknowledging the receipt of the roadside check instructions.

3.5.3.3.2.1 Transmit Instructions Acknowledgement - Mandatory Requirements

The following information is included in the acknowledgement transmitted from a connected CMV to an RSU.

3.5.3.3.2.1.1 Transmit Instructions Acknowledgement - VIN

A connected CMV shall include its VIN as part of its acknowledgement transmitted to an RSU confirming its receipt of the screening instructions.

3.5.3.3.2.2 Transmit Instructions Acknowledgement - Optional Requirements

If the connected CMV is instructed to pull into a roadside check station as part of its screening instructions, the following information is included in the acknowledgement transmitted from a connected CMV to an RSU.

3.5.3.3.2.2.1 Transmit Instructions Acknowledgement - Pull-In Location

A connected CMV shall retransmit the geographic location (latitude, longitude) of the roadside check station where the CMV should pull-into as part of its acknowledgement transmitted to an RSU confirming its receipt of the screening instructions.

3.5.3.3.2.2.2 Transmit Instructions Acknowledgement - Pull-In Location Name

A connected CMV shall retransmit the name of the roadside check station where the CMV should pull-into as part of its acknowledgement transmitted to an RSU confirming its receipt of the screening instructions.

3.5.4 Transit Vehicle Requirements

In addition to the generic vehicle requirements in Section 3.5.1, there are several requirements specific to public transit vehicles (PTV). These requirements include providing preferential treatment to PTVs to improve the throughput of travelers through the transportation network.

The detailed requirements for a connected PTV to exchange transit information are listed below.

3.5.4.1 Request Signal Priority Requirements

A connected public transit vehicle (PTV) approaching a signalized intersection may wish to send a priority request to stay on schedule. For example, a transit connected vehicle with a passenger load in revenue service and behind schedule may send a signal priority request to maintain its schedule.

The detailed requirements for a connected PTV to transmit requests for signal priority at an intersection are listed below.

3.5.4.1.1 Transmit Priority Request

A connected PTV shall transmit a signal service request message with its request for preferential treatment at a signalized intersection to an RSU.

3.5.4.1.2 Transmit Priority Request - Mandatory Requirements

The following are the minimum requirements for a connected PTV to transmit a request for preferential treatment at a signalized intersection to an RSU.

3.5.4.1.2.1 Transmit Priority Request - Message Identifier

A connected PTV shall include a request identifier for each signal service request transmitted to an RSU. The message (request) identifier is used to identify a sequence number within a stream of messages (of the same message type) from the connected PTV. The message identifier increments by one whenever the contents of the message has changed. This identifier is used by the RSU to distinguish between requests from different connected devices and to distinguish different requests from the same connected vehicle.

3.5.4.1.2.2 Transmit Priority Request - Intersection Identifier

A connected PTV shall include the unique identifier of the intersection that is the target of the signal service request transmitted to an RSU. The intersection identifier is assigned as part of a roadway geometric message broadcasted by an RSU at or near the intersection.

3.5.4.1.2.3 Transmit Priority Request - Operational Strategy

A connected PTV shall include the identifier of the operational strategy desired as part of the signal service request transmitted to an RSU. Each operational strategy defines the phases being serviced, the phases to be omitted, the maximum green time that can be reduced, or the maximum green time that can be extended to service the priority. For example, operational strategy number 3 may result in a signal controller extending the green time for the northbound approach, while operational strategy number 8 may result in a protected leading left turn for the transit vehicle traveling on the westbound approach.

It is assumed that the operational strategies are defined by the transportation agency that operates the traffic signal controller, with input from the transit agencies.

3.5.4.1.3 Transmit Priority Request - Optional Requirements

The following are the optional requirements for a connected PTV to include in a request for preferential treatment at a signalized intersection to an RSU. However, if the requirement is selected to be supported according to the PRL in Section 3.3.3 (Under the Support column), then that requirement is required to be implemented.

3.5.4.1.3.1 Transmit Priority Request - Approach Lane

A connected PTV shall include the lane number to be used to approach the intersection on as part of the signal service request transmitted to an RSU. The lane number is assigned by the RSU at the signalized intersection as part of the roadway geometrics information broadcasted by the RSU.

3.5.4.1.3.2 Transmit Priority Request - Egress Lane

A connected PTV shall include the lane number to be used to exit the intersection on as part of the signal service request transmitted to an RSU. The lane number is assigned by the RSU at the signalized intersection as part of the roadway geometrics information broadcasted by the RSU. The egress lane information is needed to determine which priority strategy may be appropriate for the connected PTV.

3.5.4.1.3.3 Transmit Priority Request - Validation

A connected PTV shall include a validation code as part of the signal service request transmitted to an RSU. The validation code is a string of bytes used by authorized connected vehicles to establish the validity of the signal service request and the identity of the vehicle. For example, the transportation agency that owns and operates the traffic signal controller may provide this validation code only to transit agencies it has agreements with. Without a proper validation code, the preferential request will be ignored by the traffic signal controller.

3.5.4.1.3.4 Transmit Priority Request - Vehicle Class

A connected PTV shall include its vehicle class type and level as part of the signal service request transmitted to an RSU. Signalized intersections can use the vehicle class type and vehicle class level to determine which vehicle receives priority in the event multiple conflicting requests are received by the same signalized intersection. Examples of vehicle class types may be public safety vehicle, transit vehicles, or commercial motor vehicles carrying freight. A signal service request from a higher vehicle class type will take priority over another a signal service request from a lower vehicle class type. In addition, within each vehicle class type, a vehicle may also be assigned a vehicle class level. For example, of a transit vehicle class type, a bus rapid transit vehicle may have a higher vehicle class level than a local transit vehicle. A signal service request with a higher vehicle class level will take priority over another a signal service request from a lower vehicle class level. The order of precedence for the signal service request priority is by signal priority vehicle class type and then class level.

3.5.4.1.3.5 Transmit Priority Request - Time of Service

A connected PTV shall include the time when the signal service is requested to start as part of the signal service request transmitted to an RSU. This is the estimated time in hours, minutes, and seconds that the connected vehicle arrives at the intersection's stopping point (e.g., stop bar).

3.5.4.1.3.6 Transmit Priority Request - End of Service

A connected PTV shall include the time when the signal service is requested to end as part of the signal service request transmitted to an RSU. This is the estimated time in hours, minutes, and seconds that the connected vehicle expects to have passed through the intersection. This is defined as the time the connected vehicle expects to pass through the intersection's stopping point (e.g., stop bar) at the downstream side of the intersection.

3.5.4.1.3.7 Transmit Priority Request - Vehicle Identity

A connected PTV shall include its vehicle identifier as part of the signal service request transmitted to an RSU. The vehicle identifier may be a permanent identifier assigned by the transit agency and used to track the service performance for that vehicle; or it may be a random number to ensure the overall anonymity of the connected device. The vehicle identifier is used to allow the RSU to distinguish requests from different connected vehicles and to distinguish different requests from the same connected vehicle.

3.5.4.1.3.8 Transmit Priority Request - Vehicle Location and Speed

A connected PTV shall include its current location, speed and heading as part of the signal service request transmitted to an RSU. This information may be used by the traffic signal controller to determine what operational strategy it will perform (service) in the event there are more than one conflicting) request for preferential treatment from different connected vehicles.

3.5.4.1.3.9 Transmit Priority Request - Service Information A connected PTV shall include its transit service status as part of the signal service request transmitted to an RSU. Such status information include the passenger load of the PTV, if the PTV is stopped, if the PTV vehicle door is open, and if the PTV is in the process of loading a mobility device (e.g., wheelchair) or bicycle (device that needs to be racked). The passenger load information may be used by the traffic signal controller to determine what operational strategy to service in the event there are more than one conflicting request for preferential treatment from different connected vehicles. The other status information to help the traffic signal controller determine when to provide preferential treatment if a transit vehicle is stopped to load/unload before reaching the intersection.

3.5.4.1.3.10 Transmit Priority Request Cancellation

A connected PTV shall transmit to an RSU a message to cancel a previously transmitted signal service request.

3.5.5 Probe Data Requirements

Probe data is designed to gather anonymous data from connected devices at a series of points throughout the roadway network. Agencies can use this data to monitor road conditions, identify incidents, and analyze and reduce the collected data for operational and planning strategies. The information is gathered according to a policy that manages how data is collected, stored, and transmitted. The default probe data collect policy is designed to collect data uniformly across the network.

The communication processes within connected devices are geographically limited. Thus data is needed in a manner such that connected devices, such as connected vehicles, collect data as they move through the network. This data should be saved and then transmitted to the infrastructure when a connection is made between the connected device and an RSU that provides the appropriate service (collecting probe data).

A snapshot is a collection of data values at a single point in time and space. The collection of this data is called probe data. All snapshots from a specific connected device contain the same collection of data: position, speed, heading, and those data elements for which the connected device is equipped, or appropriate for. For example, while position and heading can be collected from a connected vehicle or other connected mobile devices, vehicle type cannot be collected from a smart phone.

3.5.5.1 Probe Data Request

An RSU shall broadcast requests for the collection of a connected device's probe data. By requesting and collecting probe data from connected devices, agencies can use this data to monitor road conditions, identify incidents, and analyze and reduce the collected data for operational and planning strategies.

3.5.5.2 Transmit Probe Data Message

A connected device shall transmit a message with its probe data to an RSU upon request. This requirement allows a connected device to transmit its snapshots to an RSU for dissemination and processing. Each probe data message transmitted contains one to four snapshots. In a typical use, the connected device has collected one or more snapshots that it will send to a receiving RSU along with information (the vector) about the point in time and space when the snapshot was collected.

A maximum of four (4) snapshots was selected to protect the privacy of connected device, as four snapshots will limit the ability to track a device's trajectory. Another consideration to limiting the number of snapshots in a message is a connected device traveling at high speed may be unable to transmit more than a certain number of snapshots while remaining within the transmission range of the connected device and the RSU receiving the probe data.

3.5.5.2.1 Transmit Probe Data Information - Mandatory Requirements

The probe data collected by a connected device and transmitted to an RSU are listed below.

3.5.5.2.1.1 Transmit Probe Data - Probe Segment Number

Snapshots that are generated at periodic intervals (periodic snapshots) are tagged with a short-lived Probe Segment Number (PSN). A connected device shall include its PSN as part of the probe data message transmitted to an RSU. The purpose of the PSN is to identify a device's trajectory through the roadway network for applications such as signal control. The PSN is randomly generated by the connected device after traveling a certain distance or certain period of time, whichever comes last, so the PSN is not associated with a particular device (See Section 3.6.1.5.3.1). Snapshots with different PSNs cannot be transmitted within the same probe data message.

3.5.5.2.1.2 Transmit Probe Data - Position

A connected device shall include its position (latitude, longitude, elevation), based on the WGS-84 coordinate system, at the time of the transmission as part of the probe data message transmitted to an RSU. The latitude and longitude are measured in units of 1/10th micro degree. For connected vehicles, the elevation represents the location of the surface of the roadway above or below the WGS-84 reference ellipsoid in units of 1 decimeter.

The device position also can be used by transportation agencies to determine if there are any holes in their probe collection range. For example, by examining the device positions of all probe data collected, a transportation agency can determine if there is any geographic region where no probe data message has been received, potentially indicating a hole in their data collection.

3.5.5.2.1.3 Transmit Probe Data - Snapshots

A connected device shall include its accumulated data (snapshots) as part of the probe data message transmitted to an RSU. As anonymity is a concern, no more than 4 snapshots will be included in a probe data message. Each snapshot includes the date and time the snapshot was generated, the position (longitude, latitude, elevation) of the device and the device's sensor readings at the time the snapshot was generated.

For a connected vehicle, some sensor readings may not be available unless a vehicle network connection exists. In addition to any factory-installed devices, the vehicle network needs to support connections with original equipment manufacturer (OEM) devices, and after-market safety devices (ASD). If the connected vehicle has a vehicle network connection, and those sensor readings are available, all best efforts should be made to provide that data to the connected device on the connected vehicle.

Table 9 lists the sensor readings (data values) that are mandatory to be included in the snapshot, and the section where the sensor readings are described.

TABLE 9 - SNAPSHOT DATA - MANDATORY

Data	Section
Positional Accuracy	3.5.1.1.3.5
Transmission State	3.5.1.1.3.6
Heading	3.5.1.1.3.8
Device Acceleration	3.5.1.1.3.10
Device Vertical Acceleration	3.5.1.1.3.11
Yaw Rate	3.5.1.1.3.12
Braking Activity	3.5.1.1.3.13.1
Antilock Brake Status	3.5.1.1.3.13.2
Traction Control State	3.5.1.1.3.13.3
Stability Control Status	3.5.1.1.3.13.4
Braking Boost Status	3.5.1.1.3.13.5

Table 10 lists the sensor readings (data values) that are mandatory to be collected in the snapshot if that sensor reading is available, and the section where the sensor readings are described.

TABLE 10 - SNAPSHOT DATA

Data	Section
Broadcast Vehicle Information - Applied Pressure on the Vehicle Brakes	3.5.1.1.4.3.2
Wheel Vertical Acceleration	3.5.1.1.4.3.3
Vehicle Lights State	3.5.1.1.4.4.1
Vehicle Front Wiper Status	3.5.1.1.4.4.11
Vehicle Front Wiper Sweeping Rate	3.5.1.1.4.4.12
Vehicle Rear Wiper Status	3.5.1.1.4.4.13
Coefficient Of Friction	3.5.1.1.4.4.14
Solar Radiation	3.5.1.1.4.4.15
Ambient Air Temperature	3.5.1.1.4.4.16
Ambient Air Pressure	3.5.1.1.4.4.17
Precipitation Rate	3.5.1.1.4.4.19
Obstacle Information	3.5.1.1.4.5
Vehicle Status Change	3.5.1.1.4.6

3.5.5.2.2 Transmit Probe Data Information - Optional Requirements

The following are optional probe data that may be collected by a connected device and transmitted to an RSU.

3.5.5.2.2.1 Transmit Probe Data - Vehicle Type

A connected vehicle shall include its vehicle type (classification) of the vehicle, as defined by the FHWA 13-Category Classification System, as part of the probe data message transmitted to the RSU. Note that this requirement applies to connected vehicles only.

3.5.5.2.2.2 Transmit Probe Data - Identifier

A connected device shall include its identifier as part of its probe data message transmitted to an RSU. For example, for fleet devices such as maintenance and construction vehicles for a public work department, the device may send its identifier so that an agency can possibly track the path of the device. The identifier may be assigned by its owning agency, or it may be the vehicle's identification number (VIN).

3.5.5.2.2.3 Transmit Probe Data Information - Weather Report

Transportation agencies may wish to equip its fleet vehicles or personnel with additional sensors to collect road and atmospheric weather data to improve maintenance operations of its roadways by collecting existing road weather conditions, and to improve better weather forecasting. The collected information may also be shared with the broader weather community to improve weather forecasting and shared with the traveling public to improve better route planning.

The detailed requirements for a connected device to transmit weather reports to an RSU are listed below.

3.5.5.2.2.3.1 Transmit Probe Data - Wind Direction

A connected device shall include the measured (spot) wind direction at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The wind direction is the direction from which the wind is blowing measured in degrees clockwise from true North as measured by the wind sensor. The wind direction is measured from 0 degrees to 360 degrees, inclusively, in one degree units and corrected for the movement of the device.

3.5.5.2.2.3.2 Transmit Probe Data - Wind Speed

A connected device shall include the measured wind speed at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The wind speed is measured from 0 to 126 meters per second, in 1 meter per second units, corrected for the movement of the device.

3.5.5.2.2.3.3 Transmit Probe Data - Dewpoint Temperature

A connected device shall include the measured ambient dewpoint temperature at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The dewpoint temperature is measured from -100 to +100 degrees celsius, in one tenth of a degree celsius units.

3.5.5.2.2.3.4 Transmit Probe Data - Total Radiation

A connected device shall include the measured total radiation at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The total radiation is the total radiation hitting the sensor, and is measured from 0 to 1000 watts per square meter, in 1 watt per square meter units.

3.5.5.2.2.3.5 Transmit Probe Data - Visibility

A connected device shall include the measured surface visibility at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The visibility is measured from 0 to 100 kilometers, in units of one tenth of a meter.

3.5.5.2.2.3.6 Transmit Probe Data - Surface Temperature

A connected device shall include the measured surface temperature at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The surface temperature is the current temperature of the (roadway) pavement surface. The surface temperature is measured from -100 to +100 degrees celsius, in units of one tenth of a degree celsius.

3.5.5.2.2.3.7 Transmit Probe Data - Roadway Water/Ice Depth

A connected device shall include the measured depth of water or thickness of ice on the surface of the roadway at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The measured depth of water and thickness of ice is measured from 0 to 6553.4 millimeters, in units of one tenths of a millimeter.

3.5.5.2.2.3.8 Transmit Probe Data - Roadway Snow Depth

A connected device shall include the measured depth of unpacked snow on the surface of the roadway at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The measured depth of unpacked snow is measured from 0 to 3000 cm, in units of 1 cm.

3.5.5.2.2.3.9 Transmit Probe Data - Adjacent Snow Depth

A connected device shall include the measured depth of unpacked snow on representative areas other than the surface of the roadway at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The measured depth of unpacked snow is measured from 0 to 3000 cm, in units of 1 cm. Representative areas should avoid snow drifts and plowed areas.

3.5.5.2.2.4 Transmit Probe Data Information - Fuel

Transportation agencies may wish to determine what fuel types and fuel economy connected vehicles are using for environmental monitoring and as input to select and implement transportation operations and strategies based on environmental measures. These environmental strategies implement strategies to reduce the overall fuel consumed or reduce overall vehicle emissions.

The detailed requirements for a connected vehicles to transmit fuel information to an RSU are listed below.

3.5.5.2.2.4.1 Transmit Probe Data - Fuel Type

A connected vehicle shall include what type of fuel is used to power the engine at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The valid vehicle fuel types are: gasoline, diesel, biodiesel, electricity, ethanol, hydrogen, naturalgas, and propane.

3.5.5.2.2.4.2 Transmit Probe Data - Fuel Economy

A connected vehicle shall include its average fuel economy as part of the probe data message transmitted to an RSU. The average fuel economy is measured as the average tenths of a kilometer traveled per liter of fuel consumed over the life of the vehicle. The fuel economy can be used to distinguish vehicle types when applying eco-policies at an intersection or a region.

3.5.5.2.2.4.3 Transmit Probe Data - Fuel Remaining

A connected vehicle shall include the amount of fuel remaining as part of the probe data message transmitted to an RSU. The amount of fuel remaining in the vehicle's tank is measured in deciliter units. Large trucks may have multiple tanks.

3.5.5.2.2.4.4 Transmit Probe Data - Charge Remaining

An electric connected vehicle shall include the amount of charge remaining in its battery as part of the probe data message transmitted to an RSU. The amount of charge remaining is measured in one tenth of a kilowatt-hour.

3.5.5.2.2.5 Transmit Probe Data Information - Emissions

Transportation agencies may wish to determine the amount of emissions from a connected vehicle for environmental monitoring and as input for forecasting models.

The detailed requirements for a connected vehicles to transmit emissions information to an RSU are listed below.

3.5.5.2.2.5.1 Transmit Probe Data - CO Emissions (Running)

A moving connected vehicle shall include the average amount of carbon monoxide emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. Carbon monoxide forms when carbon in fuel doesn't burn completely (incomplete combustion). The average amount of carbon monoxide emitted by a moving vehicle is measured in milligrams per kilometer.

3.5.5.2.2.5.2 Transmit Probe Data - CO Emissions (Idling)

An idling connected vehicle shall include the average amount of carbon monoxide emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. Carbon monoxide forms when carbon in fuel doesn't burn completely (incomplete combustion). The average amount of carbon monoxide emitted by an idling (not moving) vehicle is measured in decigrams per hour.

3.5.5.2.2.5.3 Transmit Probe Data - NOx Emissions (Running)

A moving connected vehicle shall include the average amount of nitrogen oxide (NOx) emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. In atmospheric chemistry, air pollution, and related fields, nitrogen oxides refers specifically to NOx (NO and NO2). The average amount of nitrogen oxide emitted by a moving vehicle is measured in centigrams per kilometer.

3.5.5.2.2.5.4 Transmit Probe Data - NOx Emissions (Idling)

An idling connected vehicle shall include the average amount of nitrogen oxide (NOx) emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. In atmospheric chemistry, air pollution, and related fields, nitrogen oxides refers specifically to NOx (NO and NO2). The average amount of nitrogen oxide emitted by an idling (not moving) vehicle is measured in centigrams per hour.

3.5.5.2.2.5.5 Transmit Probe Data - SO2 Emissions (Running)

A moving connected vehicle shall include the average amount of sulfur dioxide (SO2) emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. Some fuels generate sulfur dioxide after combustion. The average amount of sulfur dioxide emitted by a moving vehicle is measured in 0.1 milligrams per kilometer.

3.5.5.2.2.5.6 Transmit Probe Data - SO2 Emissions (Idling)

An idling connected vehicle shall include the average amount of sulfur dioxide (SO2) emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. Some fuels generate sulfur dioxide after combustion. The average amount of sulfur dioxide emitted by an idling (not moving) vehicle is measured in 0.1 milligrams per hour.

3.5.5.2.2.5.7 Transmit Probe Data - CO2 Emissions (Running)

A moving connected vehicle shall include the average amount of carbon dioxide (CO2) emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The average amount of carbon dioxide emitted by a moving vehicle is measured in decigrams per kilometer.

3.5.5.2.2.5.8 Transmit Probe Data - CO2 Emissions (Idling)

An idling connected vehicle shall include the average amount of carbon dioxide (CO2) emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The average amount of nitrogen oxide emitted by an idling (not moving) vehicle is measured in decigrams per hour.

3.5.5.2.2.5.9 Transmit Probe Data - PM10 Emissions (Running)

A moving connected vehicle shall include the average amount of particulate matter smaller than 10 microns (PM10) in diameter emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. Particulate matter are solid or liquid particles found in the air. The average amount of PM10 emitted by a moving vehicle is measured in milligrams per kilometer.

3.5.5.2.2.5.10 Transmit Probe Data - PM10 Emissions (Idling)

An idling connected vehicle shall include the average amount of particulate matter smaller than 10 microns (PM10) in diameter emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. Particulate matter are solid or liquid particles found in the air. The average amount of PM10 emitted by an idling (not moving) vehicle is measured in milligrams per hour.

3.5.5.2.2.5.11 Transmit Probe Data - PM2.5 Emissions (Running)

A moving connected vehicle shall include the average amount of particulate matter smaller than 2.5 microns (PM2.5) in diameter emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. Particulate matter are solid or liquid particles found in the air. The average amount of PM2.5 emitted by a moving vehicle is measured in milligrams per kilometer.

3.5.5.2.2.5.12 Transmit Probe Data - PM2.5 Emissions (Idling)

An idling connected vehicle shall include the average amount of particulate matter smaller than 2.5 microns (PM2.5) in diameter emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. Particulate matter are solid or liquid particles found in the air. The average amount of PM2.5 emitted by an idling (not moving) vehicle is measured in milligrams per hour.

3.5.5.2.2.5.13 Transmit Probe Data - VOC Emissions (Running)

A moving connected vehicle shall include the average amount of volatile organic compounds (VOC) emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The average amount of VOCs emitted by a moving vehicle is measured in milligrams per kilometer.

3.5.5.2.2.5.14 Transmit Probe Data - VOC Emissions (Idling)

An idling connected vehicle shall include the average amount of volatile organic compounds (VOC) emitted by the vehicle at the time the snapshot was generated as part of the probe data message transmitted to an RSU. The average amount of VOCs emitted by an idling (not moving) vehicle is measured in decigrams per hour.

3.5.5.3 Broadcast Probe Management Information

An RSU shall broadcast to connected devices a message to manage the policy for the collection and transmission of probe data by the devices. This requirement allows an agency, such as a traffic management agency, to modify the policy of data collection and transmission inside a connected device. For example, an operator of a rural road with long stretches between RSUs could modify the distance between snapshots to gather data along the entire road length. An adaptive traffic signal controller may modify the data collection and reporting frequency to obtain device trajectory data to assist in signal optimization.

3.5.5.3.1 Broadcast Probe Management Information - Mandatory Requirements

The probe management information broadcasted from an RSU to connected devices to manage the policy for probe data collection and transmission for a connected device are listed below.

3.5.5.3.1.1 Manage Probe - Sample Size

An RSU shall include the criteria to determine if the probe data collection policy being transmitted is applicable as part of the probe management message broadcasted to connected devices. This requirement allows only a fixed percentage of devices to be affected by the data collection policy changes requested in the probe management message. The sample size is determined inclusively by a start value and an end value of the last two digits of a device's MAC address.

3.5.5.3.1.2 Manage Probe - Configure Termination Parameters

The probe management process in a device as configured by an RSU is intended to be only transitory in nature - after a defined period of time or distance, the connected device should return to its default probe collection policy. Because of the variety of environments (e.g., urban, rural) that the probe management process needs to operate in, the probe management process needs to support termination based on time or distance.

The requirements for an RSU to terminate a probe management process in a connected device are listed below.

3.5.5.3.1.2.1 Manage Probe - Termination Time

An RSU shall include the amount of time, in one second increments, to be traveled by the connected device before the temporary probe management policies ceases, as part of the probe management message broadcasted to connected devices.

3.5.5.3.1.2.2 Manage Probe - Termination Distance

An RSU shall include the distance, in one meter units, to be traveled by the connected device before the temporary probe management policies ceases, as part of the probe management message broadcasted to connected devices.

3.5.5.3.1.3 Manage Probe - Configure Snapshot Generation Parameters

A snapshot is comprised of device attributes and sensor data that are collected at a point in time by the connected device. How often a snapshot is generated by a connected device will vary based on the speed and the purpose for collecting the probe data. For example, the frequency of collecting probe data from connected vehicles in an urban environment, where an RSU collecting probe data may be located every quarter mile, will likely be higher than the frequency of collecting probe data in a rural environment, where an RSU collecting probe data may be located every ten miles. Thus, the time interval between each data accumulation need to vary based on different ranges of speed of the connected device.

The requirements for an RSU to configure the parameters for when a connected device will accumulate record data (take a snapshot) are listed below.

3.5.5.3.1.3.1 Manage Probe - Generation by Time

An RSU shall include the parameters to configure the time intervals, in one second units, between snapshots (data accumulation) in the connected device, as part of the probe management message broadcasted to connected devices. A lower interval and a higher interval are sent, along with a lower speed threshold and higher speed threshold. The speed thresholds are measured in units of one tenth of a meter per second. The lower interval is the time between snapshots when the connected device is traveling at or below the lower speed threshold. The higher interval is the time between snapshots when the connected device is traveling at or above the higher speed threshold. The interval between snapshots when the connected device is traveling between the lower and higher speed thresholds is a linear relationship between the corresponding lower and higher intervals.

3.5.5.3.1.3.2 Manage Probe - Generation by Distance

An RSU shall include the parameters to configure the distance intervals, in one meter units, between snapshots (data accumulation) in the connected device based on the distance traveled, as part of the probe management message broadcasted to connected devices. A lower interval and a higher interval are sent, along with a lower speed threshold and higher speed threshold. The speed thresholds are measured in units of one tenth of a meter per second. The lower interval is the distance between snapshots when the connected device is traveling at or below the lower speed threshold. The higher interval is the distance between snapshots when the connected device is traveling at or above the higher speed threshold. The interval between snapshots when the connected device is traveling between the lower and higher speed thresholds is a linear relationship between the corresponding lower and higher intervals.

3.5.5.3.2 Broadcast Probe Management Information - Optional Requirements

The following are the optional probe management information that may be broadcasted from an RSU to connected devices to manage the policy for probe data collection and transmission for a connected device.

3.5.5.3.2.1 Manage Probe - Heading Slice

An RSU shall include the heading slices that a device is traveling towards (direction of motion) as part of the probe management message broadcasted to connected devices. The probe management process broadcasted will apply only those devices traveling in the direction(s) included in the heading slice(s). For example, a signal controller application may be interested only in vehicles traveling in an easterly heading, thus the probe management message would include heading slices in an easterly direction. Each heading slice is 22.5 degrees wide, resulting in 16 possible heading slices.

3.5.5.3.2.2 Manage Probe - Interval Between Transmissions

An RSU shall include the time interval, in one second units, between probe data transmissions from the connected device to the RSU as part of the probe management message broadcasted to connected devices. For example, if as part of the probe management message a connected device is collecting snapshots once every two seconds, the RSU might also transmit that the connected device send its probe data to the RSU every two seconds.

3.5.5.3.2.3 Manage Probe - Start and Stop Snapshots

A connected device can generate snapshots based on starts and stops. Starts and stops are useful indicators in a variety of traffic flow measures, including incident detection and clearance, and traffic signal operational measures such as cycle failures - where the queue does not dissipate in the first green phase, and for ramp metering. See Section 0 for the definition of a start and stop.

3.5.5.3.2.3.1 Manage Probe - Stop Time Threshold

An RSU shall include the stop time threshold, in one tenth of a second units, as part of the probe management message broadcasted to connected devices. A connected device is considered stopped when there is no movement for at least this stop time threshold and when no other stops have occurred within another threshold time (last stop threshold). For example, if the stop time threshold is 5.0 seconds and the last stop threshold is 15.0 seconds, then the device is considered stopped if it has not moved for at least 5.0 seconds and no other stops has occurred for the last 15.0 seconds.

3.5.5.3.2.3.2 Manage Probe - Last Stop Threshold

An RSU shall include the last stop threshold, in one tenth of a second units, as part of the probe management message broadcasted to connected devices. A connected device is considered stopped when there is no movement for at least the stop time threshold and when no other stops have occurred for at least this threshold time (last stop threshold). For example, if the stop time threshold is 5.0 seconds and the last stop threshold is 15.0 seconds, then the device is considered stopped if it has not moved for at least 5.0 seconds and no other stops has occurred for the last 15.0 seconds. The last stop threshold prevents multiple counts when cars creep forward.

3.5.5.3.2.3.3 Manage Probe - Start Speed Threshold

An RSU shall include the start speed threshold, in .02 meters per second units, as part of the probe management message broadcasted to connected devices. A connected device is no considered stopped when its point speed exceeds this start speed threshold. For example, if the start speed threshold is set to 4.5 meters per second, if a connected device stops (i.e., there is no movement) and then starts moving again, the device is considered to remain stopped until its point speed exceeds 4.5 meters per second.

3.5.5.3.2.4 Manage Probe - Event Triggered Snapshots

A connected device can generate snapshots based on events, that is, based on a change in status elements, either a state change (e.g., from off to on) or when a value exceeds a specific threshold or undergoes a transition. The purpose of event triggered snapshots is to record the device's data and sensor readings when the device undergoes a transition or a value exceeds a threshold. Such data can be used to determine the location of a slippery road section or the location of a pothole. Threshold values can also be set for the measured value of a vehicle's vertical acceleration. State changes includes a change in the status of stability control, traction control, or anti-lock brakes.

An RSU needs to be able to temporarily change the event triggers of a connected device, such as transmitting the threshold values that triggers the generation of a snapshot. For example, an RSU can temporarily remove the event triggered snapshot based on a change in Vehicle Lights Status for a connected vehicle about to enter or exit a tunnel. Also, an RSU can temporarily change the thresholds that generate a start and stop thresholds while a connected vehicle goes through a work zone where heavy delays are expected.

The detailed requirements for an RSU to configure the parameters for when a connected device will generate a snapshot based on an event are listed below.

3.5.5.3.2.4.1 Manage Probe - Support Reading

An RSU shall include an instruction to a connected device to include all sensor readings available and supported by the standard when it generates a snapshot as part of the probe management message broadcasted to connected devices.

3.5.5.3.2.4.2 Manage Probe - Support Greater Than Event

An RSU shall include an instruction to a connected device to generate a snapshot when a specified sensor value exceeds a defined threshold, as part of the probe management message broadcasted to connected devices. For example, an RSU may include a threshold for a connected device's elevation so an agency can sample how many devices take an on-ramp to an elevated roadway. This connected device will then generate a snapshot if its elevation goes above the threshold established by the RSU.

3.5.5.3.2.4.3 Manage Probe - Support Less Than Event

An RSU shall include an instruction to a connected device to generate a snapshot when a specified sensor value falls below a defined threshold, as part of the probe management message broadcasted to connected devices. For example, an RSU may change the threshold for the coefficient of friction on a maintenance vehicle so the vehicle generates a snapshot whenever the measured coefficient of friction drops below the threshold. This is useful to determine locations where the roadway surface may be slippery.

3.5.6 Broadcast Roadway Geometrics Requirements

Roadway geometric information is used to provide connected devices with information about the roadway geometry, including intersection descriptions, speed curve outlines, and roadway segment information. For example, roadway geometric data can be used by a connected vehicle to support warnings to drivers for accident prevention.

The detailed requirements for providing roadway geometric information from the infrastructure to connected devices are as follows.

3.5.6.1 Broadcast Roadway Geometrics

An RSU shall broadcast a message with information about the roadway geometrics to connected devices. The following sub-requirements identify the types of information allowed to support roadway geometrics.

3.5.6.1.1 Broadcast Roadway Geometrics - Message Identifier

An RSU shall include a message identifier as part of the roadway geometrics information broadcasted to connected devices. The message identifier is used to identify a message within a stream of messages (of the same message type) from the RSU. The message identifier increments by one whenever the contents of the message has changed. This requirement allows a receiving connected device to ignore (not process) messages from an RSU when the content has not changed.

3.5.6.2 Broadcast Details of an Intersection Geometric

At intersections, connected vehicles need a geometric description of the intersection, including information about each lane approaching the intersection. This description allows connected devices to determine the coordinates and geometry of the intersection, and determine the permitted maneuvers at the intersection.

3.5.6.2.1 Broadcast Intersection - Mandatory Requirements

The following are the minimum requirements for an RSU to broadcast roadway geometric information for an intersection to connected devices.

3.5.6.2.1.1 Broadcast Intersection - Identifier

An RSU shall include the unique identifier of the intersection as part of the geometric information broadcasted to connected devices. This identifier is used to uniquely define an intersection within a country or region.

3.5.6.2.1.2 Broadcast Intersection - Reference Point

An RSU shall include the geographic location (latitude, longitude, elevation) of a reference point for the intersection as part of the geometric information broadcasted to connected devices. This reference point will be used to determine the offset for other data points. The latitude and longitude are measured in units of 1/10th microdegrees. The elevation represents the intersection’s geographic position above or below the WGS-84 reference ellipsoid in units of 1 cm.

3.5.6.2.1.3 Broadcast Intersection - Lane Default Width

An RSU shall include the default lane width for the intersection as part of geometric information broadcasted to connected devices. The default lane width, measured in one centimeter units, is used so a lane width does not have to be transmitted for each lane at the intersection. For each lane at an intersection, the default lane width is used unless a lane width is broadcasted for that specific lane.

3.5.6.2.1.4 Broadcast Intersection - Lane Description Requirements

The detailed requirements for an RSU to describe a lane at an intersection to connected devices are as follows.

3.5.6.2.1.4.1 Broadcast Intersection - Egress Lanes

An RSU shall include all the vehicular lanes that are leaving the intersection as part of the geometric information broadcasted to connected devices. These lanes, known as egress lanes, allow vehicles that have entered into the intersection to exit out of the same intersection.

3.5.6.2.1.4.2 Broadcast Intersection - Approach Lanes

An RSU shall include all the vehicular lanes that are approaching the intersection as part of the geometric information broadcasted to connected devices. These lanes, known as approach lanes, allow vehicles to enter into an intersection.

3.5.6.2.1.4.3 Broadcast Intersection - Lane Number

For each lane at an intersection, the RSU shall include a lane number as part of the geometric information broadcasted to connected devices. Each lane number shall be unique for that intersection.

3.5.6.2.1.4.4 Broadcast Intersection - Lane Centerline Coordinates

For a lane at an intersection, an RSU shall include a sequence of node locations that together describe the path of the lane’s center line, as part of the geometric information broadcasted to connected devices. Each node location (x-axis, y-axis, and z-axis, based on the WGS-84 coordinate system and its reference ellipsoid) is represented as an offset, in one centimeter units, from the previous node. The first node location should be the node that is closest to the geometric center of the intersection, and is typically at the stop line of the lane, and the offset values should be the offset from the intersection’s reference point (See Section 3.5.6.2.1.2). Each subsequent set of offset values (node) is additive and is the offset from the location of the previous node.

Note that the number (and location) of nodes needed to represent the path of a lane shall be selected such that the perpendicular distance between the lane center line and the straight line connecting the two consecutive nodes is less than 1 meter. For example, two nodes may be sufficient to represent a straight lane, while for a curved roadway segment, more nodes will be needed. Also, note that a tolerance of 1 meter is effectively 2 meters, when considering the position of a vehicle within a lane may be off by one meter and another vehicle in the adjacent lane may be off by one meter in the opposite direction.

3.5.6.2.1.5 Broadcast Intersection - Lane Attributes Requirements

Three types of travelers, and thus intersection lanes, are supported by this standard: general motorized vehicles, pedestrians (including bicyclists), and specialized motor vehicles. Vehicular lanes are lanes for motorized vehicles; pedestrian lanes (cross walks) are for pedestrians, including non-motorized vehicles such as bicycles; while special lanes are for lanes for a specific type of motorized vehicle such as trains or transit vehicles.

The detailed requirements for an RSU to broadcast the attributes of a lane at an intersection to connected devices are as follows.

3.5.6.2.1.5.1 Broadcast Intersection - Vehicle Lane Movements

For each vehicular lane at an intersection, an RSU shall include the allowed (valid) movements from the lane as part of the geometric information broadcasted to connected devices. The allowed movements indicate the types of movement(s) permitted through the intersection and the type(s) of vehicles that are allowed to perform those movements. Valid movement values are no data available, straight, left, right, yield, no U-turn, no turn on red, no stop, HOV lane, bus only, bus and taxi only, bike lane, egress path, shared lane, and a ramp/maneuver into or from a HOV lane. The egress path is a described path representing the outbound flow of traffic from the intersection. The shared lane represents a lane, generally in the center of the roadway, that can be used as a left turn lane for both directions of traffic. A lane may have more than one valid movement value - for example, a lane may have straight, left, right and no U-turn as valid movement values.

3.5.6.2.1.5.2 Broadcast Intersection - Pedestrian Lane Movements

For each pedestrian lane at an intersection, an RSU shall include the allowed (valid) movements from the lane as part of the geometric information broadcasted to connected devices. The allowed movements for a pedestrian lane are related to the type of crosswalk, bicycle-crossing, or non-motorized lane as follows: no data available, two-way path, pedestrian crosswalk only, bicycle crossing only, and a railroad track is present. Two-way path indicates that the lane is open to all non-motorized travelers.

3.5.6.2.1.5.3 Broadcast Intersection - Special Lane Movements

For each special lane at an intersection, an RSU shall include the allowed (valid) movements from the lane as part of the geometric information broadcasted to connected devices. The allowed movements indicate the allowed navigational maneuvers through the intersection and any other restrictions. Valid movement values for special lanes are no data available, egress path, railroad track, transit-only lane, HOV lane, bus only lane, vehicles entering the lane only, and vehicles leaving the lane only, and eco-lane. The egress path is a described path representing the outbound flow of traffic from the intersection.

3.5.6.2.2 Broadcast Intersection - Optional Requirements

The following are the optional requirements for an RSU to broadcast roadway geometrics information to connected devices. However, if the requirement is selected to be supported according to the PRL in Section 3.3.3 (Under the Support column), then that requirement is required to be implemented.

3.5.6.2.2.1 Broadcast Intersection - Version Identifier

An RSU shall include a version identifier as part of the geometrics information broadcasted to connected devices. This version identifier is used to identify the version of the roadway geometrics currently being broadcasted from the RSU. A map version identifier should be assigned whenever the roadway geometrics change. For example, an intersection may have an approach with two reversible lanes, which are used as egress lanes in the morning, and allows vehicles to enter the intersection at all other times. This intersection may have a version identifier of "2" during the weekday morning peak hours, and a version identifier of "3" all other times. If the intersection geometrics were to change, e.g., a new lane was added to the approach, it would be assigned a new version identifier.

This requirement allows a receiving connected device to ignore (not process) the intersection's geometric information if the geometric information has not changed. A connected device also may have the capability to store the intersection's geometric information in its memory - if that connected device already has that version of the geometric information stored, the device may ignore the remainder of the geometric information being transmitted, if the version identifier has not changed.

3.5.6.2.2.2 Broadcast Intersection - Computed Lane

For a lane at an intersection, an RSU shall include an offset value from another defined lane at the intersection, to indicate its path relative to a parallel lane as part of the geometric information broadcasted to connected devices. The offset value indicates the perpendicular distance, in centimeters, between the centerline of the parallel lane and the centerline of the subject (computed) lane. This offset value also includes the lane number of the parallel (referenced) lane. This requirement reduces the bandwidth needed to define parallel lanes at an intersection - instead of transmitting a new sequence of offset values for each lane, only an offset value and the lane number of a referenced lane is transmitted.

3.5.6.2.2.3 Broadcast Intersection - Crossings

An RSU shall include all the crossings in the intersection as part of the geometric information broadcasted to connected devices. Crossings can generally be considered bi-directional and do not have approaches or egresses. The users of crossings are typically not vehicles but include pedestrians, bicyclists or railroad cars (including light rail).

3.5.6.2.2.4 Broadcast Intersection - Lane Width

For each lane at an intersection, an RSU shall include its lane width as part of the geometric information broadcasted to connected devices. This is the lane width, in one centimeter units, at each offset value defining the path of the lane. A non-zero value will take precedence over the default lane width for the intersection, otherwise the default lane width for the intersection (See Section 3.5.6.2.1.3) should be used.

3.5.6.2.2.5 Broadcast Intersection - Node Lane Width

For a lane at an intersection, an RSU shall include its lane width at each node location describing the path of the lane as part of the geometric information broadcasted to connected devices. This requirement allows an RSU to broadcast the width of the lane at each node (offset value) for lanes when the width of the lane varies. A non-zero value will take precedence over the default lane width for the intersection (See Section 3.5.6.2.1.3) and any lane width defined for length of the lane (See Section 3.5.6.2.2.4). It is expected that if the lane width at each node is broadcast, a lane width for the length of the lane will not be broadcasted.

3.5.6.2.2.6 Broadcast Intersection - Egress Connection

For each approach lane at an intersection, an RSU shall include the lanes that the subject lane connects to, called the egress lanes, as part of the geometric information broadcasted to connected devices. Each egress lane that the subject lane connects to, is identified by its lane number (See Section 3.5.6.2.1.4.3). The egress lane information is needed because potential pedestrian conflicts on the far side has an effect on the turning movement times for that vehicle.

A maneuver code indicating the vehicle maneuver needed to turn into the egress lane is also included. Valid maneuver codes are unknown (or not applicable), uTurn, leftTurn, rightTurn, straightAhead, softLeftTurn, and softRightTurn. SoftLeftTurn and softRightTurn are used only if more than one left turn or one right turn, respectively, is allowed at the intersection.

3.5.6.2.2.7 Broadcast Intersection - Computed Intersection

Often, intersections along an arterial have the exact same intersection geometrics (e.g., number of lanes, lane directions, lane widths, etc…). For these intersections that follow repeating patterns, "citing" a reference intersection instead of resending the same intersection geometrics but with a different location, significantly reduces the amount of data that has to be broadcasted. Thus, an RSU shall include the referenced intersection and orientation, as part of the geometric information of an intersection broadcasted to connected devices. An intersection that "cite" a referenced intersection for its geometric information, is called a computed intersection. The orientation, measured in 0.0125 degree units, define the rotation of the intersection geometrics relative to the referenced intersection, with orientations to the east in the positive direction (i.e., east is +90.0000 degrees).

3.5.6.2.2.8 Broadcast Signal Control Zone Requirements

The signal control zone is a geo-physical zone of an intersection where a specific signal priority or signal preempt scheme is allowed to be requested by an authorized connected vehicle for a traffic signal. Authorized connected vehicles may issue a preempt or priority request for a given movement. More than one signal control zone may be defined for an intersection.

The detailed requirements for an RSU to broadcast the signal control zones for an intersection as part of the geometric information are listed below.

3.5.6.2.2.8.1 Broadcast Preempt or Priority Scheme

An RSU shall include the available preempt and priority operational strategies for a specific zone at the intersection, as part of the geometric information broadcasted to connected devices.

3.5.6.2.2.8.2 Broadcast Preempt or Priority Scheme - Valid Lane

An RSU shall include the lane number(s) that a preempt or priority scheme is valid for as part of the geometric information broadcasted to connected devices. The lane number is defined in Section 3.5.6.2.1.4.3.

3.5.6.2.2.8.3 Broadcast Preempt or Priority Scheme - Valid Zone

For each lane, an RSU shall include a sequence of offset values relative to the intersection’s reference point that together define the center line of the valid zone where a preempt or priority scheme is valid for as part of the geometric information broadcasted to connected devices. This sequence of offset values form nodes that are a description of the path of this valid zone towards the intersection, starting with the node (point) that is closest to the intersection, which is typically the stop line of the lane. The offset values (x-axis, y-axis, and z-axis, based on the WGS-84 coordinate system and its reference ellipsoid) are measured in one centimeter units, with each successive node being located further along the path from the intersection reference point (See Section 3.5.6.2.1.2).

The width of the valid zone, in one centimeter units, along the centerline is also included as part of the geometric information broadcasted to connected devices.

3.5.6.3 Broadcast Details of a Roadway Segment

Connected devices need geometric descriptions of roadway segments on freeways and between intersections, particularly on curved segments. These descriptions allow connected devices to determine the curvature of the roadway, the banking of the roadway, and the permitted movements.

3.5.6.3.1 Broadcast Roadway Segment - Mandatory Requirements

The following are the minimum requirements for an RSU to broadcast roadway geometric information for a roadway segment to connected devices.

3.5.6.3.1.1 Broadcast Roadway Segment - Identifier

An RSU shall include an identifier of the roadway segment as part of the geometric information broadcasted to connected devices. This identifier is used to uniquely define the roadway segment within a country or region.

3.5.6.3.1.2 Broadcast Roadway Segment - Reference Point

An RSU shall include the geographic location (latitude, longitude, elevation) of a reference point for the roadway segment as part of the geometric information broadcasted to connected devices. This reference point will be used to determine the offset for other data points. The latitude and longitude are measured in units of 1/10th micro degree. The elevation represents the geographic position of the roadway surface above or below the WGS-84 reference ellipsoid in units of 1 decimeter. It is recommended that the reference point be at the “beginning" of the roadway segment to make calculations to determine the trajectory of the roadway segment easier.

3.5.6.3.1.3 Broadcast Roadway Segment - Lane Default Width

An RSU shall include the default lane width of each lane on the roadway segment as part of geometric information broadcasted to connected devices. The default lane width, measured in one centimeter units, may be used so a lane width does not have to be broadcasted for each lane of the roadway segment.

3.5.6.3.1.4 Broadcast Roadway Segment - Lane Description Requirements

The detailed requirements for an RSU to describe a lane on a roadway segment to connected devices are as follows.

3.5.6.3.1.4.1 Broadcast Roadway Segment - Lane Number

For each lane on a roadway segment, the RSU shall assign a lane number as part of the geometric information broadcasted to connected devices. Each lane along a roadway segment is assigned a unique lane number for that roadway segment identifier.

3.5.6.3.1.4.2 Broadcast Roadway Segment - Lane Path

For each lane on a roadway segment, the path of the lane's centerline is needed to determine the type of vehicles allowed in the lane. The path is defined by one of two methods.

3.5.6.3.1.4.3 Broadcast Roadway Segment - Lane Centerline Coordinates

For a lane on a roadway segment, an RSU shall include a sequence of node locations representing the path of the lane's center line, as part of the geometric information broadcasted to connected devices. Each node location (x-axis, y-axis, and z-axis) is based on the WGS-84 coordinate system and its reference ellipsoid and is represented as an offset, in one centimeter units, from the previous node. The first node location should be the most upstream node (point) of the lane (within the road segment) in the normal direction of traffic, and the offset values should be the offset from the roadway segment's reference point (See Section 3.5.6.3.1.2). Each subsequent set of offset values (node) is additive and is the offset from the location of the previous node.

Note that the number (and location) of nodes needed to represent the path of a lane shall be selected such that the perpendicular distance between the lane center line and the straight line connecting the two consecutive nodes is less than 1 meter. For example, two nodes may be sufficient to represent a straight roadway segment, while for a curved roadway segment, more nodes will be needed. Also, note that a tolerance of 1 meter is effectively 2 meters, when considering the position of a vehicle within a lane may be off by one meter and another vehicle in the adjacent lane may be off by one meter in the opposite direction.

3.5.6.3.1.4.4 Broadcast Roadway Segment - Computed Lane

For a lane at an intersection, an RSU shall include an offset value from another defined lane on the roadway segment, to indicate its path relative to a parallel lane as part of the geometric information broadcasted to connected devices. The offset value indicates the perpendicular distance, in centimeters, between the centerline of the parallel lane and the centerline of the subject (computed) lane. This offset value also includes the lane number of the parallel (referenced) lane. This requirement reduces the bandwidth needed to define parallel lanes at an intersection - instead of transmitting a new sequence of offset values for each lane, only an offset value and the lane number of a referenced lane is transmitted.

3.5.6.3.1.4.5 Broadcast Roadway Segment - Lane Attributes

For each lane on a roadway segment, an RSU shall include a lane description as part of the geometric information broadcasted to connected devices. The valid lane descriptions are defined in Section 6.18, DE_Lane/Roadway Descriptions, in SAE J2540/2.

3.5.6.3.2 Broadcast Roadway Segment - Optional Requirements

The following are the optional requirements for an RSU to broadcast the geometric information of a roadway segment to connected devices. However, if the requirement is selected to be supported according to the PRL in Section 3.3.3 (Under the Support column), then that requirement is required to be implemented.

3.5.6.3.2.1 Broadcast Roadway Segment - Version Identifier

An RSU shall include a version identifier as part of the geometrics information broadcasted to connected devices. This version identifier is used to identify the version of the roadway segment geometrics currently being broadcasted from the RSU. A map version identifier should be assigned whenever the roadway geometrics of the roadway segment change. For example, a roadway segment may be a two-way, three lane roadway, with the middle lane being used as an HOV lane in the morning, and the middle lane being used two-way left-turn lane during the weekday morning peak hours. This roadway segment may have a map version identifier of "2" during the weekday morning peak hours, and a map version identifier of "3" all other times. If the roadway geometrics were to change, e.g., a fourth lane was added, it would be assigned a new map version identifier.

This requirement allows a receiving connected device to ignore (not process) the roadway geometric information of a roadway segment if the roadway geometric information has not changed. A connected device also may have the capability to store the roadway geometric information in its memory - if that connected device already has that version of the geometric information stored, the device may ignore the remainder of the geometric information being transmitted, if the version identifier has not changed.

3.5.6.3.2.2 Broadcast Roadway Segment - Lane Width

For each lane on a roadway segment, an RSU shall include its lane width, in one centimeter units, as part of the geometric information broadcasted to connected devices. A non-zero value will take precedence over the default lane width for the roadway segment defined in Section 3.5.6.3.1.3.

3.5.6.3.2.3 Broadcast Roadway Segment - Node Lane Width

For each lane on a roadway segment, an RSU shall include its lane width at each node location describing the path of the lane as part of the geometric information broadcasted to connected devices. This requirement allows an RSU to broadcast the width of the lane at each node for lanes when the width of the lane varies. A non-zero value will take precedence over the default lane width for the roadway segment (See 3.5.6.3.1.3) and any lane width defined for length of the lane (See Section 3.5.6.3.2.2). It is expected that if the lane width at each node is broadcast, a lane width for the length of the lane will not be broadcasted.

3.5.6.3.2.4 Broadcast Roadway Segment - Superelevation

For each lane on a roadway segment, an RSU shall include the superelevation, or banking of the roadway, as part of the geometric information broadcasted to connected devices. The purpose of employing superelevation of the roadway cross section is to counterbalance the centrifugal force, or outward pull, of a vehicle traversing a horizontal curve. The superelevation, in tenths of a percent, is measured at each node across the width of the lane. A positive superelevation represents a bank where the edge of the lane closest to the reference point has a lower elevation than the edge of the lane furthest from the reference point.

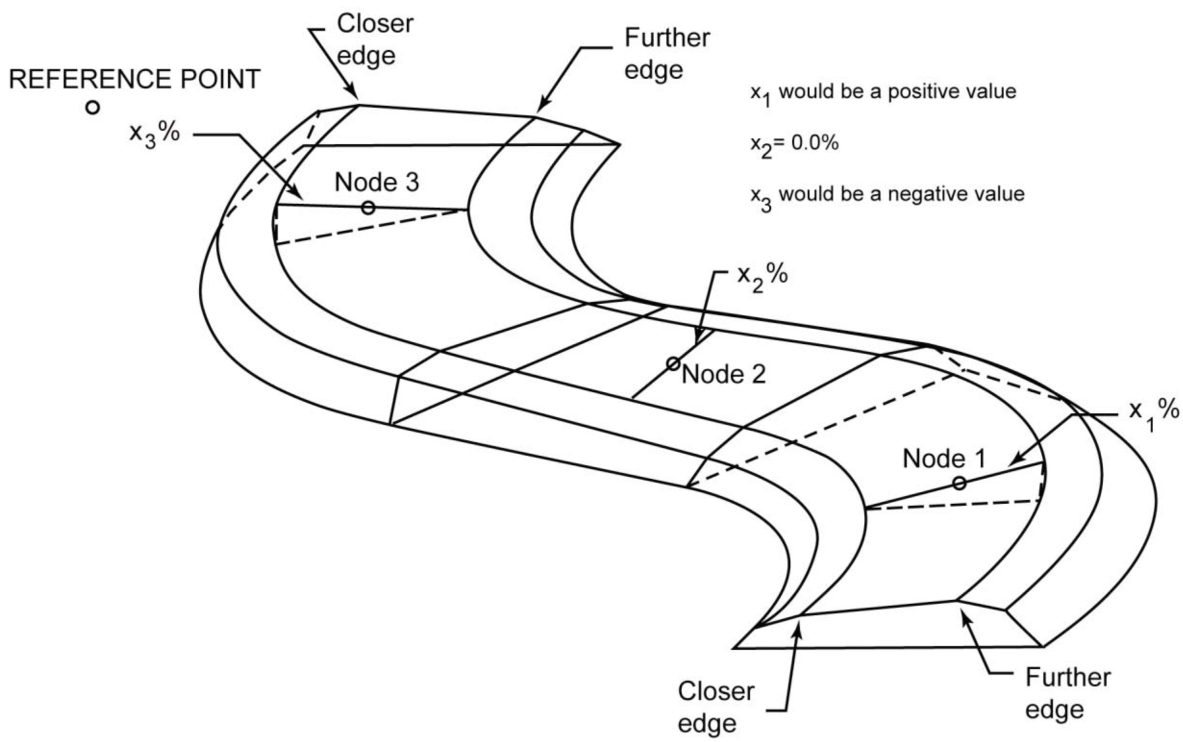


FIGURE 3 - SUPERELEVATION

3.5.6.4 Broadcast Location Correction Details

Connected devices need information to improve its positional accuracy estimate. These differential GPS corrections allows a mobile GPS receiver, such as a GPS system in a connected vehicle, to achieve a greater absolute positional accuracy, compensating for errors that exist in satellite positioning. GPS receivers use the differential GPS corrections to improve the accuracy of their positioning, by comparing its position with the RSU's location, which is known.

The detailed requirements for transmitting differential GPS corrections are as follows.

3.5.6.4.1 Broadcast Location Corrections Detail - NMEA

The RSU shall broadcast National Marine Electronics Association (NMEA) 0183 differential GPS correction messages to connected devices. NMEA 0183 is a standard that defines the interface between two different devices, generally marine devices. NMEA 0183 includes support for a GPS receiver to provide its real time position information, such as position, velocity and time as computed by the GPS receiver.

3.5.6.4.2 Broadcast Location Corrections Detail - RTCM

The RSU shall broadcast Radio Technical Commission for Maritime Services (RTCM) messages, as defined by RTCM special committee number 104, to connected devices. These standards support very high accuracy navigation and positioning through a broadcast to mobile Global Navigation Satellite System (GNSS) receivers, which allows the receivers to compensate for errors that exist in satellite positioning without augmentation.

3.5.7 Signalized Intersection Requirements

Signal phase and timing information is used to provide connected vehicles with information to safely and efficiently pass through the intersection. For example, signal phase and timing information can be used by the connected vehicles to determine imminent signal changes.

3.5.7.1 Broadcast Signal Phase and Timing Information

An RSU shall broadcast a message with signal phase and timing information to connected devices. Signal phase and timing information is used to provide connected devices with the current status of a signalized intersection. Together with the intersection geometric information, connected vehicles can determine what movements are currently permitted by lane, and when their permitted movement may end.

3.5.7.1.1 Broadcast Signal Phase and Timing - Mandatory Requirements

The following are the minimum requirements for an RSU to broadcast signal phase and timing information to connected devices.

3.5.7.1.1.1 Broadcast Signal Phase and Timing - Message Identifier

An RSU shall include a message identifier as part of the signal phase and timing message broadcasted to connected devices. A change in the message identifier indicates a change in the message content. This requirement allows a connected device to ignore (not process) messages from an RSU when the content has not changed.

3.5.7.1.1.2 Broadcast Signal Phase and Timing - Intersection Identifier

An RSU shall include the unique identifier for the intersection as part of the signal phase and timing message broadcasted to connected devices. The intersection identifier is assigned as part of a roadway geometric message broadcasted by an RSU at or near the intersection.

3.5.7.1.1.3 Broadcast Signal Phase and Timing - Intersection Status

An RSU shall include the operational status of the intersection's traffic signal controller as part of the signal phase and timing message broadcasted to connected devices. Valid operational status include operating normally, intersection is in conflict flash mode, preempt is active, priority is active, manual control is enabled, and stop time is activated and all counting/timing has stopped.

3.5.7.1.1.4 Broadcast Signal Phase and Timing - Timestamp

An RSU shall include a timestamp as part of the signal phase and timing message broadcasted to connected devices. The timestamp indicates when the message was generated. This time indication allows detection and correction of different rates and offsets between the clocks and latency of message transmission.

3.5.7.1.2 Broadcast Signal Phase and Timing - Optional Requirements

The following are the optional requirements for an RSU to broadcast signal phase and timing information to connected devices. However, if the requirement is selected to be supported according to the PRL in Section 3.3.3 (Under the Support column), then that requirement is required to be implemented.

3.5.7.1.2.1 Broadcast Signal Phase and Timing - Preempt State

If the traffic signal controller is servicing a preempt request, an RSU shall indicate the preempt state as part of the signal phase and timing message broadcasted to connected devices. The preempt state indicates which operational strategy is being serviced, and what state the associated preempt is in. The states are defined in Section 2.7.2.16, Preempt State, in NTCIP 1202, v2.19f, with support for two (2) additional values - none (no preemption) and acknowledgedButOverriden.

3.5.7.1.2.2 Broadcast Signal Phase and Timing - Priority State

If the traffic signal controller is servicing a priority request, an RSU shall indicate the priority state as part of the signal phase and timing message broadcasted to connected devices. The priority state indicates which operational strategy is being serviced and what state the associated priority is in. Valid values for priority state includes noneActive (no signal priority), (signal priority (SP)) requested, (SP) active, activeButInhibitd (SP Reservice), (SP) success, (SP) removed, (SP) clearFail, (SP) detectFail, (SP) detectClear, (SP) abort, (SP) delayTiming, (SP) extendTiming, preemptOverride, and adaptiveOverride.

3.5.7.1.3 Broadcast Signal Phase and Timing - Movement Data Requirements

The intersection movement data describes the active (permitted) movements that currently allowed at a signalized intersection. A movement represents the allowable path or paths at the intersection. Active movements are those traveler paths (vehicles, pedestrians, bicyclists, etc…) that are currently permitted to move through the intersection.

The detailed requirements for an RSU to broadcast intersection movement data as part of the signal phase and timing information are listed below.

3.5.7.1.3.1 Broadcast Movement - Mandatory Requirements

The following are the minimum requirements for an RSU to broadcast intersection movement data as part of the signal phase and timing information to connected devices.

3.5.7.1.3.1.1 Broadcast Movement - Lane Data

For each active movement at a signalized intersection, an RSU shall include the lane numbers at the intersection for which this movement is permitted as part of the signal phase and timing message broadcasted to connected devices. The lane number is assigned as part of a roadway geometrics message broadcasted by the RSU at the signalized intersection.

3.5.7.1.3.1.2 Broadcast Movement - Movement State

For each active movement at a signalized intersection, an RSU needs to indicate the state and signal indications pertaining to that movement. The valid state and signal indications will vary based the type of traveler that the signal indications are intended for. The three types of travelers supported by this standard are: general motorized vehicles, pedestrians (including bicyclists), and specialized motor vehicles.

The detailed requirements for an RSU to broadcast the current state and signal indications for each active movement at an intersection to connected devices are as follows.

3.5.7.1.3.1.2.1 Broadcast Movement - Vehicular State

For each active vehicular movement at a signalized intersection, an RSU shall include the current state and signal indications pertaining to that movement as part of the signal phase and timing message broadcasted to connected devices. The valid signal states are green, yellow, red, and flashing, and the valid signal indications are a ball, left arrow, right arrow, straight arrow, soft left arrow, soft right arrow, and U-Turn arrow.

A soft left arrow and a soft right arrow are used at a signalized intersection only if there is two left turn arrows and two right turn arrows, respectively. The soft turn arrow is for permitted movements between a movement straight ahead and a movement with a larger turn angle.

3.5.7.1.3.1.2.2 Broadcast Movement - Pedestrian State

For each active pedestrian movement at a signalized intersection, an RSU shall include the current state of the pedestrian signal indications pertaining to that movement as part of the signal phase and timing message broadcasted to connected devices. The valid states for pedestrian signal indications are unavailable or not equipped, don't-walks, flashing don't-walks, and walk.

3.5.7.1.3.1.2.3 Broadcast Movement - Special State

For each active movement for specialized motor vehicles at a signalized intersection, an RSU shall include the current state of that movement as part of the signal phase and timing message broadcasted to connected devices. This requirement is intended for travelers other than those listed in Sections 3.5.7.1.3.1.2.1 or 3.5.7.1.3.1.2.2. Special signal states are needed for traffic in non-vehicular (special) lanes, such as trains. The allowable states for the special signal indications are the special lane is empty (no traveler) or not in use (closed), the special lane is about to be occupied, the special lane is occupied, and the special lane is about to be empty.

3.5.7.1.3.1.3 Broadcast Movement - Time of Change - Minimum

For each movement at a signalized intersection, an RSU shall include the earliest time when the movement state is predicted to change as part of the signal phase and timing message broadcasted to connected devices. This is the earliest time that the movement's signal indication will change. For example, with this information, connected devices can calculate if it has sufficient time to safely pass through the intersection before the movement state changes.

For actuated traffic signal controllers, since the actuation on a side street can occur at any time, this earliest time will be equal to the time that the minimum green or pedestrian times have been satisfied, whichever is later. The same earliest time value will continue to be transmitted by the RSU even after the minimum green and pedestrian time have been satisfied. Note that the earliest time is subject to and could be overridden by pedestrian movement actuations.

For traffic signal controllers operating fixed time, where the time of change is known, the earliest time of change will be equal to the latest time of change (See Section 3.5.7.1.3.1.4).

3.5.7.1.3.1.4 Broadcast Movement - Time of Change - Maximum

For each movement at a signalized intersection, an RSU shall include the latest time for when the movement state is predicted to change as part of the signal phase and timing message broadcasted to connected devices. This is the latest time that the movement's signal indication will change. For example, with this information, connected vehicles can calculate if it has sufficient time to safely pass through the intersection before the movement state changes.

For actuated traffic signal controllers, since the actuation on a side street can occur at any time, this latest time will be equal to the time that the movement state will reach the maximum allowable green or pedestrian duration, whichever is later. Once this time is reached, the movement state will change. Note that the latest time is subject to and could be overridden by pedestrian movement actuations.

For traffic signal controllers operating fixed time, where the time of change is known, the latest time of change will be equal to the earliest time of change (See Section 3.5.7.1.3.1.3).

3.5.7.1.3.2 Broadcast Movement - Optional Requirements

The following are optional requirements for an RSU to broadcast intersection movement data as part of the signal phase and timing information to connected devices. However, if the requirement is selected to be supported according to the PRL in Section 3.3.3 (Under the Support column), then that requirement is required to be implemented.

3.5.7.1.3.2.1 Broadcast Movement - Succeeding Signal Indications

For each movement at a signalized intersection, an RSU shall include the next expected signal indications pertaining to that movement (the succeeding movement) as part of the signal phase and timing message broadcasted to connected devices. The signal indications after an allowed vehicle movement is usually a clearance state, such as a yellow or red state. Valid signal indications for a vehicle movement include a ball, left arrow, right arrow, straight arrow, soft left arrow, soft right arrow, and U-Turn arrow. For pedestrian movements, the valid states for pedestrian signal indications are unavailable or not equipped, don’t-walks, flashing don’t-walks, and walk.

For example, if the current signal indication for a vehicle movement is a green ball and a green left arrow, the next expected signal indication for the movement may be a green ball and a yellow left arrow. This indicates to connected vehicles continuing straight through the intersection that the next clearance state does not apply to them, while connected vehicles intending to make a left turn at the intersection is now aware that a yellow left arrow signal indication is expected soon so the vehicle should approach the intersection with caution.

3.5.7.1.3.2.2 Broadcast Movement - Succeeding Signal Indication Time of Change

For each movement at a signalized intersection, an RSU shall include the time for when the succeeding movement state is predicted to change as part of the signal phase and timing message broadcasted to connected devices. The succeeding movement state is generally a clearance state, such as a yellow indication. Thus this time generally defines the time the clearance state will end. With this information, travelers with connected devices can calculate if it has sufficient time to clear an intersection before the clearance movement state changes. If the movement(s) at a signalized intersection is currently in a clearance state, e.g., an all-red indication, the transmission of the time when the succeeding movement state is predicted to change is optional.

3.5.7.1.3.2.3 Broadcast Movement - Pedestrian Detect

As part of the signal phase and timing message broadcasted to connected devices, for each movement at a signalized intersection, an RSU shall indicate if one or more pedestrians has been detected in the pedestrian crossing. Valid values are one or more pedestrians has been detected, no pedestrians detected, and unavailable. This requirement can be used to warn turning vehicles at an intersection, e.g., transit vehicles, that a pedestrian may be in its blind spot.

3.5.7.1.3.2.4 Broadcast Movement - Pedestrian Call

As part of the signal phase and timing message broadcasted to connected devices, for each movement at a signalized intersection, an RSU shall transmit an indication if a pedestrian call (request) has been detected in the pedestrian crossing. Valid values are no call detected, pedestrian call detected, and unavailable. This requirement can be used to warn turning vehicles at an intersection, e.g., transit vehicles, that a pedestrian may be entering a pedestrian crosswalk.

3.5.7.2 Broadcast Signal Preferential Treatment Status

If a request for signal preferential treatment is received, an RSU shall broadcast a signal request status message indicating what preferential treatment, if any, a signal controller is processing.

Preferential treatment at signalized intersections, generally in the form of signal preemption for emergency vehicles and signal priority for transit vehicles, provides improved safety and operational efficiencies at the intersection. After a connected vehicle approaching a signalized intersection transmits a signal preemption request or a signal priority request, it is helpful for the connected vehicle to determine if their preferential treatment request is currently being serviced by the signal controller.

The detailed requirements for an RSU broadcast signal request status message to connected devices are listed below.

3.5.7.2.1 Broadcast Preferential Treatment - Message Identifier

If a request for signal preferential treatment is received, an RSU shall include a message identifier for each signal request status message broadcasted to connected devices. The message identifier is used to identify a sequence number within a stream of messages from the RSU. The message identifier increments by one whenever the contents of the signal request status message has changed. This requirement allows a connected device receiving the signal request status message to ignore (not process) the message from the RSU when the contents has not changed.

3.5.7.2.2 Broadcast Preferential Treatment - Intersection Identifier

If a request for signal preferential treatment is received, RSU shall include the unique identifier of the intersection for which the signal request status is broadcasted to connected devices. The intersection identifier is assigned as part of a roadway geometrics message broadcasted by an RSU near or at the signalized intersection.

3.5.7.2.2.1 Broadcast Preferential Treatment - Intersection Status

An RSU shall include the operational status of the traffic signal controller as part of the signal request status message broadcasted to connected devices. Valid operational status include intersection is normal (normal operation), conflictmode (controller is in conflict flash state), preemptactive (preempt is active), priorityactive (priority is active), stoptime (stop time is activated and all counting/timing has stopped), and manualcontrol (manual control is enabled).

3.5.7.2.2.2 Broadcast Preferential Treatment - Preempt State

If the traffic signal controller is servicing a preempt request, an RSU shall include the preempt state as part of the signal request status message broadcasted to connected devices. The preempt state provides status on which state the associated preempt is in. The states are defined in Section 2.7.2.16, Preempt State, in NTCIP 1202, v2.19f.

3.5.7.2.2.3 Broadcast Preferential Treatment - Priority State

If the traffic signal controller is servicing a priority request, an RSU shall include the priority state as part of the signal request status message broadcasted to connected devices. The priority state provides the current priority state the traffic signal controller is in. The valid states are: no signal priority active (noneActive), no signal priority requested, signal priority active, signal priority active but inhibited, signal priority successful, signal priority removed, signal priority clear fail, signal priority detect fail, signal priority detect clear, signal priority abort, signal priority delay timing, signal priority extend timing, signal priority preempt override, signal priority adaptive override.

3.5.7.2.2.4 Broadcast Preferential Treatment - Vehicle Source

An RSU shall include the identifier of the vehicle that is the source of the signal service request currently being serviced by the signal controller as part of the signal request status message broadcasted to connected devices.

3.5.8 Traveler Information Requirements

Traveler information is used to provide connected devices with travel advisories and information. Traveler information can be customized for travelers in a specific location, traveling in a specific direction, or at specific times. Examples of traveler information include traffic information, traffic incidents, major events, evacuations, and road signs.

The detailed requirements for providing traveler information from the infrastructure to connected devices are as follows.

3.5.8.1 Broadcast Traveler Information

An RSU shall broadcast a packet containing traveler information to connected devices. Each packet may contain one or more individual traveler information messages. Multiple traveler information messages may be packaged into a single traveler information packet for transmission efficiency.

3.5.8.2 Broadcast Traveler Information - Mandatory Requirements

The following are the minimum requirements for an RSU to broadcast traveler information to connected devices.

3.5.8.2.1 Broadcast Traveler Information - Packet Identifier

An RSU shall include a packet identifier for the traveler information packet broadcasted to connected devices. A change in the packet identifier indicates a change in the packet content. Receivers of the packet can ignore subsequent packets with the same packet identifier, otherwise the receiver should parse the packet contents.

3.5.8.2.2 Broadcast Traveler Information - Message Identifier Requirements

For each traveler information message in a traveler information packet, an RSU needs to identify each message transmitted as part of a traveler information packet broadcasted to connected devices. This requirement allows a receiving connected device to ignore (not process) a traveler information message that has already previously received. The identifier for each message is dependent on the type of traveler information.

Two types of traveler information are supported - traveler advisories and road sign messages. Traveler advisories are temporary in nature, that is, the information being broadcasted are finite in duration. Examples of traveler advisories include traffic information, traffic incidents, major events, evacuations, etc… Road sign messages are static in nature and generally emulate the message on a physical roadside sign.

3.5.8.2.2.1 Broadcast Traveler Advisories - Message Identifier

For traveler advisories, an RSU shall include a message identifier for each traveler advisory message as part of a traveler information packet broadcasted to connected devices. This message identifier is expected to be assigned by a transportation agency. It is suggested that the message identifier should be the same as the identifier assigned to that event (e.g., icing conditions) or incident that results in the need for the traveler advisory message, creating a relationship between the traveler advisory message to the event or incident. This assumes that the transportation agency has an incident or event tracking system that assigns an identifier to each incident or event.

3.5.8.2.2.2 Broadcast Road Sign - Message Identifier

For road sign messages, the message identifier is determined by its geographic location and its viewing angle. Thus, for each road sign message, an RSU shall include the geographic location (latitude, longitude, elevation), based on the WGS-84 coordinate system, and the viewing angle of the road sign as part of a traveler information packet broadcasted to connected devices. The latitude and longitude are measured in units of $1/10^{th}$ microdegree. The elevation represents the height of the geometric center of the road sign above or below the WGS-84 reference ellipsoid in units of 1 decimeter. The viewing angle is the direction of travel of the connected device while facing the "active" side of the road sign. The direction of travel is measured by one or more heading slices, with each heading slice 22.5 degrees wide.

3.5.8.3 Broadcast Traveler Information - Optional Requirements

The following are the optional requirements for an RSU to broadcast traveler information to connected devices. However, if the requirement is selected to be supported according to the PRL in Section 3.3.3 (under the Support column), then that requirement is required to be implemented.

3.5.8.3.1 Broadcast Road Sign - MUTCD Type

For road sign messages, an RSU shall include the type of road sign as part of a traveler information packet broadcasted to connected devices. The type of road sign defines the type of information being communicated to road users. The valid MUTCD types are: none (non-MUTCD information), regulatory sign, warning sign, maintenance and construction, motorist services, guide signs, and recreation and cultural interest. The type of road sign may guide connected devices on the relative importance of each road sign message. For example, a connected device processing more than one road sign message may determine to display information on a regulatory sign first before displaying the information on a motorist services sign to a user.

3.5.8.3.2 Broadcast Traveler Information - Start Time

For each traveler information message in a traveler information packet, an RSU shall include the start time that the message becomes valid as part of a traveler information packet broadcasted to connected devices. The start time is measured in minute of the year, in one minute units. If a start year is included, then the start time is the minutes of the included start year, otherwise the start time is the minute of the current year. This requirement allows an agency to preload traveler information messages into an RSU, then make that message valid at a certain time, such as warning travelers about upcoming roadway construction only after construction has begun. If no start time is broadcasted as part of the traveler information message, the traveler information message is immediately valid for the valid region.

3.5.8.3.3 Broadcast Traveler Information - Start Year

For each traveler information message in a traveler information packet, an RSU shall transmit the start year along with the start time that the message becomes valid as part of a traveler information packet sent to a connected device. If a start year is also transmitted as part of the traveler information message broadcasted, then the start time is the minute within this start year that the traveler information message becomes valid.

3.5.8.3.4 Broadcast Traveler Information - Validity Duration

For each traveler information message in a traveler information packet, an RSU shall include the duration from the start time that the traveler message is valid for as part of a traveler information packet broadcasted to connected devices. The duration is measured in one minute units.

3.5.8.3.5 Broadcast Traveler Information - Importance

For each traveler information message in a traveler information packet, an RSU shall include the importance of the message relative to other traveler information messages being broadcasted as part of a traveler information packet broadcasted to connected devices. Values shall be from 0 to 7, with 0 being least important and 7 being most important. The selection of importance will be made by the agency broadcasting the messages. How a connected device presents two messages with the same importance is outside the scope of this standard.

3.5.8.3.6 Broadcast Traveler Information - Presentation Requirements

Agencies may need to present traveler information messages only to specific travelers, such as travelers within specific geographic (spatial) regions or a direction of travel. Multiple valid regions and directions of travel may be defined for each traveler information message.

The detailed requirements for defining the conditions when the traveler information content shall be presented to the driver are as follows.

3.5.8.3.6.1 Broadcast Traveler Information - Default Anchor Point Position

For each traveler information message in a traveler information packet, an RSU shall include the geographic location (latitude, longitude, elevation) of the default anchor point for which valid regions are determined as part of a traveler information packet broadcasted to connected devices. The latitude and longitude are measured in units of $1/10^{th}$ microdegree. The elevation represents the height above or below the WGS-84 reference ellipsoid in units of 1 decimeter. The default anchor point is included so an anchor point does not have to be broadcasted for each valid region defined for a traveler information message.

3.5.8.3.6.2 Broadcast Traveler Information - Heading Slice

For each traveler information message in a traveler information packet, an RSU shall include the direction of motion (of the connected device) that the message is valid for as part of a traveler information packet broadcasted to connected devices. The connected device's direction is measured by one or more heading slices, with each heading slice 22.5 degrees wide. This requirement allows traveler information messages to be valid for only those connected devices traveling in a specific direction. For example, a weather message may apply to all directions, while an incident message may be applicable for travelers heading towards the location of an incident.

3.5.8.3.6.3 Broadcast Traveler Information - Circular Valid Region Requirements

A spatial region for which a traveler information message is valid for may be a circular region around an anchor point. The connected device should be located within the circular region for the traveler information message to be presented to the traveler.

The detailed requirements for defining the circular region where the traveler information content should be presented to the traveler are as follows.

3.5.8.3.6.3.1 Broadcast Traveler Information - Circular Region - Radius

For each traveler information message in a traveler information packet, an RSU shall include the radius for the circular region defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices. The valid circular region is defined by the radius, measured in one meter units, from the specified anchor point defined in Section 3.5.8.3.6.3.2. If that specified anchor point is not broadcasted, the default anchor point defined in Section 3.5.8.3.6.1 is used.

3.5.8.3.6.3.2 Broadcast Traveler Information - Circular Region - Anchor Point

For each traveler information message in a traveler information packet, an RSU shall include the geographic location (latitude, longitude, elevation) of the anchor point for the circular region of travel defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices. The latitude and longitude are measured in units of $1/10^{th}$ microdegree. The elevation represents the height above or below the WGS-84 reference ellipsoid in units of 1 decimeter. If this anchor point is included, it takes precedence over the default anchor point, otherwise, the default anchor point defined in Section 3.5.8.3.6.1 should be used.

3.5.8.3.6.4 Broadcast Traveler Information - Polygon Valid Region Requirements

A spatial region for which a traveler information message is valid for may be a polygon, which may represent the jurisdictional boundaries of a specific transportation agency or a work zone. The connected device should be located within this polygon region for the traveler information message to be presented to the traveler. The detailed requirements for defining the polygon region where the traveler information content should be presented to the driver are as follows.

3.5.8.3.6.4.1 Broadcast Traveler Information - Polygon Region - Offsets

For each traveler information message in a traveler information packet, an RSU shall include the area of travel defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices. The valid area of travel (polygon) is defined by a series of offset points (x-axis, y-axis based on the WGS-84 coordinate system), measured in one meter units. These offset points describes the perimeter of the polygon. Each offset point defines the offset from the anchor point defined in Section 3.5.8.3.6.4.2, or the default anchor point defined in 3.5.8.3.6.1. The anchor point in Section 3.5.8.3.6.4.2 takes precedence over the default anchor point.

Optionally, an elevation offset point (z-axis) and an elevation tolerance, both in one meter units, may also be transmitted for each set of offset points. If the elevation offset point is not transmitted, all connected devices within the x-y polygon area are part of the valid area of travel. For example, if a node has an elevation offset point of +5 meters with an elevation tolerance of ±2 meters, any connected device located between +3 meters to +7 meters offset from the anchor point, while connected devices outside this range are not. This requirement is necessary in case the traveler information message is valid for specific overpasses or underpasses in a specific direction.

3.5.8.3.6.4.2 Broadcast Traveler Information - Polygon Region - Anchor Point

For each traveler information message in a traveler information packet, an RSU shall include the geographic location (latitude, longitude, elevation) of the anchor point for the area of travel defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices. The latitude and longitude are measured in units of 1/10th microdegree. The elevation represents the height above or below the WGS-84 reference ellipsoid in units of 1 decimeter. If this anchor point is included, it takes precedence over the default anchor point, otherwise the default anchor point defined in Section 3.5.8.3.6.1 should be used.

3.5.8.3.6.5 Broadcast Traveler Information - Valid Shape Point Set Region Requirements

A spatial region for which a traveler information message is valid for may be a shape point set, which allows a spline-like representation of a geographic area such as a road segment. A connected device should be located within the shape point set region for the traveler information message to be presented to the traveler. Unlike the valid circular region of travel or the area of travel (polygon), which both can be used to define a wide geographic area, the shape point set is used to represent a short segment of a specific roadway. The detailed requirements for defining the shape point set region where the traveler information content should be presented to the traveler are as follows.

3.5.8.3.6.5.1 Broadcast Traveler Information - Shape Point Set - Default Direction

For each traveler information message in a traveler information packet, an RSU shall include the default direction of travel along the shape point set as part of a traveler information packet broadcasted to connected devices. This requirement indicates the direction of travel along the series of offset points defined in Section 3.5.8.3.6.5.3. Valid values are forward (direction of travel follows node ordering), reverse (direction of travel is the reverse of node ordering), or both (direction of travel allowed in both directions). The default direction is included so the direction does not have to be broadcasted for each shape point set defined for a traveler information message.

3.5.8.3.6.5.2 Broadcast Traveler Information - Shape Point Set - Default Width

For each traveler information message in a traveler information packet, an RSU shall include the default width of the shape point set as part of a traveler information packet broadcasted to connected devices. The width, measured in one centimeter units, is used to define the width of the valid region of travel at each offset point defined in Section 3.5.8.3.6.5.3, with the offset point located on the centerline path of the geographic area (width). The default width is included so a width does not have to be broadcasted for each shape point set defined for a traveler information message.

3.5.8.3.6.5.3 Broadcast Traveler Information - Shape Point Set - Offsets

For each traveler information message in a traveler information packet, an RSU shall include the shape point set defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices. The shape point set is a path defined by a series of offset points (x-axis, y-axis based on the WGS-84 coordinate system and its reference ellipsoid), measured in centimeters. Each offset point represents the center line of the shape point set.

The first offset point is from the default anchor point defined in Section 3.5.8.3.6.1, or the specified anchor point in Section 3.5.8.3.6.5.7 (the specified anchor point takes precedence over the default anchor point). All successive offsets are from the previous offset point. For example, the first set of offset points (node) describes the offset from the anchor point, the second set of offset points describes the offset from the first node, the third set of offset points describes the offset from the second node, etc…

Optionally, an elevation offset point (z-axis) and an elevation tolerance, both in one meter units, may also be transmitted for each set of offset points. If the elevation offset point is not transmitted, all connected devices within the x-y shape point set are part of the valid area of travel. For example, a node has an elevation offset point of +5 meters with an elevation tolerance of ±2 meters. Thus any connected device located between +3 meters to +7 meters offset from the previous node is within the area of travel, while connected devices outside this range are not. This requirement is necessary in case the traveler information item is only valid for specific overpasses or underpasses in a specific direction.

3.5.8.3.6.5.4 Broadcast Traveler Information - Shape Point Set - Direction

For each shape point set in a traveler information message, an RSU shall include the allowed direction of travel along the shape point set as part of a traveler information packet broadcasted to connected devices. This requirement is used to indicate the direction of travel along the series of offset points defined in Section 3.5.8.3.6.5.3. Valid values are forward (direction of travel follows node ordering), reverse (direction of travel is the reverse of node ordering), or both (direction of travel allowed in both directions). This direction of travel takes precedence over the default direction defined in Section 3.5.8.3.6.5.1, otherwise the default direction is used for the shape point set.

3.5.8.3.6.5.5 Broadcast Traveler Information - Shape Point Set - Width

For a shape point set in a traveler information message, an RSU shall include the width for the shape point set as part of a traveler information packet broadcasted to connected devices. The width, measured in one centimeter units, is used to define the width of the valid region of travel at each offset point defined in Section 3.5.8.3.6.5.3, with each offset point on the center line of the shape point set. This width takes precedence over the default width defined in Section 3.5.8.3.6.5.2, otherwise the default width is used for the shape point set.

3.5.8.3.6.5.6 Broadcast Traveler Information - Shape Point Set - Node Width

For a shape point offset in a traveler information message, an RSU shall include the width of the geographic area at that node as part of a traveler information packet broadcasted to connected devices. Each shape point offset (node) defined in Section 3.5.8.3.6.5.3 represents a point along the center line of the shape point set. The width, measured in one centimeter units, represents the width of the geographic area at that node. This width takes precedence over the default width defined in Section 3.5.8.3.6.5.2, and the width of the shape point set defined in Section 3.5.8.3.6.5.5.

3.5.8.3.6.5.7 Broadcast Traveler Information - Shape Point Set - Anchor Point

For each shape point set in a traveler information message, an RSU shall include the geographic location (latitude, longitude, elevation) of the anchor point for the shape point set defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices. The latitude and longitude are measured in units of 1/10th microdegree. The elevation represents the height above or below the WGS-84 reference ellipsoid in units of 1 decimeter. If this anchor point is included, it takes precedence over the default anchor point, otherwise the default anchor point defined in Section 3.5.8.3.6.1 should be used.

3.5.8.3.7 Broadcast Traveler Advisories - Content

For traveler advisory message in a traveler information packet, an RSU shall include the contents of the travel advisory information as part of a traveler information packet broadcasted to connected devices. Traveler advisory information consists of ITIS codes, as defined in SAE J2540/2, and free-form text. Traveler advisories include information on travel or route restrictions, work zone information such as work zone signs and directions, speed advisories including speed limits, and traveler services available at upcoming exits. For commercial vehicles, traveler advisories may be the availability of parking spaces and services information, including availability times and parking space dimensions.

3.5.8.3.8 Broadcast Road Sign - Content

For each road sign message in a traveler information packet, an RSU shall include the road sign information as part of a traveler information packet broadcasted to connected devices. Road sign information consists of ITIS codes, as defined in Section 9 of SAE J2540/2, and free-form text.

3.5.8.3.9 Broadcast Traveler Information - Uniform Resource Locator

For each traveler information message in a traveler information packet, an RSU shall include a uniform resource locator (URL) for the traveler information message as part of a traveler information packet broadcasted to connected devices. The URL is a network-retrievable locator where other resources can be found, which, in this context, provides additional information about the event or topic of the traveler information message. The URL, in the form of a text string, provides a link to the designated resources. For example, the URL may be the address of a link that points to a map image showing the location and extent of the event, or the address of a link containing a text file with additional information about the travel advisory such as start and end dates and times. These resources may be retrieved by the user via a different communications medium and device, such as a smart phone over a cellular or wi-fi network.

3.5.8.3.10 Broadcast Traveler Information - Valid Vehicle Type

For each traveler information message, an RSU shall include the vehicle types that the traveler advisory or road sign is valid for as part of a traveler information message broadcasted to connected vehicles. The vehicle type is defined by the FHWA 13-Category Classification System. The connected vehicle must be of the vehicle type for the traveler advisory or road sign to be presented to this traveler. All combinations of vehicle types are allowed. If the vehicle types are not included as part of the a traveler information message broadcasted to connected vehicle, it is assumed that the traveler information message is valid for all types of vehicles.

3.5.8.3.11 Broadcast Traveler Information - Parking Availability

Information about parking availability downstream is important for commercial vehicle drivers who are nearing the end of their allowable hours of service. The parking availability information is treated as a traveler advisory message.

The following are the detailed requirements for providing parking availability information that may be broadcasted from an RSU to connected devices.

3.5.8.3.11.1 Broadcast Parking Availability - Mandatory Requirements

For each traveler information message in a traveler information packet, an RSU shall include parking availability at downstream rest areas as part of a traveler information packet broadcasted to connected devices. Parking availability information broadcasted includes the following: the time the information was last updated, the location of the parking facility (latitude, longitude, elevation), and the number of parking spaces available at that facility by maximum vehicle size (length and width, in centimeters) that the space can fit.

3.5.8.3.11.2 Broadcast Parking Availability - Optional Requirements

The following are optional information that an RSU may include with the parking availability information broadcasted from the RSU to connected devices.

3.5.8.3.11.2.1 Broadcast Parking Availability - Location Description

An RSU shall include a description of the parking facility as part of a traveler information packet broadcasted to connected devices. The textual description may include additional information about the parking facility, such as what exit to use to get the parking facility, or what parking amenities is available at the facility.

3.5.8.3.11.2.2 Broadcast Parking Availability - Availability Time

An RSU shall include the time one or more parking spaces, by maximum vehicle size, will be available as part of a traveler information packet broadcasted to connected devices. This requirement is transmitted only if no parking spaces, by that maximum vehicle size, is currently available but expect to be. Parking spaces may become available when the parking facility opens, or if a reservation for a parking space expires.

3.5.8.3.11.2.3 Broadcast Parking Availability - Availability End Time

An RSU shall include the time one or more parking spaces, by maximum vehicle size, will no longer be available as part of a traveler information packet broadcasted to connected devices. This requirement is transmitted only if parking spaces, by that maximum vehicle size, is expected to be no longer available after that time. Parking spaces may become no longer available because it is the parking facility's closing time, or if there is a prior reservation for that size parking space.

3.5.9 Vehicle Mayday Transmission

If the owner enables the capability, a connected vehicle needs to be able to broadcast to other connected devices that it is involved in an incident or is disabled. An RSU or public safety vehicle receiving this transmission can then forward the transmission to the proper dispatch center so that the appropriate roadside assistance can be dispatched.

The detailed requirements to support the broadcast and relay of mayday information are as follows.

3.5.9.1 Broadcast Mayday Message

A connected vehicle shall broadcast a mayday message to connected devices when the vehicle's sensors detect an event that may require assistance from others. Due to privacy considerations this capability may require an opt-in capability by the driver of the disabled connected vehicle.

3.5.9.1.1 Broadcast Mayday Message - Mandatory Requirements

The following are the minimum requirements for a connected vehicle to broadcast a mayday message to connected devices.

3.5.9.1.1.1 Broadcast Mayday - Vehicle Location

A connected vehicle shall include the vehicle's geographic position (latitude, longitude, elevation) based on the WGS-84 coordinate system as part of a mayday broadcast to other connected devices. The latitude and longitude are measured in units of 1/10th micro degree. The elevation represents the vehicle's geographic position above or below the WGS-84 reference ellipsoid in units of 1 decimeter.

3.5.9.1.1.2 Broadcast Mayday - Timestamp

A connected vehicle shall include the date and time the vehicle first broadcasts its mayday message as part of the mayday broadcast to other connected devices.

3.5.9.1.1.3 Broadcast Mayday - Event

A connected vehicle shall indicate the event that triggered the mayday condition as part of a mayday broadcast to other connected devices. Valid events are the vehicledisabled, airbagsdeployed, vehicleoverturned, manuallyactivated and unavailable. Airbags being deployed or an overturned vehicle represent situations where one or more passengers may be injured and require medical attention. A driver may also manually activate the mayday transmission. For all other situations when a vehicle may need assistance, such as a mechanical failure or out of fuel, the vehicle will indicate that the vehicle is disabled.

3.5.9.1.2 Broadcast Mayday - Optional Requirements

The following are the optional requirements for a connected vehicle to broadcast a mayday message to connected devices. However, if the requirement is selected to be supported according to the PRL in Section 3.3.3 (Under the Support column), then that requirement is required to be implemented.

3.5.9.1.2.1 Broadcast Mayday - Number of Airbags

A connected vehicle shall include the number of airbags that have been deployed as part of a mayday broadcast to connected devices. Public safety agencies receiving the mayday transmission, whether directly or indirectly, can use this information to determine how many occupants are in the vehicle and may be injured.

3.5.9.1.2.2 Broadcast Mayday - Vehicle Make Model and Fuel Type

A connected vehicle shall include its vehicle class, make, model, model year and fuel type as part of a mayday broadcast to connected devices. Public safety agencies may use this information so responders are aware of what type of vehicle to expect at the incident location (e.g., a motorcycle versus a full-size van), and to determine if any special equipment may be needed. The vehicle class is defined by the FHWA 13-Category Classification System. Due to privacy considerations this capability may require an opt-in capability by the driver of the disabled connected vehicle.

3.5.9.1.2.3 Broadcast Mayday - Hazmat Codes

A connected vehicle shall include the hazmat code(s) of all hazardous materials on-board the connected vehicle as part of a mayday broadcast to connected devices. The hazmat codes are defined in CFR Title 49 hazardous material codes. Up to 8 hazmat codes can be transmitted for each connected vehicle.

3.5.9.1.2.4 Broadcast Mayday - Placards

A connected vehicle shall include the hazmat placard codes that are displayed on the vehicle as part of a mayday broadcast to connected devices. Up to 8 hazmat placard codes can be transmitted for each connected vehicle.

3.5.9.2 Forward Mayday

Upon receiving a broadcasted mayday message from a connected vehicle, a connected device needs to forward the mayday message to a public safety agency. This capability is particularly important in remote areas, where no infrastructure may exist to receive a broadcasted mayday message. This capability allows a connected device to forward the broadcast to the proper dispatch center so that the appropriate roadside assistance can be dispatched to the originating connected vehicle.

The detailed requirements to support receiving and forwarding of mayday information are as follows.

3.5.9.2.1 Receive Mayday Broadcasts

A connected device shall receive a mayday broadcast from a connected vehicle. The mayday message received contains the location of the connected vehicle, the time the connected vehicle began broadcasting the mayday message, and the event that caused the connected vehicle to broadcast a mayday message.

3.5.9.2.2 Forward Mayday Broadcasts

A connected device shall transmit a received Mayday broadcast to the first RSU that advertises the Mayday service. The forwarded mayday transmission will include the date and time the connected device received the mayday transmission from the connected vehicle in distress. Because an RSU supporting mayday services may not be within the transmission range of the disabled vehicle, a connected device that has received the mayday message, needs to forward the mayday message to the next RSU that supports a mayday service. This capability may improve the assistance that is provided to the disabled vehicle by providing public safety responders information about the location and type of incident.

3.5.10 Vehicle Manufacturers / Fleet Operator Requirements

The detailed requirements for enabling vehicle manufacturers and fleet operators to transmit customized data to and from specific vehicles are as follows.

3.5.10.1 Transfer Fleet Data to a Connected Vehicle

An RSU shall transmit customized data from vehicle manufacturers and fleet operators to a connected vehicle based upon a vehicle identification number.

3.5.10.2 Transfer Fleet Data from a Connected Vehicle

A connected vehicle shall transfer customized data to vehicle manufacturers or fleet operators via an RSU.

3.6 Supplemental Non-Communications Requirements

Supplemental requirements are provided in the following subsections. These requirements do not directly involve communications via the communications interfaces addressed by this standard, but, if the supplemental requirement is selected in the PRL, the implementation must fulfill the stated requirement in order to claim conformance to this standard.

3.6.1 Performance Requirements

This subsection specifies both the static and dynamic numerical requirements for the J2735 SE candidate.

3.6.1.1 Transmission Requirements

Detailed performance requirements related to data transmission rates and latency are found in Appendix G.

3.6.1.2 Device Identifier

A connected device needs to change the code identifying itself to another connected device periodically to ensure the overall anonymity of the connected device.

The detailed requirements for when a connected device will change its device identifier transmitted are as follows.

3.6.1.2.1 Change Device Identifier on Security Certificate

A connected device shall change its device identifier transmitted to another connected device when any security certificate associated with a message to be transmitted is changed. Security certificate requirements are addressed in the Section 3.6.2. However, security certificates are expected to change approximately every 5 (five) minutes.

3.6.1.2.2 Change Device Identifier on Identifier Conflict

A connected device shall change its device identifier transmitted to another connected device if the same value is detected to be in use by another connected device. This is to resolve conflicting device identifiers so that the source of transmitted messages can be distinguished from different connected devices. Conflicting device identifiers occur when two connected devices using the same device identifier value are in transmitting range with each other and on the same communications channel.

3.6.1.2.3 Randomized Change - Device Identifier

When a connected device changes its device identifier, the new device identifier shall not be predictable based on past device identifier values. This is to ensure quality randomization for privacy concerns. For example, the connected device should not just increment the device identifier value by a fixed value (e.g., N = N + 1).

3.6.1.3 Message Identifier

A connected vehicle shall change the message identifier transmitted to another connected device when its device identifier (See 3.6.1.2) has changed. This is done to protect the overall anonymity of the connected vehicle.

3.6.1.4 Path History

A connected vehicle maintains a history of the past locations traversed by the vehicle. This path history provides a concise representation of recent vehicle movement over a certain distance. In this context, concise is defined as using a minimum number of points that still satisfies the required error tolerance between the vehicle path and its path history representation. This path history is consistently updated for use by the connected vehicle's various applications and for broadcast to other connected devices.

3.6.1.4.1 Path History - Data Points

A connected vehicle's path history distance (i.e., the distance between the first and last path history point) shall represent at least 300 meters of the connected vehicle's traveled path, or the distance since the vehicle ignition was turned ON, whichever distance is smaller.

3.6.1.4.2 Path History - Position Error Tolerance

The path history points shall be selected such that the perpendicular distance between any point on the actual vehicle path and the straight line connecting two consecutive path history points is less than 1 meter.

3.6.1.5 Probe Data

Probe data requirements define the performance requirements for the management and collection of probe data.

The detailed performance requirements for the collection and management of probe data are as follows.

3.6.1.5.1 Snapshot Generation

The following defines the conditions when a connected vehicle generates (creates) a snapshot.

3.6.1.5.1.1 Initial Snapshot

Unless otherwise specified in the PRL (Section 3.3.3), a connected vehicle shall not collect snapshots until it has traveled a certain distance (default = 500), in meters, from when its ignition was turned on. This requirement protects the privacy of a connected vehicle - if a snapshot is generated when the engine is first turned on (ignition), the origin of the trip, which may be a person's home, can be determined.

3.6.1.5.1.2 Periodic Snapshot

To obtain ubiquitous coverage nationwide, snapshots are needed at periodic intervals to provide road, weather and traffic conditions between RSUs that collect probe data. The default method for generating periodic snapshots is to use time and the vehicle's current speed to linearly space the intervals between snapshots. Although the method could use distance, the arguments for distance depend on uneven flow, such as when incidents occur. However, most flow occurs when there are no incidents and thus using time as the default should provide a more uniform distribution of snapshots. As vehicle speed increases, the snapshot interval increases. This results in more widely spaced snapshots at higher speeds and closer spaced snapshots at lower speeds. This approach is used because in general RSUs will be further apart on higher speed roads.

3.6.1.5.1.2.1 Periodic Snapshot - Default

Unless otherwise specified in the PRL (Section 3.3.3), a connected vehicle shall generate a snapshot:

- Every 4 seconds if speed is ≤ 8.9 meters per second (20 mph);
- Every 20 seconds if speed is ≥ 26.8 meters per second (60 mph); and

Between 20 mph and 60 mph, the interval is determined by a linear relationship between 4 and 20 seconds, precise to 1 second, as determined by the vehicle speed when the snapshot is taken (taken to set a timer to count down to the next snapshot).

3.6.1.5.1.2.2 Periodic Snapshot - Stops

A connected vehicle shall not generate a periodic snapshot when it is stopped. A vehicle is stopped when there is no movement for a threshold stop time (stop time threshold (default = 5.0)), precise to tenths of a second, and no other stops have occurred within another threshold time (last stop threshold (default = 15.0)), precise to tenths of a second. The vehicle is considered to remain stopped until the vehicle speed exceeds a threshold (start speed threshold (default = 4.5)), in meters per second.

3.6.1.5.1.3 Event Snapshot

A connected vehicle shall generate a snapshot when it experiences a state change, or when a sensor value exceeds a specific threshold. The purpose of event triggered snapshots is to gather data on occurrences in the vehicle that are transitory by nature. An example of an event driven device is traction control switching from off to on. Multiple activations of traction control at adjacent locations could be used to indicate the location of a slippery road section.

Table 11 lists the vehicle state changes that will generate an event snapshot.

TABLE 11 - EVENT SNAPSHOT - BASED ON CHANGE

Section	Data
3.5.1.1.4.4.1	Broadcast Vehicle Information - Vehicle Lights State
3.5.1.1.4.6.1	Broadcast Vehicle Information - Vehicle Hazard Lights
3.5.1.1.4.6.2	Broadcast Vehicle Information - Vehicle Stopline Violation
3.5.1.1.4.6.3	Broadcast Vehicle Information - Anti-Lock Brake System Activation
3.5.1.1.4.6.4	Broadcast Vehicle Information - Traction Control System Activation
3.5.1.1.4.6.5	Broadcast Vehicle Information - Stability Control System Activation
3.5.1.1.4.6.7	Broadcast Vehicle Information - Hard Braking Warning
3.5.1.1.4.6.8	Broadcast Vehicle Information - Change in Vehicle Light State
3.5.1.1.4.6.15	Broadcast Vehicle Information - Change in Wiper Status
3.5.1.1.4.6.16	Broadcast Vehicle Information - Flat Tire
3.5.1.1.4.6.17	Broadcast Vehicle Information - Vehicle Is Disabled
3.5.1.1.4.6.18	Broadcast Vehicle Information - Air Bag Deployment

Table 12 lists the sensor values, along with the threshold values that also will generate a snapshot. Note: this table has the default thresholds that will generate an event-driven snapshot. For example, when the wheel vertical acceleration exceeds the threshold, it indicates there may be a bump in the roadway.

TABLE 12 - EVENT SNAPSHOT - BASED ON THRESHOLDS

Section	Data	Comments
3.5.1.1.4.5	Broadcast Vehicle Information - Obstacle Information	Upon detection of an obstacle in the roadway.

3.6.1.5.1.4 Start and Stop Snapshots

Snapshots are also needed when a connected vehicle is stopped and when the vehicle starts up again. Starts and stops are useful indicators in a variety of traffic flow measures, including incident detection and clearance, traffic signal operational measures such as cycle failures - where the queue does not dissipate in the first green phase, and for ramp metering.

A connected vehicle is considered stopped when there is no movement for a threshold stop time (stop time threshold) and when no other stops have occurred within another threshold time (last stop threshold). The last stop threshold prevents multiple counts when cars creep forward.

A connected vehicle is considered to be no longer stopped when its vehicle speed exceeds a threshold speed (start speed threshold).

3.6.1.5.1.4.1 Snapshot - Vehicle Stop

A connected vehicle shall generate a snapshot when the vehicle is stopped. A vehicle is stopped when there is no movement for a threshold stop time (stop time threshold), in one second units, and no other stops have occurred within another threshold time (last stop threshold), in one second units. The vehicle is considered to remain stopped until the vehicle speed exceeds a threshold (start speed threshold), in tenths of a meter per second. The default stop time threshold and last stop threshold are 5 seconds and 15 seconds, respectively.

3.6.1.5.1.4.2 Snapshot - Vehicle Start

A connected vehicle shall generate a snapshot when the vehicle starts again (from a vehicle stop). A vehicle is started (no longer stopped) when the vehicle speed exceeds a threshold (start speed threshold (default = 4.5 meters per second)), in units of tenths of a meter per second.

3.6.1.5.2 Snapshot Deletion

Connected devices need to be able to delete snapshots to protect the privacy of the device.

3.6.1.5.2.1 Delete Snapshot - Transmission

A connected vehicle shall delete a snapshot after the snapshot is transmitted to an RSU. Each connected vehicle will have a limited buffer for storing snapshots, so as snapshots are transmitted, the snapshots should be deleted from the buffer.

3.6.1.5.2.2 Delete Snapshot - Expiration

Unless otherwise specified in the PRL (Section 3.3.3), a connected device shall store probe data snapshots that have not been transmitted to an RSU until the probe data is expired. The probe data is expired when a communications link with an RSU supporting probe data collection is not available for a default expiration time (default = 360), in one second units, or a default expiration distance (default = 4000), in one meter units, whichever comes first.

3.6.1.5.2.3 REQ969 Delete Snapshot - Vehicle Turned Off

A connected vehicle shall delete all snapshots when the vehicle ignition is turned off. This will complicate any attempt to associate a vehicle with a precise destination or in recreating a history from manipulating its memory storage area.

3.6.1.5.3 Probe Segment Number (PSN)

Periodic snapshots are tagged with a short-lived Probe Segment Number (PSN). The PSN is regularly changed to ensure privacy. The purpose of the PSN is to identify a vehicle's trajectory through the roadway network for applications such as signal control. The PSN is randomly generated by the connected vehicle after traveling a certain distance or certain period of time, whichever comes last, so the PSN is not associated with a particular vehicle. Snapshots with different PSNs cannot be transmitted within the same probe data message.

3.6.1.5.3.1 Change PSN

Unless otherwise specified in the PRL (Section 3.3.3), a connected vehicle shall change its PSN following either a default time (default PSN time (default = 120 seconds)), in 1 second units, or after the connected device has traveled a default distance (default PSN distance (default = 1000 meters)), in 1 meter units, whichever comes last.

3.6.1.5.3.2 PSN - Gap

When a connected vehicle generates a new PSN, the connected vehicle shall stop transmitting snapshots for a random changeover gap of 50 to 250 meters, or 3 to 13 seconds, whichever comes first. During this changeover gap, no periodic snapshots are generated. This changeover gap is implemented to add another layer of anonymity - with the changeover gap, it is more difficult to associate two PSNs (one PSN prior to the changeover gap and the second PSN after the changeover gap) with the same connected vehicle.

3.6.2 Security Requirements

This process uses certificates that must be kept current and which have a consequent input on the available bandwidth. The IEEE Standard 1609.2 Trial-Use Standard for Wireless Access in Vehicular Environments - Security Services for Applications and Management Messages provides this service. IEEE Standard 1609.2 provides security at the protocol level and does not directly impact J2735; however it does introduce timing elements into the data transfer due to the encryption process. The duration of these timing elements are not yet known but needs to be considered as the requirements are fully developed.

3.6.2.1 Authentication

A connected device shall authenticate each message received to ensure that it is from a non-impersonated valid source.

Systems need to have confidence that information being provided is from a real source rather than being impersonated as a part of a malicious attack. This scheme will likely need to distinguish between common authority (e.g., as may be given to a typical connected device) and special authority (e.g., as may be given to traffic signals, emergency vehicles, etc.)

3.6.2.2 Data Integrity

A connected device shall verify that each message received has not been altered since its transmission.

Messages may become corrupted in transmission due to bit errors or man-in-the-middle attacks. A recipient needs to be able to eliminate any such corrupted packets.

3.6.2.3 Uniqueness

A connected device shall ensure that each message received is not an inappropriate retransmission of a previous transmission.

There is a need to ensure that the information being shared cannot be stored for later retransmission as a part of a replay attack.

4. SECTION 4 - DIALOGS [NORMATIVE]

This section is intended for product developers, such as connected device manufacturers, and system integrators. Other parties might find Sections 4 and 5 helpful to gain a full understanding of the design details of J2735 SE.

This section presents the standardized dialogs (i.e., sequence of data exchanges) that fulfill various requirements. Sometimes the requirements require the broadcast of information, that is, the information is transmitted to whatever connected device might be in range and is listening. Other times, the requirements require the exchange of information between two or more connected devices.

These standardized dialogs define a *lowest common denominator* approach to communications between two connected devices for each data exchange requirement. The purpose of these standardized dialogs is to ensure interoperability - the assurance that all connected devices will effectively communicate with one another as needed. To improve communications efficiency, connected devices may support other non-standard dialogs (e.g., use a sequence of data exchanges that is not defined as a standardized dialog in this section) to fulfill these same data exchange requirements, as long as these dialogs are consistent with the rules defined in J2735 SE. However, if the required data is not properly shared between two connected devices using these non-standard dialogs, two conformant connected devices can always share the data using the standardized dialogs.

The standardized dialogs also allow connected devices be tested against a standard set of procedures, which would use the standardized dialogs in this standard (as defined in Section 4.3 and Appendix A). It is important to note that this standard, including the standardized dialogs, does **not** define how the data is processed by the connected devices, or any application on the connected device. These standardized dialogs only define when data are exchanged on the interface of two connected devices.

The rules for the standardized dialogs are as follows:

1. The dialogs are defined by a sequence of one or more messages originating from a connected device to another connected device. These messages are defined in Section 5.2 of J2735 SE;

2. The contents of each message are identified by data frames and data elements. Formal definitions of each data frame and data element are provided in Sections 5.3 and 5.4, respectively, of J2735 SE;

3. Each message shall contain all of the data frames and data elements as shown, unless otherwise indicated;

4. A message shall not contain any other data frame or data element; and

5. The order of the data frames and data elements within the message shall match the order as shown in J2735 SE to provide for the highest probability of interoperability.

4.1 Tutorial [Informative]

A dialog describes a sequence of message exchanges. For example, a request-response dialog would include a minimum of two messages being shared between two connected devices to accomplish information sharing. The first message may include the request for information, followed by a message containing the information (response). Some dialogs are simple and may consist of a single broadcast message or a single exchange of messages. Complex dialogs might include a larger number of steps and alterations of sequence steps based on some criteria, such as what communications media is used. For example, the response from a connected device may result in one sequence of steps, while a different response from the same connected device may result in a different sequence of steps.

The Requirements Traceability Matrix (RTM) presented in Appendix A identifies the standardized dialog that can be used to achieve each of the data exchange requirements defined in Section 3.5. Many of the steps references messages, data frames and data elements that are defined in Section 5. These data concepts are also shown in the corresponding row of the RTM along with their precise section number.

The dialogs may also be accompanied by an informative figure that provides a graphical depiction of the normative text. The figures conform to the Unified Modeling Language (UML) Sequence Diagrams. These figures are consistent with the ISO 14817 standard, which is being used by J2735 as the guide-specification for defining J2735 SE data concepts. A conceptual UML Sequence Diagram is shown below to illustrate relevant portions. The diagram shows examples of several types of "calls," not all of which are employed in the actual dialogs defined in later sections. If there is any conflict between the figure and the text, the text takes precedence.

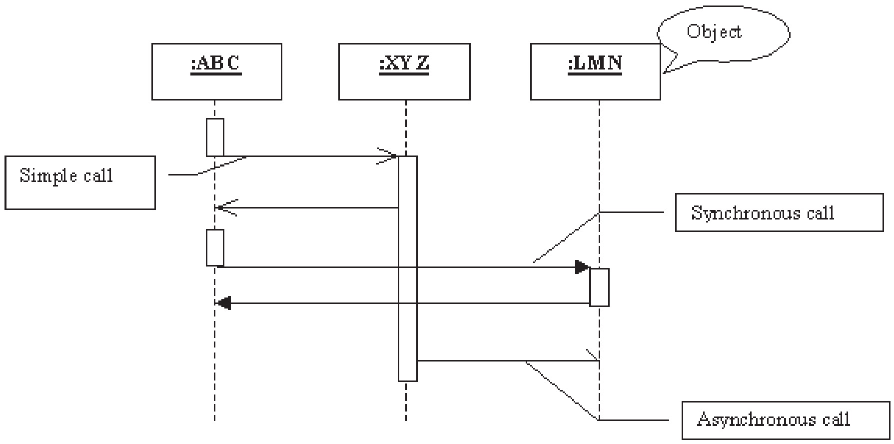
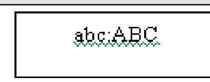
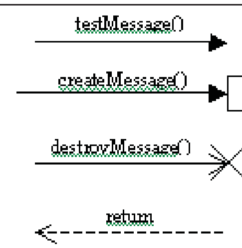


FIGURE 4 - PARTS OF A UML SEQUENCE DIAGRAM

UML Sequence Diagram Element and Description	Symbol
Object: The primary element sequence diagram is an object—an instance of a class. A sequence diagram consists of sequences of interaction among different objects over a period of time. An object is represented by a named rectangle. The name to the left of the ":" is the object name and to its right is the class name.	
Message: The interaction between different objects in a sequence diagram is represented as messages. A message is denoted by a directed arrow. Depending on the type of message, the notation differs. In a sequence diagram, you can represent simple messages, special messages to create or destroy objects and message responses. In this document only the top and bottom message types (as shown in the diagram) are used.	

Section 4.2 describes the encoding and transport mechanisms that may be used to exchange data between connected devices.

Section 4.3 defines how the system is designed to work for a given data exchange requirement. It indicates the sequence of actions that connected devices must follow to provide the specific service. While Section 4.3 describes the sequence of actions that must be performed by the connected devices to support a feature, Section 3.5 provides a formal definition of the functional requirements, specifically:

1. What data must be supported;

2. The relationships among this data;

3. The operations that can be performed on each piece of data; and

4. The required reaction to any action, which may be dependent upon the current state of the device.

Section 4.4 defines specific state-machine mechanisms used within SAE J2735 SE. It describes the states that may be present and what transitions are or are not allowed.

4.2 Defining Message Encoding and Transport

4.2.1 Message Encoding

The ASN specified by J2735 SE is encoded for transport by the lower layers (the encoded stream of bytes becomes the payload of that lower layer). The encoding style required to be used to conform with J2735 SE is the DER variant of BER (the CER variant is not used). The Distinguished Encoding Rules are a specific subset of the Basic Encoding Rules which were developed to allow one (and only one) encoding for any specific message content. The DER style follows the normal byte-aligned Tag-Length-Value format of BER for ASN.

In the production of the data concepts found in J2735 SE (Section 5), there are OCTET STRING segments defined which are made up of inner content constructed as outlined in the definitions. In such cases, the OCTET STRING shall be encoded to match the described inner content and using the bit and byte numbering and packing order as defined by ASN. When the inner content of an OCTET STRING refers to another data frame or data element found in this standard for its construction, the definition of that element shall be used in the place it is referred to. The resulting content of that portion of the OCTET STRING shall be conformant to the definition of the referenced data frame or data element. As an example, the *vehicle-temporary-identifier* field in *BSMPart1* shall conform to the definition of *vehicle-temporary-identifier*.

4.2.2 Message Transport

An information level standard, such as the J2735 SE, does not define the mechanism of transporting messages; or the communications medium (such as 5.9 Ghz) between connected devices - this is defined by Application Level Standards and lower layer standards such as the IEEE 1609 family of standards (specifically, IEEE 1609.3 and IEEE 1609.4).

An informational level standard specifies the format and structure of message content and the sequence of message exchanges. The J2735 SE dialogs are information level dialogs, intended to be separate from the application level dialogs specified in the IEEE 1609.3 and IEEE 1609.4 standards. In this way, a J2735-based solution can be developed with different standards at the application level.

4.3 Specified Dialogs [Normative]

This section provides the standardized data exchange sequences that can be used by connected devices to ensure interoperable implementations for the various data exchange requirements identified in Section 3.5. Diagrams and graphical representations are included to supplement the text (i.e., not used as a replacement for the text) - If there is any conflict between the diagrams and the text, the text takes precedence.

4.3.1 Broadcast Dialog

The broadcast dialog shall consist of an asynchronous Broadcast message being sent from a connected device, called the Transmitter. The broadcast message is not addressed to a specific recipient; instead, any connected device within range to receive the transmission is a Recipient and is allowed to process the message.

The contents of the broadcast message shall conform to the requirements of this standard.

The broadcast dialog is depicted in Figure 5.

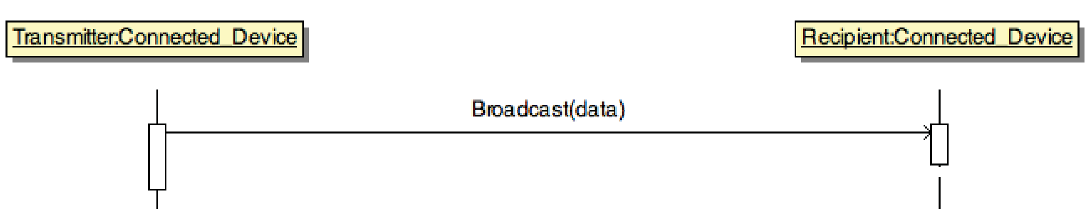


FIGURE 5 - BROADCAST DIALOG

Note that the broadcast dialog consists of a single message without any type of response.

This broadcast dialog is a generic dialog used to satisfy many data exchange requirements. This generic process is customized by subsequent clauses of this standard, by referencing the 'Broadcast' dialog, and directly by the RTM in Appendix A, by section number, in order to fulfill a wide range of the requirements defined in Section 3. Each single message being sent contains the referenced data concepts (i.e., data frames and data elements) that are shown in the corresponding row of the RTM along with their precise section number.

4.3.2 Forwarded Request Dialog

The Forwarded Request Dialog includes the following objects:

- **Requester**: The Requester is a connected device that is attempting to send a Request to a remote Application.

- **Messenger**: A Messenger is a connected device that receives the Request from the Requester, then delivers the Request to the Recipient. In practice, there will often be multiple Messenger devices each attempting to deliver the message.

- **Recipient**: A Recipient is a connected device that is authorized to receive the specific type of Request being sent by the Requester.

The forwarded request dialog shall include the following steps:

1. The Requester shall broadcast a BroadcastFwd message containing the Request to all connected devices within transmission range. The BroadcastFwd shall indicate the time at which the Request initially became active.

2. Upon receiving a BroadcastFwd message, a host connected device shall store the contents of the BroadcastFwd message received from the remote connected vehicle into a buffer. Each connected device receiving this message will become a "Messenger" connected device.

3. NOTE: This will result in multiple "Messenger" devices, all attempting to forward the message with the intent of getting the message to the Recipient as quickly as possible.

4. If a Recipient connected device is using IEEE 1609 for communications, go to Step 4 otherwise go to Step 8.

5. A Recipient shall broadcast a WAVE Service Advertisement (WSA) indicating its support for receiving the contents of the BroadcastFwd message (with a PSID as determined by IEEE Std 1609), and the service channel (SCH) the Messenger should transmit its BroadcastFwd message on.

6. A Messenger, upon receiving a WSA indicating support for the contents of the BroadcastFwd message, shall transmit the BroadcastFwd message, with its contents, on the SCH indicated by the Recipient.

7. The Recipient shall send the message to the appropriate application for processing.

8. When the Messenger is no longer in transmission range of the Recipient, that is, it no longer receives the WSA messages from the Recipient, it shall clear the BroadcastFwd message received from the Requester from its buffer. Exit the process.

9. The Recipient shall broadcast a serviceAdvertisementMsg message, indicating its support for receiving BroadcastFwd messages.

10. The Messenger, upon receiving a serviceAdvertisementMsg message indicating support for BroadcastFwd messages, shall transmit the forwardedMessage to the Recipient.

11. The Recipient shall send the message to the appropriate application for processing.

12. When the Messenger no longer receives serviceAdvertisementMsg messages from the Recipient, it shall clear the BroadcastFwd message received from the Requester from its buffer. Exit the process.

The dialog is depicted in Figure 6.

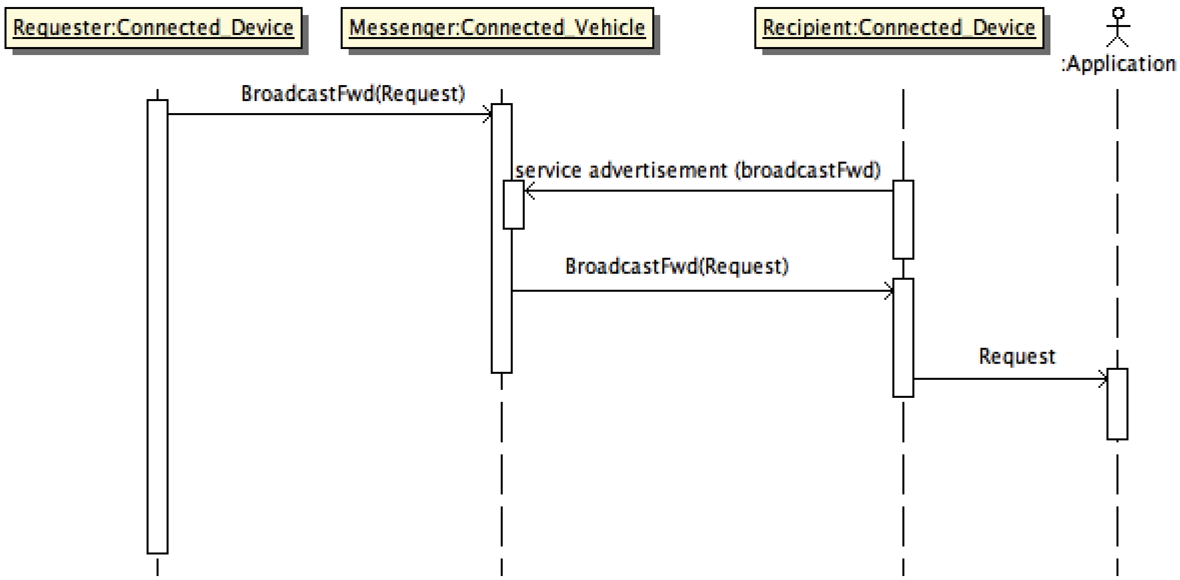


FIGURE 6 - FORWARD MAYDAY DIALOG

4.3.3 Broadcast Vehicle Information Dialog

There are two forms of messages for a connected vehicle to broadcast its vehicle information to another connected device - a blob message and a verbose message. The blob message compacts the mandatory elements into a packed object and is more efficient, resulting in lower bandwidth requirements. The verbose message expands the mandatory elements of the message with BER tagging between each data element, but is intended for use with system testing and development use only.

4.3.3.1 Broadcast Vehicle Information Dialog - Blob Format

The standardized dialog for a connected vehicle to broadcast information about itself to other connected devices shall be as follows:

1. (Precondition). A connected device shall be in transmission range of the connected vehicle, and shall know the device identifier of the subject transmitting connected vehicle.

2. The transmitting connected vehicle shall broadcast a *basicSafetyMessage* to other connected devices, in accordance with Section 4.3.1, where the connected vehicle is the Transmitter and the connected device is the Recipient.

4.3.3.2 Broadcast Vehicle Information Dialog - Verbose Format

The standardized dialog for a connected vehicle to broadcast information about itself to other connected devices shall be as follows:

1. (Precondition). A connected device shall be in transmission range of a transmitting connected vehicle, and shall know the device identifier of the subject transmitting connected vehicle.

2. The transmitting connected vehicle shall broadcast a *basicSafetyMessageVerbose* to other connected devices, in accordance with Section 4.3.1, where the transmitting connected vehicle is the Transmitter and the connected device is the Recipient.

4.3.4 Request Information From Connected Vehicles Dialog

The standardized dialog for a connected device to request additional information from a connected vehicle shall be as follows:

1. (Precondition) Both the requesting connected device and the connected vehicle that the connected device needs additional information from shall be in transmission range of each other.

2. (Precondition) The requesting connected device shall know the device identifier of the connected vehicle that the connected device needs additional information from.

3. The connected device shall transmit a *commonSafetyRequest* message to a connected vehicle, with the *id* field set to the device identifier of the connected vehicle it is requesting information from.

4. Upon receiving a *commonSafetyRequest* message, the connected vehicle shall check if the *id* matches its device identifier.

5. If the *id* in the *CommonSafetyRequest* message does not match its device identifier, the connected vehicle shall ignore the *CommonSafetyRequest* message.

6. If the *id* in the *CommonSafetyRequest* message matches its device identifier, the connected vehicle shall broadcast a *basicSafetyMessage* and the requested items contained in the *CommonSafetyRequest* message. If the connected vehicle receives a request for a data element it does not understand or support, then that request for that data element is ignored.

The dialog is depicted in Figure 7.

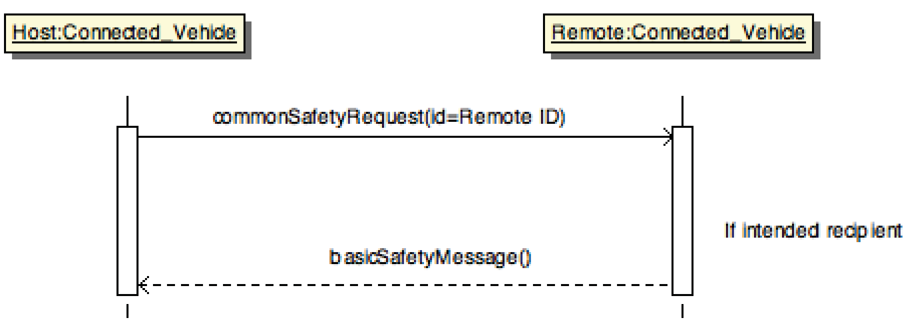


FIGURE 7 - REQUEST INFORMATION FROM OTHER VEHICLES DIALOG

4.3.5 Broadcast Intersection Infringement Dialog

The standardized dialog for a connected vehicle to broadcast intersection infringement information to connected devices shall be as follows:

1. (Precondition). The connected device shall be in transmission range of the connected vehicle, and shall know the device identifier of the subject remote connected vehicle.

2. The connected vehicle shall broadcast a *intersectionInfringement* message to other connected devices, in accordance with Section 4.3.1, where the connected vehicle is the Transmitter and the connected device is a Recipient.

4.3.6 Signal Preferential Treatment Dialogs

The following dialogs are the standardized exchanges between authorized connected vehicles and the infrastructure to provide for preferential treatment at signalized intersections. These dialogs allow authorized connected vehicles to determine what preferential schemes are available, request a specific preferential treatment, receive information if their request has been granted, and be able to cancel their request.

4.3.6.1 Request Signal Preferential Treatment Dialog

The standardized dialog for a connected vehicle to request signal preferential treatment from an RSU shall be as follows:

1. (Precondition) Both the connected vehicle and the RSU broadcasting *spat* and *mapData* messages shall be in transmission range of each other.

2. (Precondition) The connected vehicle shall be authorized to request preferential treatment at that signalized intersection.

3. If the RSU is using IEEE 1609 for communications, go to Step 4, otherwise go to Step 6.

4. The RSU shall broadcast a WAVE Service Advertisement (WSA) indicating its support for receiving traffic control messages (with a PSID as determined by IEEE Std 1609), and the service channel (SCH) the connected vehicle should transmit its request for signal preferential treatment message on.

5. If the connected vehicle desires preferential treatment at a signalized intersection, upon receiving a WSA indicating support for traffic control messages, the connected vehicle shall transmit a *signalRequestMessage* to the RSU on the SCH indicated by the RSU with the identifier of the preferential scheme it is requesting and is authorized for. Go to Step 8.

6. The RSU shall broadcast a *serviceAdvertisementMsg* message, indicating its support for receiving traffic control messages.

7. If the connected vehicle desires preferential treatment at a signalized intersection, upon receiving a message indicating support for traffic control messages, the connected vehicle shall transmit a *signalRequestMessage* to the RSU with the identifier of the preferential scheme it is requesting and is authorized for.

8. The RSU shall process the *signalRequestMessage* received, such as forwarding the signal preferential request to the traffic signal controller.

9. If the preferential scheme requested by the connected vehicle is not supported, the RSU shall broadcast *mapData* messages with the available preferential schemes and defined signal priority zones for that intersection, and then go to Step 3. Otherwise, continue to Step 10.

10. If there are one or more active or pending preferential events to report, the RSU shall broadcast a *signalStatusMessage*. Note: it is assumed that if a traffic signal controller accepts a preferential treatment request, that request is entered into the controller's queue of preferential events.

11. When there is no more active or pending preferential events to report, the RSU shall stop broadcasting the *signalStatusMessage* and continue to broadcast the *mapData* messages but without the available preferential schemes and defined signal priority zones for that intersection.

Figure 8 depicts this dialog.

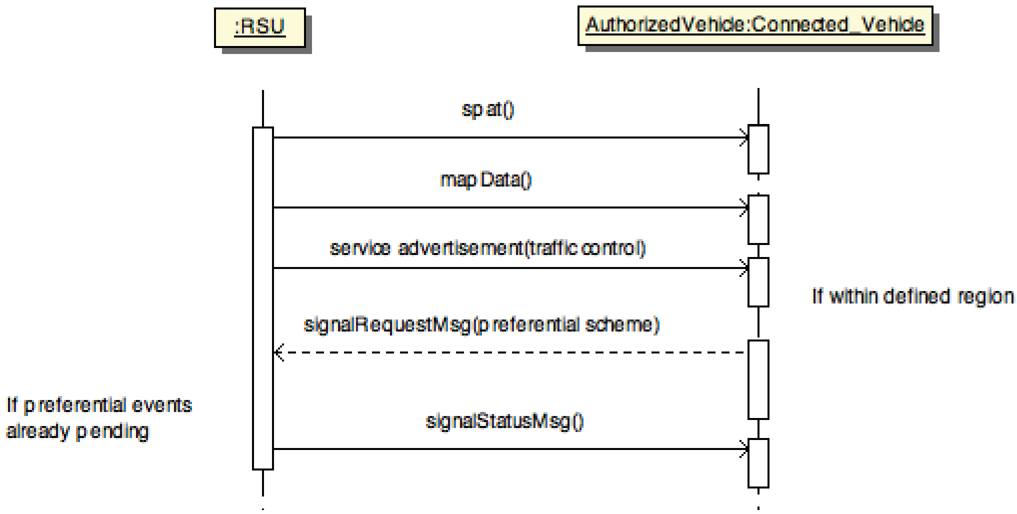


FIGURE 8 - REQUEST SIGNAL PREFERENTIAL TREATMENT DIALOG

4.3.6.2 Cancel Signal Preferential Treatment Request Dialog

The standardized dialog to cancel a previously transmitted signal preferential treatment request from a connected vehicle to an RSU shall be as follows:

1. (Precondition) Both the connected vehicle and the RSU broadcasting *spat* and *mapData* messages shall be in transmission range of each other.

2. (Precondition) The connected vehicle shall be authorized to request preferential treatment from that signalized intersection.

3. If the RSU is using IEEE 1609 for communications, go to Step 4, otherwise go to Step 6.

4. The RSU shall broadcast a WAVE Service Advertisement (WSA) indicating its support for receiving traffic control messages (with a PSID as determined by IEEE Std 1609), and the service channel (SCH) the connected vehicle should transmit its request for signal preferential treatment message on.

5. The connected vehicle, upon receiving a WSA indicating support for traffic control messages, shall transmit to the RSU a *signalRequestMessage* with the *isCancel* field equal to the identifier of the preferential scheme requested to be cancelled. Go to Step 8.

6. The RSU shall broadcast a *serviceAdvertisementMsg* message, indicating its support for receiving traffic control messages.

7. The connected vehicle, upon receiving a message indicating support for traffic control messages, shall transmit to the RSU a *signalRequestMessage* message with the element *isCancel* equal to the identifier of the preferential scheme requested to be cancelled.

8. The RSU shall process the *signalRequestMessage* received, such as forwarding the signal preferential request to the traffic signal controller.

4.3.7 Exchange Commercial Vehicle Information Dialogs

The following are dialogs specific to the sharing of commercial vehicle information. These dialogs define the sequence of events and message exchanges between an RSU and a connected commercial motorized vehicle (CMV). The dialogs for commercial vehicle information exchanges consist of a series of requests and responses between the RSU and connected CMV. Note that for these dialogs, if a response is not received by the transmitting connected device, the transmitting connected device shall periodically re-transmit a message for a fixed period of time until a valid response is received OR an amount of time has elapsed since the first message was transmitted. The interval between transmissions and the period of time that the transmitting connected device will continue to transmit is defined in Section G.2.5.4 to Section G.2.5.6.

These dialogs are applicable only if ALL the preconditions are met - if all preconditions are not satisfied, then these dialogs do not apply.

4.3.7.1 Exchange Commercial Vehicle Credentials Dialog

The standardized dialog for an RSU to exchange credentialing information with a connected CMV shall be as follows:

1. (Precondition) Both the connected CMV and the RSU transmitting *commercialVehicleRequest* messages shall be in transmission range of each other.

2. (Precondition) The connected CMV shall identify itself as a commercial vehicle.

3. (Precondition) The driver of the connected CMV has opted in to provide its vehicle identification information.

4. If the RSU is using IEEE 1609 for communications, go to Step 5, otherwise go to Step 7.

5. The RSU shall broadcast a WAVE Service Advertisement (WSA) indicating its support for receiving freight-fleet-management messages (with a PSID as determined by IEEE Std 1609), and the service channel (SCH) the connected CMV shall transmit its response on.

6. The connected CMV, upon receiving the WSA message indicating support for freight-fleet management messages, shall transmit a *commercialVehicleData* message on the SCH indicated by the RSU. Go to Step 9.

7. The RSU shall broadcast a *serviceAdvertisementMsg* message, indicating its support for receiving freight-fleet-management messages.

8. The connected CMV, upon receiving a message indicating support for freight-fleet management messages, shall transmit a *commercialVehicleData* message to the RSU.

9. The RSU, upon receiving a *commercialVehicleData* message from a connected CMV, shall respond with either a *commercialVehicleRequest* message, requesting additional information from the connected CMV, or a *commercialVehicleClearance* message, providing instructions to the connected CMV. The *commercialVehicleRequest* message and the *commercialVehicleClearance* message is addressed to a specific connected CMV, by setting the *target* field equal to the connected CMV's VIN.

10. The connected CMV, upon receiving a *commercialVehicleRequest* message or a *commercialVehicleClearance* message from the RSU, shall check if the *target* field is equal to the connected CMV's VIN. If yes, continue to Step 11, otherwise remain in Step 10.

11. If the connected CMV receives a *commercialVehicleClearance* message, go to Section 4.3.7.4, Step 5.

12. The connected CMV, upon receiving a *commercialVehicleRequest* message from the RSU, shall check if the connected CMV is within the valid region (*regions* field) and is traveling in the designated direction (*direction* field). If yes, continue to Step 13, otherwise exit the process.

13. The connected CMV shall transmit a *commercialVehicleData* message to the RSU.

    a. If the *requestItem* field in the *commercialVehicleRequest* message includes ‘driveridentification (5)’, the *commercialVehicleData* message shall include the contents of the *drivers* data frame.

    b. If the *requestItem* field in the *commercialVehicleRequest* message includes ‘driverdutylog (4)’, see Section 4.3.7.3.

    c. If the *requestItem* field in the *commercialVehicleRequest* message includes ‘trailerdata (3)’, the *commercialVehicleData* message shall include the contents of the *trailers* data frame.

    d. If the *requestItem* field in the *commercialVehicleRequest* message includes ‘cargodata (2)’, the *commercialVehicleData* message shall include the contents of the *currentTrip* data frame.

    e. If the *requestItem* field in the *commercialVehicleRequest* message includes ‘screeningevent (1)’, see Section 4.3.7.3.

14. Go to Step 9.

Figure 9 depicts this dialog.

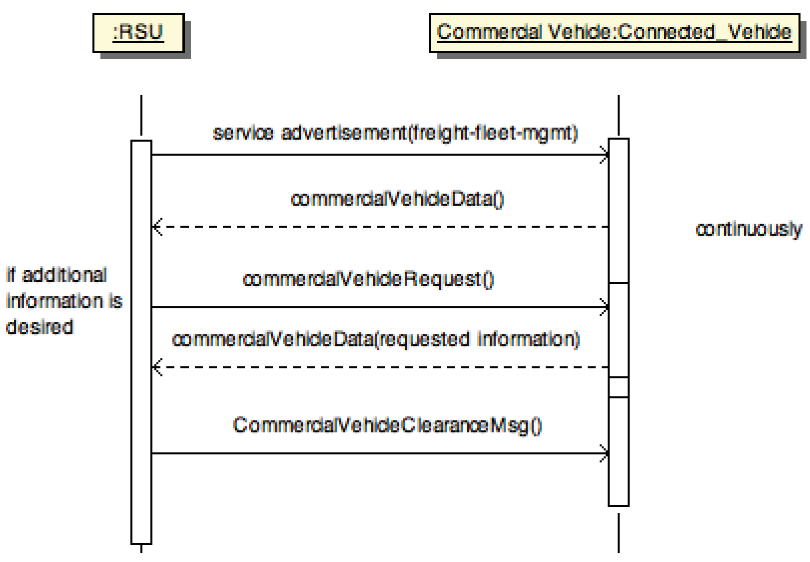


FIGURE 9 - EXCHANGE COMMERCIAL VEHICLE CREDENTIALS DIALOG

4.3.7.2 Exchange Commercial Vehicle Screening Results Dialog

After the completion of a roadside check, a connected CMV would like to receive and store the results of the roadside check so it may bypass similar roadside checks downstream. To accomplish this, the roadside check station needs to transmit the results of the screening event to the connected CMV. The connected CMV then confirms its receipt of the roadside check results.

The standardized dialog for exchanging the results of the commercial vehicle screening between an RSU and a connected CMV shall be as follows:

1. (Precondition) Both the connected CMV and the RSU transmitting *commercialScreeningData* messages shall be in transmission range of each other.

2. (Precondition) The connected CMV shall identify itself as a commercial vehicle.

3. (Precondition) The driver of the connected CMV has opted in to provide its vehicle identification information.

4. The RSU, upon completion of the roadside check, shall transmit a *commercialScreeningData* message to a connected CMV with the results of its screening.

5. The connected CMV, upon receiving a *commercialScreeningData* message from the RSU, shall check if the *target* is equal to the connected CMV's VIN. If yes, continue to Step 6, otherwise remain in Step 5.

6. The connected CMV shall transmit a *commercialScreeningAcknowledgement* message to the RSU, with the *encounterCrc* field equal to the *crc* field in the *commercialScreeningData* message it has just received.

7. The RSU, upon receiving a *commercialScreeningAcknowledgement* message from the connected CMV, shall check if the *commercialScreeningAcknowledgement* message is valid. A *commercialScreeningAcknowledgement* message is valid if the *encounterCrc* field is equal to the *crc* field in the *commercialScreeningData* message the RSU previously sent to the connected CMV. If the *commercialScreeningAcknowledgement* is valid, go to Section 4.3.7.4. Otherwise, go to Step 4.

Figure 10 depicts this dialog.

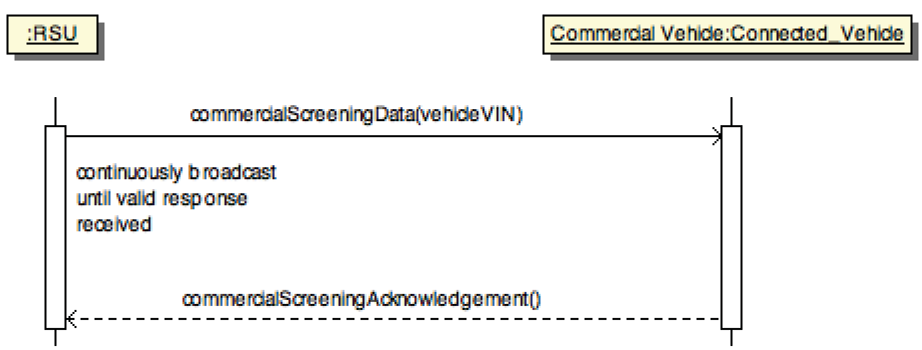


FIGURE 10 - EXCHANGE COMMERCIAL VEHICLE SCREENING RESULTS DIALOG

4.3.7.3 Exchange Previous Commercial Vehicle Screening Results Dialog

Prior to arriving at a roadside check station, a commercial vehicle agency may request a connected CMV's previous screening results. If the commercial vehicle's screening results are in order, the commercial vehicle agency may elect to allow the connected CMV to bypass the roadside check station. This capability allows a roadside check station to only inspect those connected CMVs for which no data is available or whose screening results are suspect while allowing connected CMVs that have already been screened to bypass additional screening.

The standardized dialog for exchanging a connected CMV's previous screening results with an RSU shall be as follows:

1. (Precondition) Both the connected CMV and the RSU transmitting *commercialVehicleRequest* messages shall be in transmission range of each other.

2. (Precondition) The connected CMV shall identify itself as a commercial vehicle.

3. (Precondition) The driver of the connected CMV has opted in to provide its vehicle identification information.

4. If the RSU is using IEEE 1609 for communications, go to Step 5, otherwise go to Step 7.

5. The RSU shall broadcast a WAVE Service Advertisement (WSA) indicating its support for receiving freight-fleet-management messages (with a PSID as determined by IEEE Std 1609), and the service channel (SCH) the connected CMV should transmit its commercial vehicle messages on.

6. The connected CMV, upon receiving a WSA indicating support for freight-fleet management messages, shall transmit a *commercialVehicleData* message on the SCH indicated by the RSU. Go to Step 9.

7. The RSU shall broadcast a *serviceAdvertisementMsg* message, indicating its support for receiving freight-fleet-management messages.

8. The connected CMV, upon receiving a message indicating support for freight-fleet management messages, shall transmit a *commercialVehicleData* message to the RSU.

9. The RSU, upon receiving a *commercialVehicleData* from a connected CMV, shall transmit a *commercialVehicleRequest* message to the connected CMV with the *requestItem* field to include 'screeningevent (1)'.

10. The connected CMV, upon receiving a *commercialVehicleRequest* message from the RSU, shall check if the *target* equal to the connected CMV's VIN. If yes, continue to Step 11, otherwise remain in Step 10.

11. The connected CMV shall transmit a *commercialScreeningResults* message with the screening results from its previous screening events on its current run.

12. If the RSU receives a *commercialScreeningResults* from the connected CMV, go to Section 4.3.7.4, otherwise remain in Step 12.

Figure 11 depicts this dialog:

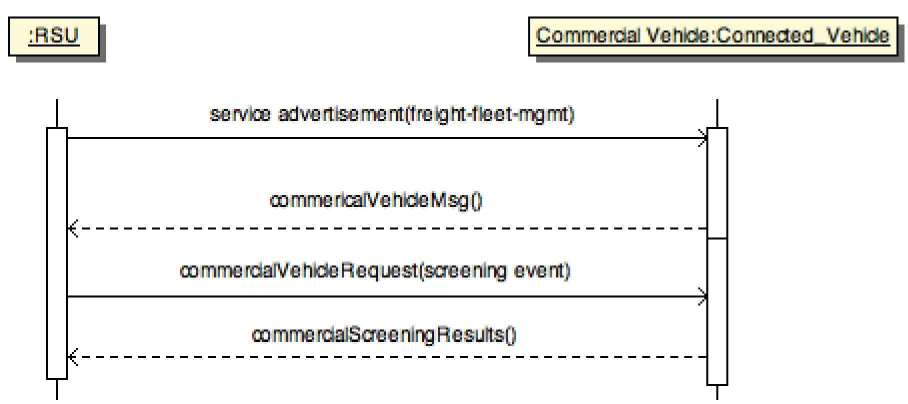


FIGURE 11 - EXCHANGE PREVIOUS COMMERCIAL VEHICLE SCREENING RESULTS DIALOG

4.3.7.4 Exchange Vehicle Clearance Dialog

This capability allows a roadside check station to either provide electronic clearance to a connected CMV, or to provide further instructions to the connected CMV.

The standardized dialog for exchanging instructions between a connected device and a connected CMV shall be as follows:

1. (Precondition) Both the connected CMV and the RSU transmitting *commercialVehicleClearance* messages shall be in transmission range of each other.

2. (Precondition) The connected CMV shall identify itself as a commercial vehicle.

3. (Precondition) The driver of the connected CMV has opted in to provide its vehicle identification information.

4. The RSU shall transmit the *commercialVehicleClearance* message, providing instructions to the connected CMV.

5. If the connected CMV receives a *commercialVehicleClearance* message from the RSU with *target* equal to the connected CMV's VIN and the *instructions* field equal to 'bypass (1)' or 'stationclosed (3)', the connected CMV shall transmit a *commercialVehicleAcknowledgement* message back to the RSU. Go to Step 8.

6. If the connected CMV receives a *commercialVehicleClearance* message from the RSU with *target* field equal to the connected CMV's VIN and the *instructions* field equal to 'pullIn (2)', the connected CMV shall transmit a *commercialVehicleAcknowledgement* message with the location (*location* field*)* of the station that the CMV is to pull into.

7. If the RSU receives a valid *commercialVehicleAcknowledgement* message from the connected CMV, it shall exit the process. A *commercialVehicleAcknowledgement* message is valid if the *vehicle-vin* field is equal to the connected CMV's VIN, and the *location* field matches the location of the station that was transmitted by the RSU. If the RSU receives an invalid *commercialVehicleAcknowledgement* message, go to Step 4, otherwise exit the process.

Figure 12 depicts this dialog.

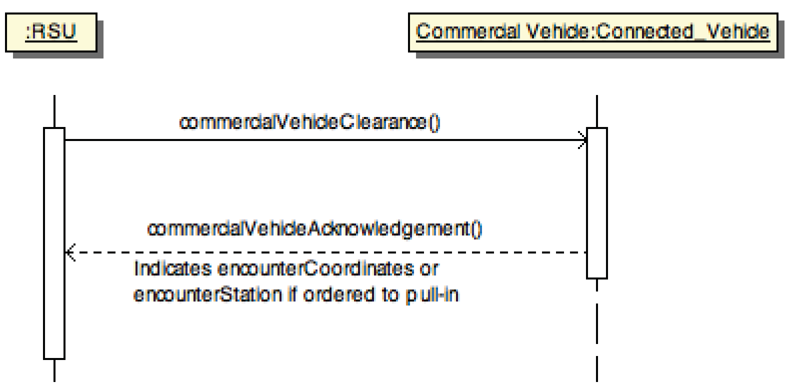


FIGURE 12 - EXCHANGE VEHICLE CLEARANCE DIALOG

4.3.8 Exchange Probe Data Dialog

The standardized dialog for a connected device to transmit its probe data to an RSU shall be as follows:

1. (Precondition). The connected device shall be in transmission range of an RSU that advertises it supports the ability to receive probe data messages (based on the PSID value and running a suitable application). Make sure both transmitter and recipient are in transmission range both ways.

2. If the RSU is using IEEE 1609 for communications, go to Step 3, otherwise go to Step 4.

3. The RSU shall broadcast a WAVE Service Advertisement (WSA) indicating its support for receiving probe data messages (with a PSID as determined by IEEE Std 1609), and the service channel (SCH) the connected device should transmit its probe data on. Go to Step 5.

4. The RSU shall broadcast a *serviceAdvertisementMsg* message, indicating its support for receiving probe data messages.

5. If the connected vehicle is in *initialization* state (See Section 4.4.1), then exit the process. Otherwise, continue to Step 6.

6. The connected device shall transmit a *probeVehicleData* message to the RSU on the SCH indicated by the RSU. Each *probeVehicleData* message shall consist of up to four (4) snapshots. Snapshots are transmitted to the RSU as part of a probe message in the following order:

    a. Event triggered snapshots are first in the transmission queue from the connected device to the RSU. Since these often relate to specific adverse conditions that are of interest to traffic operations, these are considered more critical than the other types of snapshots.

    b. Stop or start triggered snapshots are second and are needed to provide finer information on incidents and the various dynamic parameters concerning the traffic flow.

    c. Periodic snapshots are third, oldest first.

    d. Only start and stop snapshots and/or periodic snapshots with the same PSN should be transmitted in the same *probeVehicleData* message (See Section 4.5.1). Snapshots with different PSNs should be in different messages.

7. Upon adding a snapshot to the *probeVehicleData* message, the connected device shall delete that snapshot from the buffer.

Figure 13 depicts this dialog.

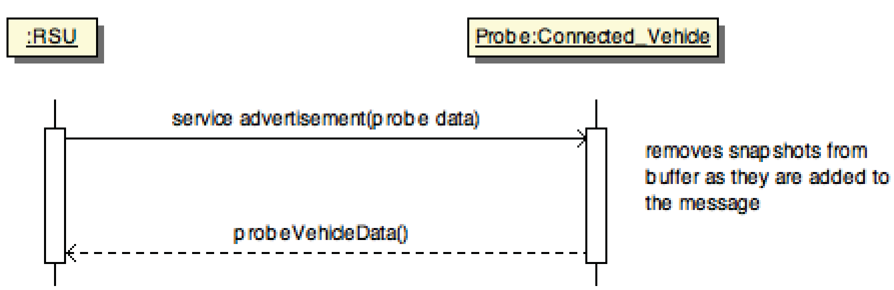


FIGURE 13 - EXCHANGE PROBE VEHICLE DATA DIALOG

Figure 14 illustrates the simplified structure of a *probeVehicleData* message. Figure 15 is a graphical representation of the order for which snapshots are sent to the RSU.

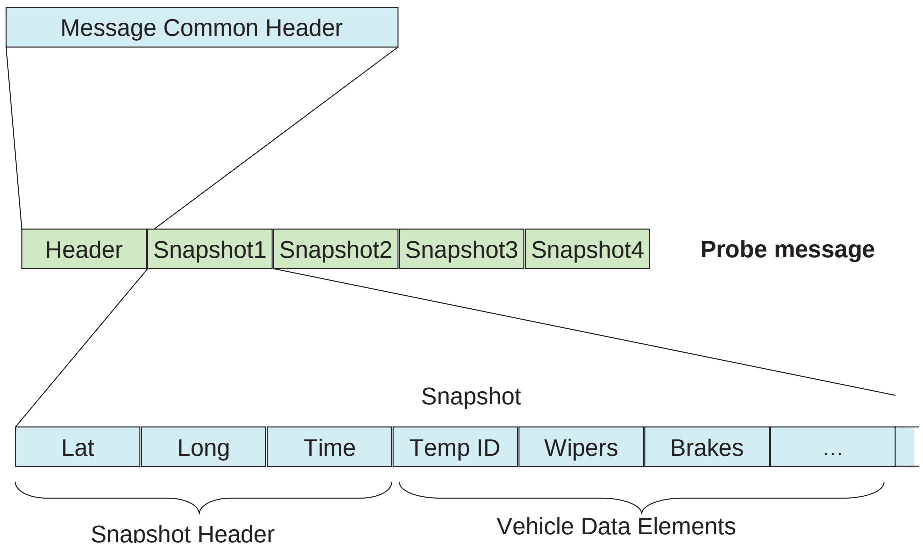


FIGURE 14 - PROBE DATA MESSAGE - STRUCTURE

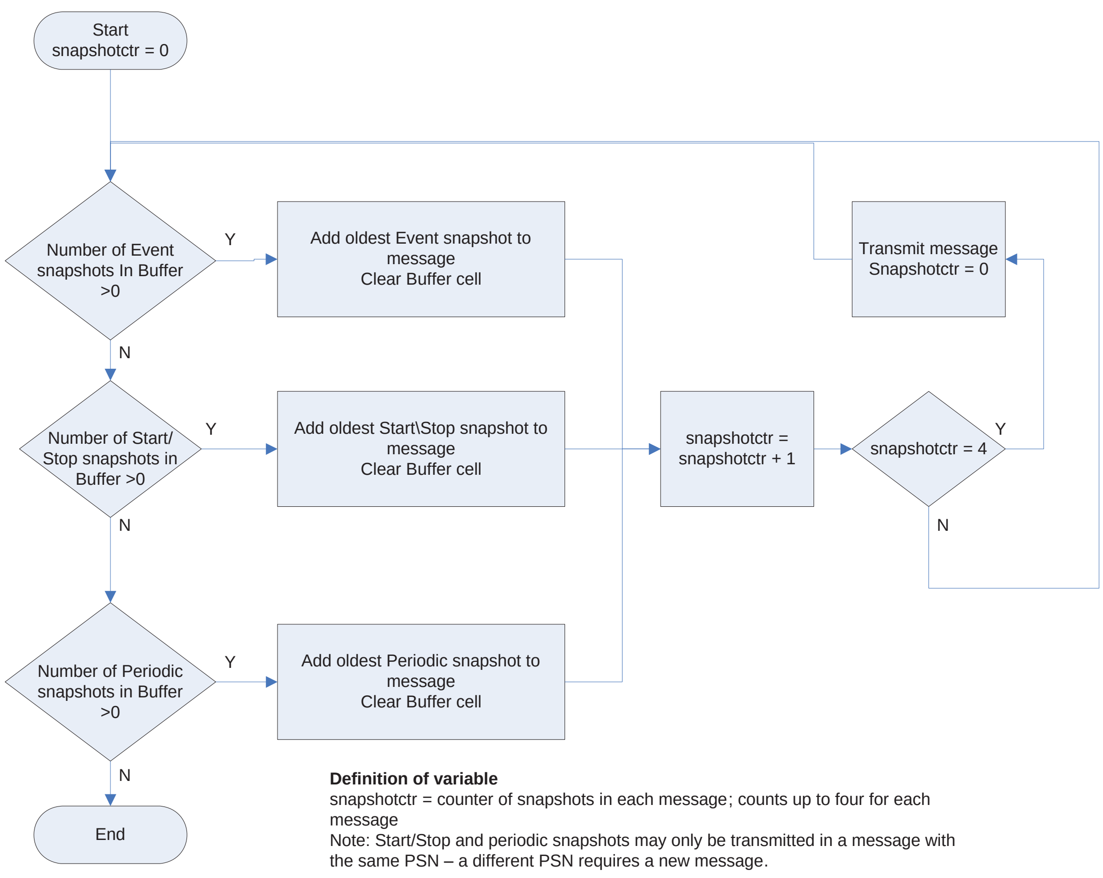


FIGURE 15 - PROBE DATA MESSAGE - SNAPSHOT ORDERING

4.3.9 Exchange Probe Data Management Dialog

The *probeDataManagement* message is broadcast from the RSU to all connected devices. Its purpose is to change the snapshot generation characteristics of a connected device. For example, the connected device can be instructed to take snapshots more frequently and transmit them more often.

Probe management is temporary. By default a probe message management process ceases when a new RSU that supports probe messages is contacted. This case overrides the termination settings below.

The standardized dialog for managing a connected device's data collection policy (see Figure 16) shall be as follows:

1. (Precondition). The connected device shall be in transmission range of an RSU that broadcasts a *probeDataManagement* message.

2. The RSU shall broadcast a *probeDataManagement* message.

3. The connected device shall check if the *probeDataManagement* message has been previously received by the connected device and if the data collection policies are already in effect. If yes, go to Step 7.

4. The connected device shall read the *sample* and *direction* fields in the *probeDataManagement* message and check if the data collection policies applies to the connected device. If the two digits of the connected device's current MAC address and the direction (of travel) of the connected device are not within the *sample* and *direction* fields in the *probeDataManagement* message, respectively, then exit the process. Otherwise continue to Step 5.

5. The connected device shall generate a new PSN.

6. The connected device shall update its data collection policy based on the settings in the *probeDataManagement* message. This includes updates to when snapshots are generated (*snapshot* field), start and stop thresholds (*stopThreshold* field), transmission intervals (*txInterval* field), and event thresholds (*dataElements* field).

7. The connected device shall repeatedly check that it has not exceeded the termination policy (*term* field) included in the *probeDataManagement* message until the termination time or termination distance is reached, or the vehicle encounters a new RSU that advertises the collection of *probeVehicleData*, or a new applicable *probeDataManagement* message is received.

8. If a new *probeDataManagement* message is received, go to Step 3.

9. The connected device shall reset to its default data collection policy.

10. The connected device shall generate a new PSN.

Figure 16 depicts the information exchanges, while Figure 17 depicts the sequence of events within the connected device.

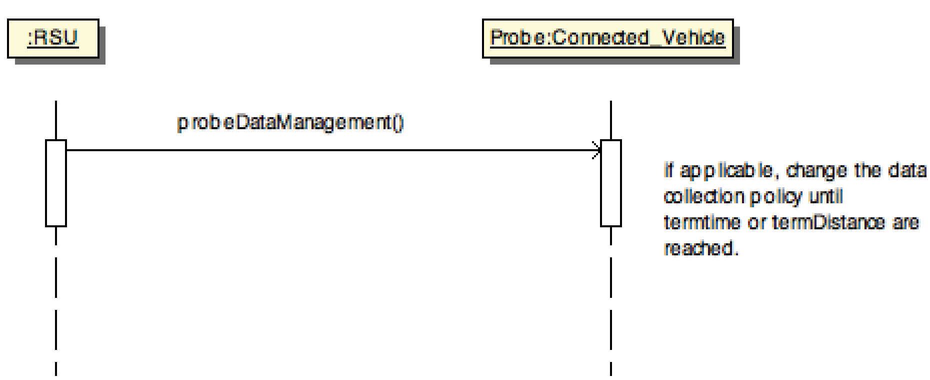


FIGURE 16 - PROBE DATA MANAGEMENT DIALOG

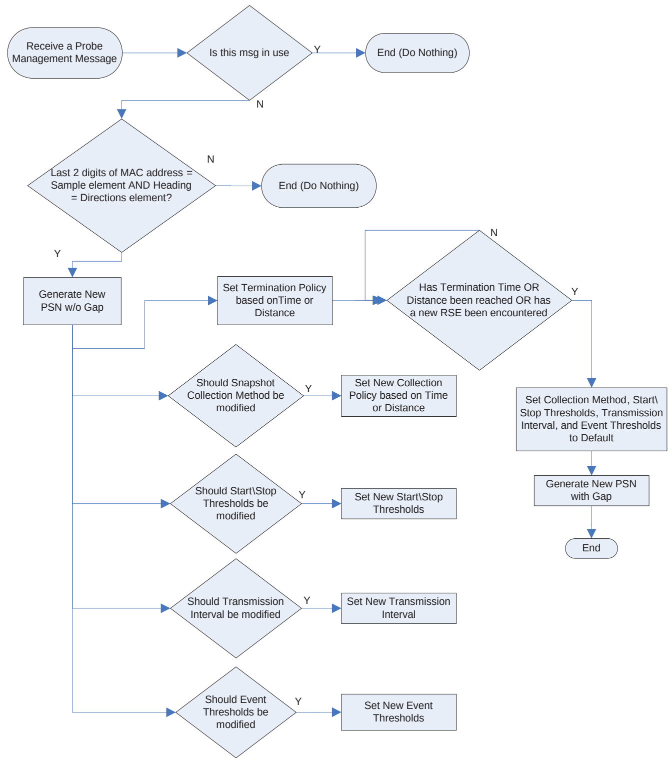


FIGURE 17 - PROBE DATA MANAGEMENT MESSAGE

4.3.10 Broadcast Roadway Geometrics Information Dialog

The standardized dialog for an RSU to broadcast roadway geometrics information to connected devices shall be as follows:

1. (Precondition). The connected device shall be in transmission range of the RSU that broadcasts the *mapData* message.

2. The RSU shall broadcast a *mapData* message to other connected devices, in accordance with Section 4.3.1, where the RSU is the Transmitter and a connected device is a Recipient.

4.3.11 Broadcast Location Correction Details Dialogs

The following dialogs allow an RSU to broadcast differential GPS correction messages to interested local users equipped with GPS to achieve a greater absolute positional accuracy estimate. Typically this application is transmitted from fixed site RSU devices, but may on occasion come from other connected devices as well.

4.3.11.1 Broadcast Location Correction Details Dialog - NMEA

The standardized dialog for a connected device, generally an RSU, to broadcast NMEA-defined location correction details information to other connected devices shall be as follows. For clarity, the transmitting connected device is called the RSU for this dialog.

1. (Precondition). The connected device shall be in transmission range of the RSU that broadcasts *nMEACorrections* messages.

2. The RSU shall broadcast a *nMEACorrections* message to other connected devices, in accordance with Section 4.3.1, where the RSU is the Transmitter and a connected device is a Recipient.

4.3.11.2 Broadcast Location Correction Details Dialog - RTCM

The standardized dialog for a connected device, generally an RSU, to broadcast RTCM-defined location correction details information to other connected devices shall be as follows. For clarity, the transmitting connected device is called the RSU for this dialog.

1. (Precondition). The connected device shall be in transmission range of the RSU that broadcasts *rTCMCorrections* messages.

2. The RSU shall broadcast a *rTCMCorrections* message to other connected devices, in accordance with Section 4.3.1, where the RSU is the Transmitter and a connected device is a Recipient.

4.3.12 Broadcast Signal Phase and Timing Information Dialog

The standardized dialog for an RSU to broadcast signal phasing and timing information to connected devices shall be as follows:

1. (Precondition). The connected device shall be in transmission range of an RSU that broadcasts *spat* messages.

2. The RSU shall broadcast a *spat* message to other connected devices, in accordance with Section 4.3.1, where the RSU is the Transmitter and a connected device is a Recipient.

4.3.13 Broadcast Traveler Information Dialog

The standardized dialog for an RSU to broadcast traveler information to connected devices shall be as follows:

1. (Precondition). The connected device shall be in transmission range of the RSU that broadcasts *travelerInformation* messages.

2. The RSU shall broadcast a *travelerInformation* message to other connected devices, in accordance with Section 4.3.1, where the RSU is the Transmitter and a connected device is a Recipient.

4.3.14 Forwarding Mayday Transmission Dialog

The standardized dialog for a connected device to forward a *maydayMessage* broadcasted from a remote connected vehicle to a public safety connected device shall be as follows:

1. (Precondition). The host connected device shall be in transmission range of a remote connected vehicle.

2. (Precondition). The host connected device shall be in reception range of a public safety connected device. The time the host connected device is in reception range of the public safety connected device shall be concurrent or after the time the host connected device is in transmission range of the remote connected vehicle.

3. (Precondition). The driver of the remote connected vehicle has opted in to transmit mayday messages in the event the vehicle is in a mayday condition.

4. This dialog shall in accordance with Section 4.3.2, where the remote connected vehicle is the Requester; the host connected device is the Messenger; and the public safety connected device is the Recipient.

5. If a Requester is indicating a mayday condition, the Requester shall broadcast a *maydayMessage* to other connected devices.

6. The Requester shall continue broadcasting the *maydayMessage* until it is turned off, either manually or by the application.

7. Upon receiving a *maydayMessage*, if a connected device supports receiving mayday messages, send the message to the appropriate application for processing, then exit the process. Otherwise, continue to Step 8.

8. Upon receiving a *maydayMessage*, a connected device shall store the contents of the *maydayMessage* received from the Requester into a buffer. Each connected device receiving this message will become a “Messenger" connected device.

NOTE: This will result in multiple “Messenger" devices, all attempting to forward the message with the intent of getting the message to the Recipient as quickly as possible.

9. If a Recipient is using IEEE 1609 for communications, go to Step 10 otherwise go to Step 14.

10. A Recipient shall broadcast a WAVE Service Advertisement (WSA) indicating its support for receiving mayday messages (with a PSID as determined by IEEE Std 1609), and the service channel (SCH) the Messenger should transmit its received mayday message on.

11. A Messenger, upon receiving a WSA indicating support for mayday messages, shall transmit the *forwardedMessage,* with the contents of the *maydayMessage*, on the SCH indicated by the Recipient.

12. The Recipient shall send the message to the appropriate application for processing.

13. When the Messenger is no longer in transmission range of the Recipient, that is, it no longer receives the WSA messages from the Recipient, it shall clear the *maydayMessage* received from the Requester from its buffer. Exit the process.

14. The Recipient shall broadcast a *serviceAdvertisementMsg* message, indicating its support for receiving mayday messages.

15. A Messenger, upon receiving a *serviceAdvertisementMsg* message indicating support for mayday messages, shall transmit the *forwardedMessage*, with the contents of the *maydayMessage*, to the Recipient.

16. The Recipient shall send the message to the appropriate application for processing.

17. When the Messenger no longer receives *serviceAdvertisementMsg* messages from the Recipient, it shall clear the *maydayMessage* received from the Requester from its buffer. Exit the process.

4.3.15 Broadcast Mayday Dialog

The standardized dialog for a connected vehicle to broadcast mayday messages to connected devices shall be as follows:

1. (Precondition). The connected device shall be in transmission range of the connected vehicle that broadcasts a *maydayMessage*.

2. The connected vehicle shall broadcast a *maydayMessage* to other connected devices, in accordance with Section 4.3.1, where the connected vehicle is the Transmitter and a connected device is a Recipient.

4.3.16 Exchange A La Carte Information Dialog

This capability allows vehicle manufacturers and fleet operators to exchange customized data with connected vehicles.

The standardized dialog for an RSU to exchange a la carte information with a connected vehicle shall be as follows:

1. (Precondition). The connected vehicle shall be in transmission range of an RSU that advertises it supports the ability to receive *alaCarte* messages (based on the PSID value and running a suitable application).

2. If the RSU is using IEEE 1609 for communications, go to Step 3 otherwise go to Step 5.

3. The RSU shall broadcast a WAVE Service Advertisement (WSA) indicating its support for receiving *alaCarte* messages (with a PSID as determined by IEEE Std 1609) and the service channel (SCH) the connected vehicle should transmit its response message data on.

4. Upon receiving the WSA message, a connected vehicle shall transmit an *alaCarte* message on the SCH indicated by the RSU. Go to Step 7.

5. The RSU shall broadcast a *serviceAdvertisementMsg* message, indicating its support for receiving mayday messages.

6. The connected vehicle, upon receiving a *serviceAdvertisementMsg* message indicating support for *alaCarte* messages, shall transmit an *alaCarte* message to the RSU.

7. Upon receiving the *alaCarte* message from the connected vehicle, the RSU shall process the *alaCarte* message. If the *alaCarte* message from the connected vehicle does not meet a deployment-specific criteria or if the desired data exchanges between the RSU and the connected vehicle is complete, then exit this process.

8. The RSU shall transmit an *alaCarte* message to the connected vehicle.

9. Upon receiving the *alaCarte* message from the RSU, the connected vehicle shall respond with an *alaCarte* message. Return to Step 4.

4.4 State-Transition Diagrams

State-Transition diagrams are included for those objects that have or manage states. “State-transition diagrams describe all of the states that an object can have, the events under which an object changes state (transitions), the conditions that must be fulfilled before the transition will occur (guards), and the activities undertaken during the life of an object (actions)." (Reference: State-Transition Diagrams: Testing UML Models. Part 4 by Lee Copeland)

The following subsections define the states for the various objects that may be supported by a connected device.

4.4.1 Snapshot State Machine Definition

A connected vehicle shall maintain three (3) states for generating and deleting snapshots:

- Initialization state;

- Modifying state; and

- Buffer Overflow state.

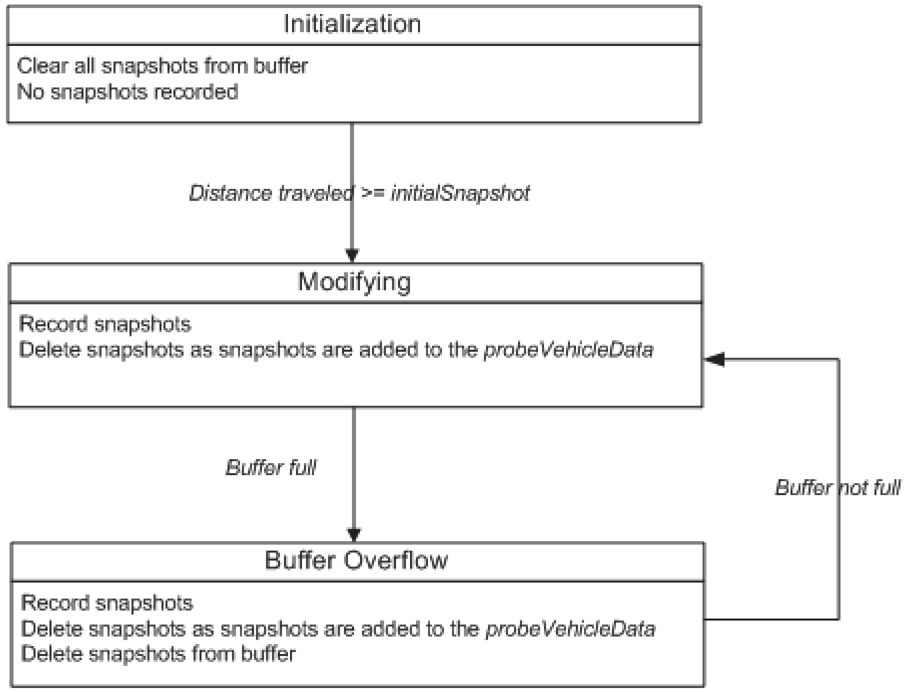


FIGURE 18 - CONNECTED VEHICLE - SNAPSHOT STATES

4.4.1.1 Initialization State

When in the initialization state, the following rules shall apply:

1. A connected vehicle shall be in the initialization state upon engine ignition.

2. A connected vehicle shall clear all snapshots from its buffer.

3. A connected vehicle shall not record any snapshots.

4.4.1.2 Modifying State

A *probeVehicleData* message transmitted from a connected vehicle to an RSU consists of a series of snapshots taken autonomously as the vehicle travels. In the absence of any overriding probe management messages snapshots are generated in three manners:

- Periodically - at intervals based on vehicle movement
- Event Triggered - these occur when the state of certain vehicle status elements change
- Starts and Stops - these occur when a vehicle starts moving and stops moving

These snapshots consist of all probe data elements that are available on the vehicle, along with the time and location when each snapshot was taken. Not all connected vehicles will support all probe data elements, therefore, if a vehicle does not have the ability to send a certain data element, it should not send any reference to that element.

When in the modifying state, the following rules shall apply:

1. A connected vehicle shall not enter the modifying state until it has traveled a certain distance, *initialSnapshot*. *initialSnapshot* is defined in Section 3.6.1.5.1.1. Note: *initialSnapshot* is not a transmitted value.

2. If the vehicle experiences a state change, or when a sensor value exceeds a specific threshold (See Section 3.6.1.5.1.3), the connected vehicle shall generate an event snapshot.

3. If the vehicle has not moved for a period more than the *snapshotStop-time*, and no other stops have occurred within the *snapshotStop-last*, then the connected vehicle shall generate a stop snapshot (See Section 3.6.1.5.1.4.1).

4. If the vehicle is considered stopped, then the vehicle speed exceeds the *snapshotStop-start*, the connected vehicle shall generate a start snapshot (See Section 3.6.1.5.1.4.2).

5. While the vehicle is not considered stopped, the connected vehicle shall generic a periodic snapshot at the appropriate time. The interval between periodic snapshots is determined by the vehicle's speed (See Section 3.6.1.5.1.2).

6. Upon adding a snapshot to the probeVehicleData message, the connected vehicle shall delete that snapshot from the buffer.

Figure 19 provides a graphic representation of when a snapshot is recorded.

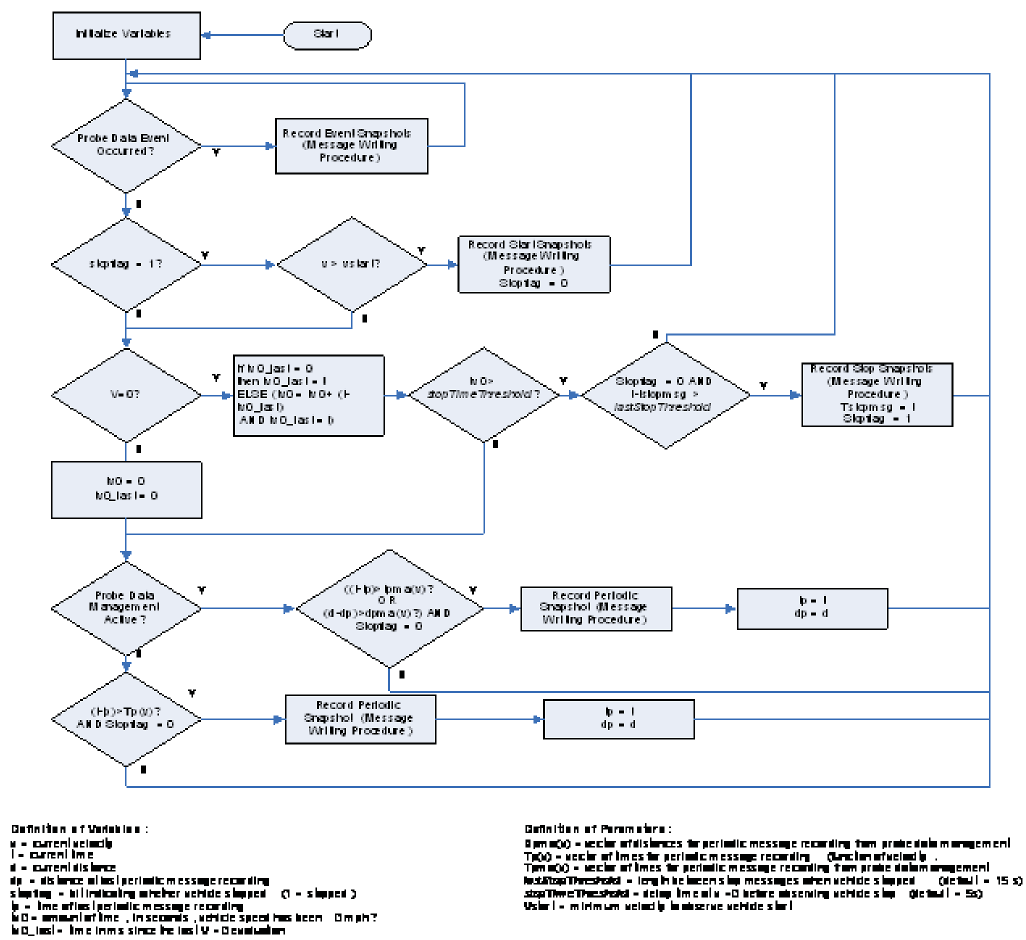


FIGURE 19 - CONNECTED VEHICLE - MODIFYING STATE

4.4.1.3 Buffer Overflow State

The connected device is in the buffer overflow state when the snapshot buffer is full. In the buffer overflow state, to store newly generated snapshots in the buffer, the following process shall apply:

1. If the snapshot buffer is full, periodic snapshots should be deleted first from the buffer. The deletion of the periodic snapshots should follow the following process: The oldest periodic snapshot is deleted last. The first snapshot to be deleted is second oldest, then the fourth, sixth etcetera. This is repeated until the snapshot in the position halfway between the oldest and the newest period snapshot is met and then the process is repeated starting again at the snapshot in the second position. This provides two features: the oldest periodic snapshot is kept to assist in the estimate of travel time and the deletion of snapshots is preferentially applied to the older data that is less relevant. The process is illustrated in Figure 20. The figure does not illustrate the effect of the deletion process if there are event snapshots; the effect of these is to reduce the point at which the deletion cycle is repeated. Once the periodic snapshot is deleted, store the generated snapshot in the buffer, then exit the process. If there are no periodic snapshots in the buffer, continue to Step 2.

2. If the buffer contains only event, start and stop snapshots and if the generated snapshot is a periodic snapshot, do not store the generated snapshot in the buffer and exit the process. Otherwise, continue to Step 3.

3. If the buffer contains only event, start and stop snapshots, delete the oldest start or stop snapshot from the buffer and store the generated snapshot in the buffer, then exit the process. Otherwise continue to Step 4.

4. If the buffer contains only event snapshots, and if the generated snapshot is a periodic, start or stop snapshot, do not store the generated snapshot in the buffer and exit the process. Otherwise, continue to Step 5.

5. Delete the oldest event snapshot from the buffer and store the generated snapshot in the buffer. Exit the process.

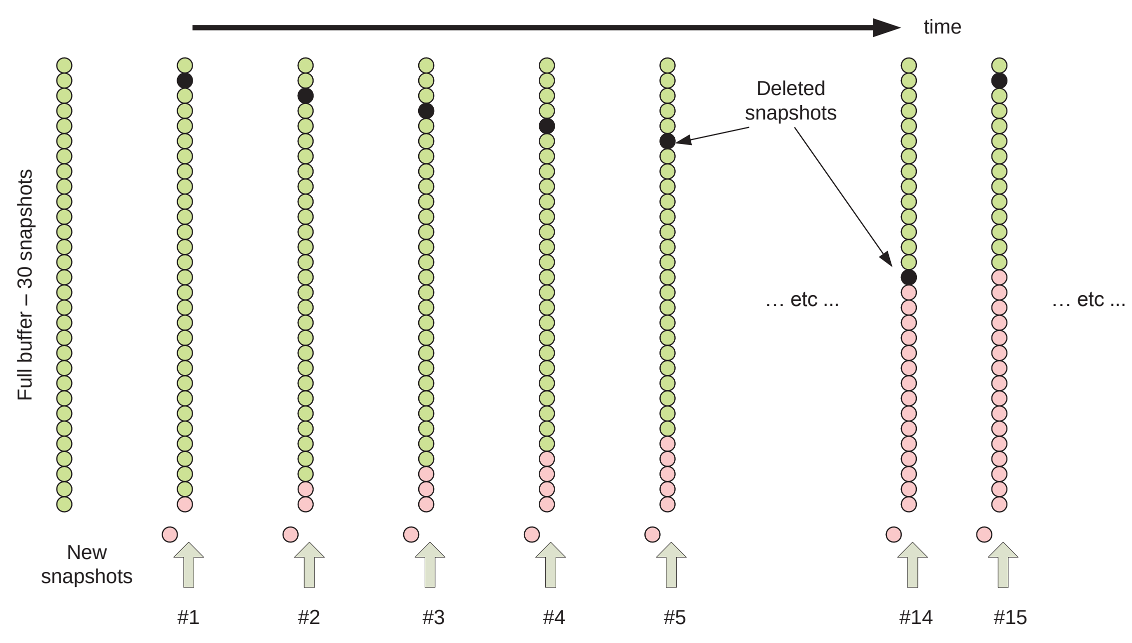


FIGURE 20 - CONNECTED VEHICLE - BUFFER OVERFLOW STATE - DELETING SNAPSHOTS

Figure 21 illustrates the snapshot recording process in the buffer overflow state.

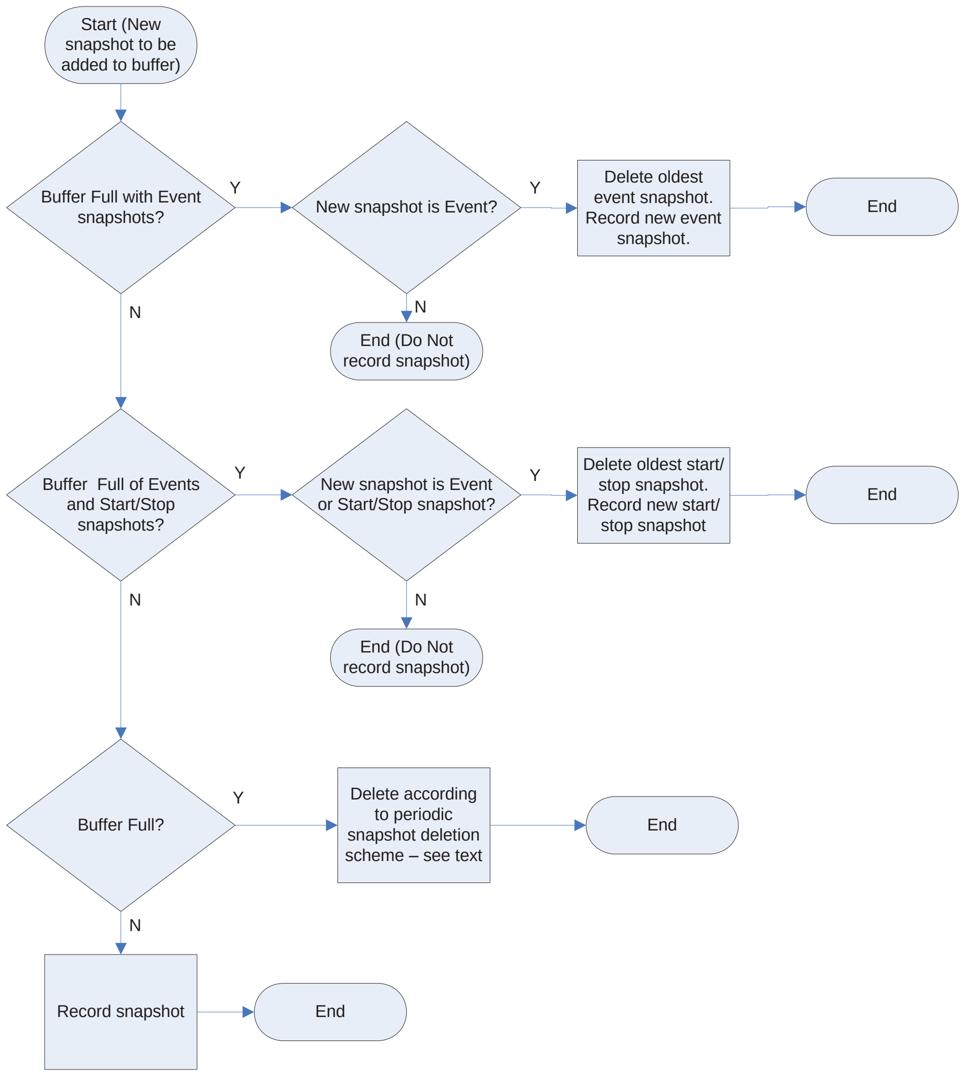


FIGURE 21 - CONNECTED VEHICLE - BUFFER OVERFLOW STATE - DELETING SNAPSHOTS

4.5 Class Diagrams

Class Diagrams are included for those objects that have states. “A class diagram describes the classes that make up a system and the static relationships between them. Classes are defined in terms of their name, attributes (or data), and behaviors (or methods). The static relationships are association, aggregation, and inheritance." (Reference: Class Diagrams: Testing UML Models. Part 3 by Lee Copeland)

4.5.1 Probe Segment Number

Periodic snapshots and start and stop snapshots are tagged with a short-lived Probe Segment Number (PSN). The purpose of the PSN is to provide anonymous short tracks of a vehicle's path that can be used for traffic control and data gathering purposes. For example, turning movements at an intersection could be counted by observing the heading changes of an individual but anonymous vehicle identified by its PSN. Tracks of vehicles could be used by traffic signal controllers to operate the signals more effectively.

To maintain anonymity, the PSN is randomly generated by the connected vehicle after traveling a certain distance or certain period of time, whichever comes last, so the PSN is not associated with a particular vehicle. To prevent observers from tracing a vehicle track backwards by using the PSN values, the PSN changes with a variable gap. This gap is 50 to 250 meters or 3 to 13 seconds in time, whichever comes last. Time is used such that in congested traffic not much distance is traveled and there should be sufficient time between changes to be uncertain about the vehicle. However in high speed locations distance is more appropriate to provide sufficient spacing to add uncertainty to any back tracking calculation. Neither value starts from zero to ensure that end of one track is sufficiently offset from the beginning of the next track.

4.5.1.1 PSN Rules

The following rules shall apply to the PSN:

- All snapshots within the same *probeVehicleData* message shall not contain different PSNs.
- When one vehicle has finished transmitting to an RSU it shall ensure that its PSN has changed before communicating with a different RSU.
- Separate *probeVehicleData* messages can be transmitted to the same RSU but with different PSNs.
- Event snapshots do not contain a PSN.

4.5.1.2 Generation of Probe Segment Numbers

A connected vehicle shall generate a new PSN when:

- The connected vehicle initializes (such as on power-up);
- A new *probeDataManagement* message is received by the OBU;
- The current PSN expires while the data collection and transmission policy of the connected vehicle has been modified by a *probeDataManagement* message. A PSN shall expire after 120 seconds, or after 1 kilometer, whichever comes last;
- After all the snapshots in the connected vehicle's buffer has been transmitted, and the connected vehicle's data collection and transmission policy has not been modified by a *probeDataManagement* message, and after the random changeover gap has expired. The random changeover gap begins after a new PSN is generated, and expires after 50 to 250 meters OR 3 to 13 seconds, whichever comes first. Two random changeover gap numbers should be used, one based on distance (traveled) and one for time (elapsed);
- After a connected vehicle loses connectivity with an RSU and the data collection and transmission policy of the connected vehicle has been modified by a *probeDataManagement* message; and
- After a connected vehicle loses connectivity with an RSU, the connected vehicle's data collection and transmission policy has not been modified by a *probeDataManagementMsg* message, and after the random changeover gap has expired. The random changeover gap begins after a new PSN is generated, and expires after 50 to 250 meters OR 3 to 13 seconds, whichever comes first. Two random changeover gap numbers should be used, one for distance one for time.

Figure 22 provides a graphic representation of when a new PSN is generated. A connected vehicle is defined to lose connectivity with an RSU if the vehicle has not received any messages from the RSU after 30 seconds.

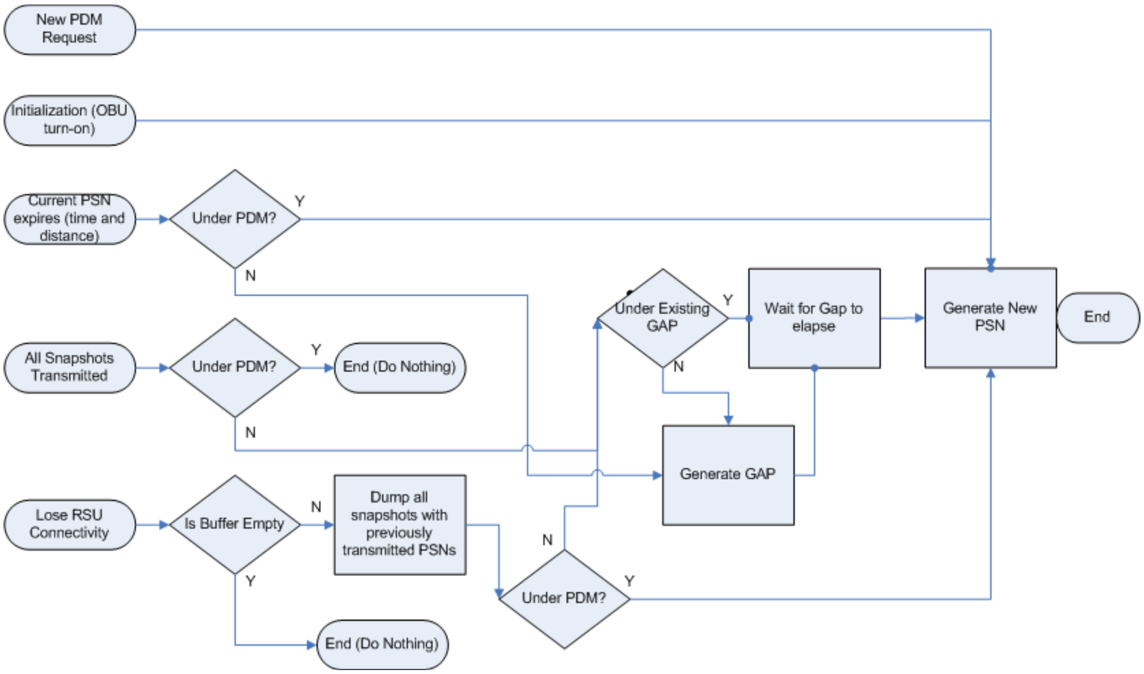


FIGURE 22 - PROBE DATA MESSAGES - PSN

5. SECTION 5 - DESIGN

The purpose of this Design section is to identify and describe the design content, in terms of dialogs, messages, data frames and data elements (data concepts), which satisfies the needs and fulfills the requirements for a connected device to exchange information with another connected device via a systems interface.

This section contains the data concept definitions for J2735 SE for the following: object classes, dialogs, messages, data frames and data elements. The following apply:

1. The title used for each data concept clause is the ISO 14817 descriptive name.

2. Each object class defined includes an ISO 14817 ASN.1 representation.

3. With the exception of object classes, each data concept defined is an ISO 14817 ASN.1 representation.

ISO 14817 is a standard that describes the meta attributes of data concepts defined in a data dictionary, such as J2735 SE. This section presents ASN.1 fragments of data concepts for: dialogs, messages, data frames, data elements and object classes. These fragments use namespace prefixes, such as “NTCIP.", “ITIS." and “IEEE.", that represent a shorthand for specific corresponding ASN.1 imports. These fragments also use OID prefixes, such as “NTCIP", “ITIS" and “IEEE", that represent a shorthand for specific corresponding ASN.1 imports. The ASN.1 imports are defined in Section 5.6 for reference. The namespace prefix, "LOCAL.", is used to represent locally defined data concepts, or extensions, such as local data frames or local elements. Extensions are discussed in further detail in Section 5.7.

5.1 Dialogs

This section defines the ISO 14817 ASN.1 representation of the dialogs.

5.1.1 Vehicle Class Dialogs

5.1.1.1 dlBasicSafetyMessage

5.1.1.1.1 DIALOG REFERENCE

See Section 4.3.3.1

5.1.1.1.2 ASN.1 REPRESENTATION

```
dlBasicSafetyMessage ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "OBU->dlBasicSafetyMessage->ConnectedDevice"
ASN-NAME "dlBasicSafetyMessage"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 1 }
URL "BROADV2DEVICES.gif"
DEFINITION     "A dialog where a connected vehicle broadcasts safety information about
itself to other surrounding connected devices."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"vehicle intersection safety data",
     "vehicle safety data"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 5 }  -- BasicSafetyMessage  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 11 },  -- connectedDevice
   { j2735ObjectClasses 30 } -- oBU  }  }
```

5.1.1.2 dlBasicSafetyMessageVerbose

5.1.1.2.1 DIALOG REFERENCE

See Section 4.3.3.2

5.1.1.2.2 ASN.1 REPRESENTATION

```
dlBasicSafetyMessageVerbose ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "OBU->dlBasicSafetyMessageVerbose->ConnectedDevice"
ASN-NAME "dlBasicSafetyMessageVerbose"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 2 }
URL "BROADV2DEVICES.gif"
DEFINITION     "A dialog where a connected vehicle broadcasts safety information about
itself to other surrounding connected devices.  This dialog is used for development and
testing purposes only."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"vehicle intersection safety data",
     "vehicle safety data"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
```

```
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 6 }  -- BasicSafetyMessageVerbose  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 11 },  -- connectedDevice
   { j2735ObjectClasses 30 } -- oBU  }  }
```

5.1.1.3 dlCommonSafetyRequest

5.1.1.3.1 DIALOG REFERENCE

See Section 4.3.4

5.1.1.3.2 ASN.1 REPRESENTATION

```
dlCommonSafetyRequest ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "ConnectedDevice<-dlCommonSafetyRequest->OBU"
ASN-NAME "dlCommonSafetyRequest"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 3 }
URL "R-RDEVICE2V.gif"
DEFINITION     "A request-response dialog that allows a connected device to request
additional safety information from a nearby connected vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"vehicle intersection safety data",
     "vehicle safety data"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 } ,  -- DSRCMessage  (Input Message)
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 32 } ,  -- CommonSafetyRequest  (Input Data Frame)
   { j2735DataFrames 5 }  -- BasicSafetyMessage  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 11 },  -- connectedDevice
   { j2735ObjectClasses 30 } -- oBU  }  }
```

5.1.1.4 dlIntersectionInfringement

5.1.1.4.1 DIALOG REFERENCE

See Section 4.3.5

5.1.1.4.2 ASN.1 REPRESENTATION

```
dlIntersectionInfringement ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "OBU->dlIntersectionInfringement->ConnectedDevice"
ASN-NAME "dlIntersectionInfringement"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 4 }
URL "BROADV2DEVICES.gif"
DEFINITION     "A dialog where a connected vehicle broadcasts information to other
surrounding connected devices that it is about to move through an intersection crossing in
a potentially unsafe manner, such as performing an unpermitted movement at signalized
intersections or not stopping at a stop sign."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"vehicle intersection safety data",
     "vehicle safety data"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
```

```
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 58 }  -- IntersectionInfringement  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 11 },  -- connectedDevice
   { j2735ObjectClasses 30 } -- oBU  }  }
```

5.1.1.5 dlMaydayForward

5.1.1.5.1 DIALOG REFERENCE

See Section 4.3.14

5.1.1.5.2 ASN.1 REPRESENTATION

```
dlMaydayForward ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "OBU->dlMaydayForward->ConnectedDevice"
ASN-NAME "dlMaydayForward"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 5 }
URL "BROADV2DEVICES.gif"
DEFINITION     "A dialog that allows a connected device to forward a mayday message
previously received from a connected vehicle to a public safety agency."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"emergency notification"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 } ,  -- DSRCMessage  (Input Message)
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 80 } ,  -- MaydayMessage  (Input Data Frame)
   { j2735DataFrames 47 }  -- ForwardedMessage  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 11 },  -- connectedDevice
   { j2735ObjectClasses 30 } -- oBU  }  }
```

5.1.1.6 dlMayday

5.1.1.6.1 DIALOG REFERENCE

See Section 4.3.15

5.1.1.6.2 ASN.1 REPRESENTATION

```
dlMayday ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "OBU->dlMayday->ConnectedDevice"
ASN-NAME "dlMaydayForward"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 5 }
URL "BROADV2DEVICES.gif"
DEFINITION     " A dialog that allows a connected vehicle to broadcast a request for
assistance to surrounding connected devices."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"emergency notification"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 } -- DSRCMessage  (Output Message) }
```

```
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 80 } -- MaydayMessage  (Output Data Frame) }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 11 },  -- connectedDevice
   { j2735ObjectClasses 30 } -- oBU  }  }
```

5.1.2 ACM Class Dialogs

5.1.2.1 dlAlaCarte

5.1.2.1.1 DIALOG REFERENCE

See Section 4.3.16

5.1.2.1.2 ASN.1 REPRESENTATION

```
dlAlaCarte ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU<-dlAlaCarte->OBU"
ASN-NAME "dlAlaCarte"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 6 }
URL "R-RI2V.gif"
DEFINITION     "A request-response dialog that allows a remote user through a connected
device, such as an RSU, to exchange information with another connected device."
DESCRIPTIVE-NAME-CONTEXT {"Provide Vehicle Monitoring and Control"}
ARCHITECTURE-REFERENCE {"(Not covered by Natl Arch)"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 } ,  -- DSRCMessage  (Input Message)
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 2 } ,  -- AlaCarte  (Input Data Frame)
   { j2735DataFrames 2 }  -- AlaCarte  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 30 }, -- oBU
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.3 CMV Class Dialogs

5.1.3.1 dlCommercialVehicleCredentialsRequest

5.1.3.1.1 DIALOG REFERENCE

See Section 4.3.7.1

5.1.3.1.2 ASN.1 REPRESENTATION

```
dlCommercialVehicleCredentialsRequest ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU<-dlCommercialVehicleCredentialsRequest->OBU"
ASN-NAME "dlCommercialVehicleCredentialsRequest"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 7 }
URL "R-RI2V.gif"
DEFINITION     "A request-response dialog that allows an RSU to request credentialing
information from surrounding connected commercial motor vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"electronic screening request",
     "safety inspection request",
     "driver log"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
```

```
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 } ,  -- DSRCMessage  (Input Message)
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 31 } ,  -- CommercialVehicleRequest  (Input Data Frame)
   { j2735DataFrames 30 }  -- CommercialVehicleData  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 30 }, -- oBU
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.3.2 dlCommercialVehicleScreeningResults

5.1.3.2.1 DIALOG REFERENCE

See Section 4.3.7.2

5.1.3.2.2 ASN.1 REPRESENTATION

```
dlCommercialVehicleScreeningResults ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU<-dlCommercialVehicleScreeningResults->OBU"
ASN-NAME "dlCommercialVehicleScreeningResults"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 8 }
URL "R-RI2V.gif"
DEFINITION     "A request-response dialog that allows an RSU to transmit the results of a
screening event to the subject connected commercial motor vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"screening event record",
     "safety inspection record"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 } ,  -- DSRCMessage  (Input Message)
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 26 } ,  -- CommercialScreeningData  (Input Data Frame)
   { j2735DataFrames 25 }  -- CommercialScreeningAcknowledgement  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 30 }, -- oBU
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.3.3 dlCommercialVehicleClearance

5.1.3.3.1 DIALOG REFERENCE

See Section 4.3.7.4

5.1.3.3.2 ASN.1 REPRESENTATION

```
dlCommercialVehicleClearance ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU<-dlCommercialVehicleClearance->OBU"
ASN-NAME "dlCommercialVehicleClearance"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 9 }
URL "R-RI2V.gif"
DEFINITION     "A request-response dialog that allows an RSU to provide instructions to
surrounding connected commercial motor vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"pass/pull-in"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
```

```
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 } ,  -- DSRCMessage  (Input Message)
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 29 } ,  -- CommercialVehicleClearance  (Input Data Frame)
   { j2735DataFrames 28 }  -- CommercialVehicleAcknowledgement  (Output Data Frame)  }

REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 30 }, -- oBU
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.3.4 dlCommercialVehicleScreeningExchange

5.1.3.4.1 DIALOG REFERENCE

See Section 4.3.7.3

5.1.3.4.2 ASN.1 REPRESENTATION

```
dlCommercialVehicleScreeningExchange ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU<-dlCommercialVehicleScreeningExchange->OBU"
ASN-NAME "dlCommercialVehicleScreeningExchange"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 10 }
URL "R-RI2V.gif"
DEFINITION     "A request-response dialog that allows a connected commercial motor
vehicle to provide its screening event results to an RSU."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"screening event record",
     "safety inspection record"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 } ,  -- DSRCMessage  (Input Message)
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 31 } ,  -- CommercialVehicleRequest  (Input Data Frame)
   { j2735DataFrames 27 }  -- CommercialScreeningResults  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 30 }, -- oBU
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.4 Map Class Dialogs

5.1.4.1 dlLocationCorrections-NMEA

5.1.4.1.1 DIALOG REFERENCE

See Section 4.3.11.1

5.1.4.1.2 ASN.1 REPRESENTATION

```
dlLocationCorrections-NMEA ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU->dlLocationCorrections-NMEA->ConnectedDevice"
ASN-NAME "dlLocationCorrections-NMEA"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 11 }
URL "BROADI2DEVICES.gif"
DEFINITION     "A dialog where an RSU broadcasts NMEA-style differential positioning
information to surrounding connected devices, such as connected vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"position fix"}
```

```
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 86 }  -- NMEACorrections  (Output Data Frame)  }

REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 11 },  -- connectedDevice
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.4.2 dlLocationCorrections-RTCM

5.1.4.2.1 DIALOG REFERENCE

See Section 4.3.11.2

5.1.4.2.2 ASN.1 REPRESENTATION

```
dlLocationCorrections-RTCM ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU->dlLocationCorrections-RTCM->ConnectedDevice"
ASN-NAME "dlLocationCorrections-RTCM"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 12 }
URL "BROADI2DEVICES.gif"
DEFINITION     "A dialog where an RSU broadcasts RTCM-style differential positioning
information to surrounding connected devices, such as connected vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"position fix"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 115 }  -- RTCMCorrections  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 11 },  -- connectedDevice
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.4.3 dlMapData

5.1.4.3.1 DIALOG REFERENCE

See Section 4.3.10

5.1.4.3.2 ASN.1 REPRESENTATION

```
dlMapData ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU->dlMapData->ConnectedDevice"
ASN-NAME "dlMapData"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 13 }
URL "BROADI2DEVICES.gif"
DEFINITION     "A dialog where an RSU broadcasts roadway geometric information to
surrounding connected devices, such as connected vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"nil"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
```

```
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 77 }  -- MapData  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 11 },  -- connectedDevice
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.5 Probe Class Dialogs

5.1.5.1 dlProbeDataManagement

5.1.5.1.1 DIALOG REFERENCE

See Section 4.3.9

5.1.5.1.2 ASN.1 REPRESENTATION

```
dlProbeDataManagement ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU<-dlProbeDataManagement->OBU"
ASN-NAME "dlProbeDataManagement"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 14 }
URL "R-RI2V.gif"
DEFINITION     "A request-response dialog that allows an RSU to manage the probe data
collection policies of surrounding connected vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"traffic probe reporting management"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 } ,  -- DSRCMessage  (Input Message)
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 107 } ,  -- ProbeDataManagement  (Input Data Frame)
   { j2735DataFrames 110 }  -- ProbeVehicleData  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 30 }, -- oBU
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.5.2 dlProbeDataExchange

5.1.5.2.1 DIALOG REFERENCE

See Section 4.3.8

5.1.5.2.2 ASN.1 REPRESENTATION

```
dlProbeDataExchange ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU<-dlProbeDataExchange->OBU"
ASN-NAME "dlProbeDataExchange"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 15 }
URL "R-RI2V.gif"
DEFINITION     "A request-response dialog that allows an RSU to collect probe data from
surrounding connected vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"traffic probe reporting management"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 2 } ,  -- ServiceAdvertisementMsg  (Input Message)
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
```

```
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 110 }  -- ProbeVehicleData  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 30 }, -- oBU
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.6 Signal Class Dialogs

5.1.6.1 dlSignalRequest

5.1.6.1.1 DIALOG REFERENCE

See Section 4.3.6.1

5.1.6.1.2 ASN.1 REPRESENTATION

```
dlSignalRequest ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "OBU<-dlSignalRequest->RSU"
ASN-NAME "dlSignalRequest"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 16 }
URL "R-RV2I.gif"
DEFINITION     "A request-response dialog that allows authorized connected vehicles to
transmit a preferential treatment request to an RSU at downstream signalized
intersections."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"location signal preemption request",
     "location signal priority request"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 } ,  -- DSRCMessage  (Input Message)
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 128 } ,  -- SignalRequestMessage  (Input Data Frame)
   { j2735DataFrames 129 }  -- SignalStatusMessage  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 30 }, -- oBU
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.6.2 dlSPAT

5.1.6.2.1 DIALOG REFERENCE

See Section 4.3.12

5.1.6.2.2 ASN.1 REPRESENTATION

```
dlSPAT ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU->dlSPAT->ConnectedDevice"
ASN-NAME "dlSPAT"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 17 }
URL "BROADI2DEVICES.gif"
DEFINITION     "A dialog where an RSU broadcasts signal phasing and timing information to
surrounding connected devices, such as connected vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"intersection status"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
```

```
REFERENCED-MESSAGES {
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 142 }  -- Spat  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 11 },  -- connectedDevice
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.1.7 TIM Class Dialogs

5.1.7.1 dlTravelerInformation

5.1.7.1.1 DIALOG REFERENCE

See Section 4.3.13

5.1.7.1.2 ASN.1 REPRESENTATION

```
dlTravelerInformation ITS-INTERFACE-DIALOGUE ::= {
DESCRIPTIVE-NAME       "RSU->dlTravelerInformation->ConnectedDevice"
ASN-NAME "dlTravelerInformation"
ASN-OBJECT-IDENTIFIER { j2735Dialogs 18 }
URL "BROADI2DEVICES.gif"
DEFINITION     "A dialog where an RSU broadcasts traveler information to surrounding
connected devices."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {"broadcast traveler information",
     "vehicle signage data"}
ARCHITECTURE-NAME {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE interface-dialogue
STANDARD "SAE J2735"
REFERENCED-MESSAGES {
   { j2735Messages 1 }  -- DSRCMessage  (Output Message)  }
REFERENCED-DATA-FRAMES {
   { j2735DataFrames 154 }  -- TravelerInformation  (Output Data Frame)  }
REFERENCED-OBJECT-CLASSES {
   { j2735ObjectClasses 11 },  -- connectedDevice
   { j2735ObjectClasses 37 }  -- rSU  }  }
```

5.2 Messages

This section defines the precise structure of the messages defined by this standard. Messages are made up of content further defined in J2735 SE (i.e., made up of entries that are either atomic or complex but which are also defined in this document) and content defined externally to this document. Such external content is reused from other functional areas and standards developed by other groups and SDOs. The contents of this standard (both at the complete message level and its component parts) may be reused by other efforts elsewhere.

5.2.1 Global Class Messages

5.2.1.1 dSRCMessage

```
dSRCMessage ITS-MESSAGE ::= {
DESCRIPTIVE-NAME "dSRCMessage:message"
ASN-NAME "DSRCMessage"
ASN-OBJECT-IDENTIFIER { j2735Messages 1 }
DEFINITION     "The dSRCMessage is used for the exchange of all DSRC information."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {   "nil" }
ARCHITECTURE-NAME      {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE message
STANDARD "SAE J2735"
```

```
META-DATA-SOURCE direct
PRIORITY "Routine"
FREQUENCY-OR-MESSAGE-MODE ""
REFERENCED-DATA-FRAMES {   { j2735DataFrames 45 }  -- DSRCMessageContents }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 44 },  -- DSRCMessage-sequence-number
     { j2735DataElements 43 }  -- DSRCMessage-crc  }
DATA-TYPE " DSRCMessage ::= SEQUENCE {  msgCount     DSRCMessage-sequence-number
OPTIONAL,
    contents   DSRCMessageContents,
    crc DSRCMessage-crc OPTIONAL,    ...  } " }
```

5.2.1.2 serviceAdvertisementMsg

```
serviceAdvertisementMsg ITS-MESSAGE ::= {
DESCRIPTIVE-NAME "serviceAdvertisementMsg:message"
ASN-NAME "ServiceAdvertisementMsg"
ASN-OBJECT-IDENTIFIER { j2735Messages 2 }
DEFINITION     "The serviceAdvertisementMsg is used announce what services are provided
by a RSU.  In addition, this message in the future provides instructions to the connected
device on how to provide the service information (e.g., communications addresses,
channels, etc..)."
DESCRIPTIVE-NAME-CONTEXT {""}
ARCHITECTURE-REFERENCE {   "nil" }
ARCHITECTURE-NAME      {"U.S. National ITS Architecture"}
ARCHITECTURE-VERSION {"7.0"}
DATA-CONCEPT-TYPE message
STANDARD "SAE J2735"
META-DATA-SOURCE direct
PRIORITY "Routine"
FREQUENCY-OR-MESSAGE-MODE "periodic"
REFERENCED-DATA-FRAMES {   { j2735DataFrames 122 }  -- ServiceAdvertisement }
DATA-TYPE " ServiceAdvertisementMsg ::= ServiceAdvertisement
" }
```

5.3 Data Frames

This section defines the ISO 14817 ASN.1 representation of the data frames.

The data models shown in this document provide a message view of the data. Every ITS-DATA-FRAME is depicted in its own box labeled with the name of the data frame. Data elements contained within the data frame are shown in the box and links to other data frames are depicted as lines connecting the associated data frame along with a name for the connection and a quantity for the associated data frame; the encapsulating data frame is shown by the diamond end of the line and the contained data frame is at the arrow end. In a few instances, a data frame contains a choice statement between two or more data frame types such as with the DSRCMessage and its component data types. These choice statements are shown by each of the data frame choices pointing to the containing data frame using triangle symbol. Finally, the name of each data element and associated data frame is coupled with a plus symbol (+) if the field is required and a minus symbol (-) if the field is optional. If there are any discrepancies between the data model and the ISO 14817 ASN.1 representation, the ISO 14817 ASN.1 representation shall take precedence.

5.3.1.1 acceleration4Way

```
acceleration4Way ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Acceleration4Way:frame"
ASN-NAME "Acceleration4Way"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 1 }
DEFINITION     "This data frame is a set of acceleration values in 3 orthogonal
directions of the vehicle and with yaw rotation rates.  The positive longitudinal axis is
to the front of the vehicle.  The positive lateral axis is to the right side of the
vehicle (facing forward).  Positive yaw is to the right (clockwise).  A positive vertical
'z' axis is upward with the zero point at the bottom of the vehicle's tires.  The frame of
references and axis of rotation used shall be accordance with that defined in SAE J670,
issued 1976-07 and its successors."
```

```
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 2 },  -- Acceleration4way-longitudinal
     { j2735DataElements 1 },  -- Acceleration4way-latitudinal
     { j2735DataElements 3 },  -- Acceleration4way-vertical
     { j2735DataElements 4 }  -- Acceleration4way-yaw  }
DATA-TYPE "
    Acceleration4Way ::= SEQUENCE {
    longitudinal       Acceleration4way-longitudinal,
    latitudinal Acceleration4way-latitudinal,
    vertical   Acceleration4way-vertical,
    yaw Acceleration4way-yaw }"}
```

5.3.1.2 alaCarte

```
alaCarte ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "AlaCarte:frame"
ASN-NAME "AlaCarte"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 2 }
DEFINITION     "A data frame that optionally includes any data frames, data elements
defined in Section 5 of this standard, or external content referenced in Appendix A of
this standard.  If the dSRCMessage-crc element is included, it must be the final content
(before any local content), as per usual rules for that element.  In the DSRC environment
the wireless channel bandwidth is often a scarce resource, so care should be taken not to
include extraneous information.  This data frame typically shall be contained within a
dSRCMessage."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the AlaCarte (ACM) message when contained within a dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { localDataFrames alaCarte(1) }  }
DATA-TYPE "
    AlaCarte ::= SEQUENCE {
    localAlaCarte      LOCAL.AlaCarte OPTIONAL,    ... }  "}
```

5.3.1.3 antennaOffset

```
antennaOffset ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "AntennaOffset:frame"
ASN-NAME "AntennaOffset"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 3 }
DEFINITION     "A data frame that is a collection of three orthogonal offset values,
which describes the location of the electrical center of an antenna is along each axis
from a known anchor point in units of 1 centimeter.  When the antenna being describes is
on a vehicle, the signed offset shall be from the geometric center of the vehicle for X
and Y following the SAE coordinate system: X is lengthwise and Y is lateral across the
vehicle, forward and to the right being positive, unsigned Z is vertical, taken from the
bottom of the tires and the surface on which the vehicle is resting and normal to the Z
axis of the vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 7 },  -- AntennaOffset-x
     { j2735DataElements 8 },  -- AntennaOffset-y
     { j2735DataElements 9 }  -- AntennaOffset-z  }
```

```
DATA-TYPE "
    AntennaOffset ::= SEQUENCE {
    antOffsetX AntennaOffset-x,
    antOffsetY AntennaOffset-y,
    antOffsetZ AntennaOffset-z }"}
```

5.3.1.4 area

```
area ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Area:frame"
ASN-NAME "Area"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 4 }
DEFINITION     "A data frame used to define a geographic area that a message or traveler
information item is valid for.  The geographic area may consist of a circular region,
consisting of a radius and an anchor point; a polygon, consisting of an area defined by a
series of offset points; or a shape point set, consisting of a series of points (nodes)
along the centerline of a geographic area along with the width of the geographic area."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 124 },  -- ShapePoint
     { j2735DataFrames 11 },  -- Circle
     { j2735DataFrames 103 }  -- Polygon  }
DATA-TYPE "
    Area ::= CHOICE
{
    shapePointSet      ShapePoint,
    circle     Circle,
    polygon    Polygon}  "}
```

5.3.1.5 basicSafetyMessage

```
basicSafetyMessage ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "BasicSafetyMessage:frame"
ASN-NAME "BasicSafetyMessage"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 5 }
DEFINITION     "A data frame used in a variety of applications to improve the safe
operation of vehicles.  This data frame typically shall be contained within a dSRCMessage
and is broadcast frequently to surrounding vehicles with a variety of data content as
required by safety and other applications. Part I data, which consists of the vehicle-bsm-
part1-oer data frame, shall be included in every basicSafetyMessage (BSM).  Part II data
are optional for a given BSM and are included as needed according to policies that are
beyond the scope of this standard.  A BSM without Part II content is also a valid message.
 Refer to the Appendix 'Operation with the Basic Safety Message in Vehicles' for examples
of how the basicSafetyMessage can be used."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the basicSafetyMessage (BSM) when contained within a dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 9 },  -- BSMSafetyExtension
     { j2735DataFrames 10 },  -- BSMStatus
     { localDataFrames basicSafetyMessage(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 201 }  -- Vehicle-bsm-part1-oer  }
DATA-TYPE "
    BasicSafetyMessage ::= SEQUENCE {
    part1      Vehicle-bsm-part1-oer,
    safetyExt  BSMSafetyExtension OPTIONAL,
    status     BSMStatus OPTIONAL,
    localBasicSafetyMessage    LOCAL.BasicSafetyMessage OPTIONAL,    ... }  "}
```

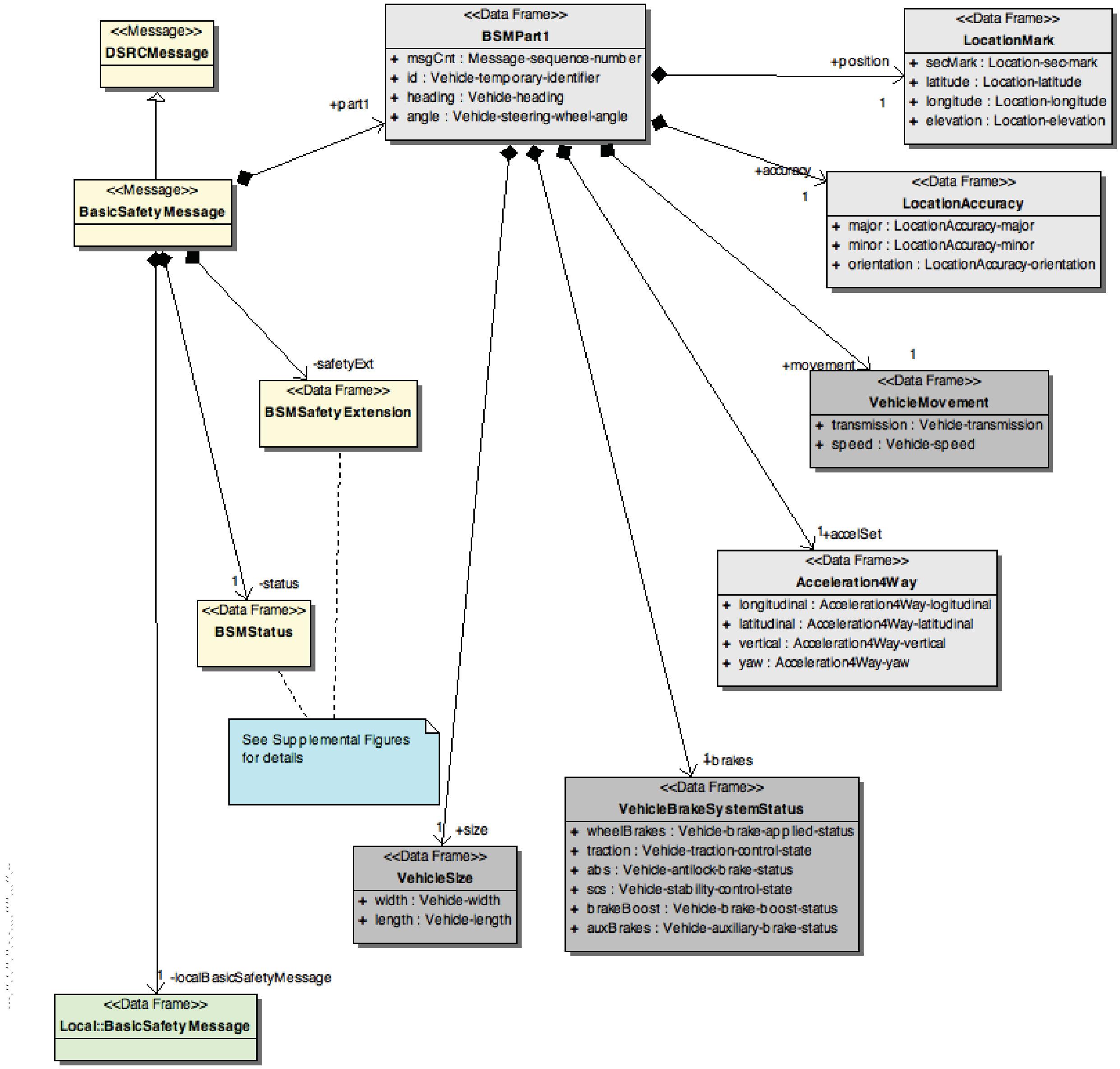


FIGURE 23 - DATA MODEL - basicSafetyMessage

5.3.1.6 basicSafetyMessageVerbose

```
basicSafetyMessageVerbose ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "BasicSafetyMessageVerbose:frame"
ASN-NAME "BasicSafetyMessageVerbose"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 6 }
DEFINITION     "A data frame used in a variety of applications to exchange safety data
regarding vehicle state.  This data frame is used only for testing and development
purposes.  Production devices should not use this data frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 8 },   -- BSMPart1Verbose
     { j2735DataFrames 9 },   -- BSMSafetyExtension
     { j2735DataFrames 10 },   -- BSMStatus
     { localDataFrames basicSafetyMessageVerbose(1) }   }
```

```
DATA-TYPE "
    BasicSafetyMessageVerbose ::= SEQUENCE {
    part1       BSMPart1Verbose,
    safetyExt   BSMSafetyExtension OPTIONAL,
    status      BSMStatus OPTIONAL,
    localBasicSafetyMessageVerbose    LOCAL.BasicSafetyMessageVerbose OPTIONAL,    ... }
 "}
```

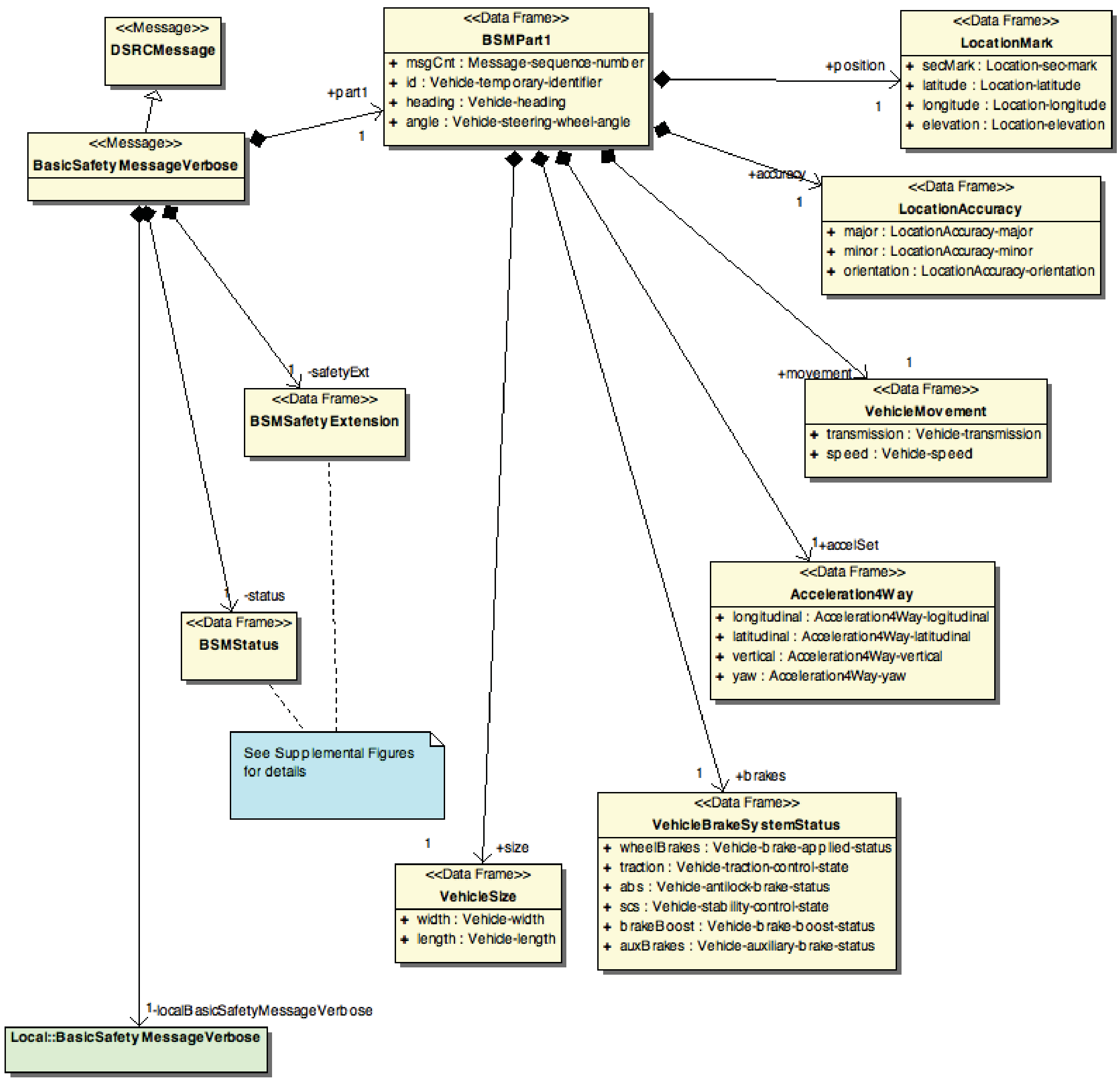


FIGURE 24 - DATA MODEL - basicSafetyMessageVerbose

5.3.1.7 bSMPart1

```
bSMPart1 ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "BSMPart1:frame"
ASN-NAME "BSMPart1"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 7 }
DEFINITION     "A data frame containing critical status information about a vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
```

```
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 175 },  -- VehiclePositionMark
     { j2735DataFrames 73 },  -- LocationAccuracy
     { j2735DataFrames 1 }  -- Acceleration4Way  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 44 },  -- DSRCMessage-sequence-number
     { j2735DataElements 236 },  -- Vehicle-temporary-identifier
     { j2735DataElements 225 },  -- Vehicle-movement-per
     { j2735DataElements 213 },  -- Vehicle-heading
     { j2735DataElements 234 },  -- Vehicle-steering-wheel-angle
     { j2735DataElements 200 },  -- Vehicle-brake-system-status-per
     { j2735DataElements 230 }  -- Vehicle-size-per  }
DATA-TYPE "
    BSMPart1 ::= SEQUENCE {
    msgCnt     DSRCMessage-sequence-number,
    id  Vehicle-temporary-identifier,
    position   VehiclePositionMark,
    accuracy   LocationAccuracy,
    movement   Vehicle-movement-per,
    heading    Vehicle-heading,
    angle      Vehicle-steering-wheel-angle,
    accelSet   Acceleration4Way,
    brakes     Vehicle-brake-system-status-per,
    size       Vehicle-size-per }"}
```

5.3.1.8 bSMPart1Verbose

```
bSMPart1Verbose ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "BSMPart1Verbose:frame"
ASN-NAME "BSMPart1Verbose"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 8 }
DEFINITION     "A data frame containing critical status information about a vehicle in
verbose format."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 175 },  -- VehiclePositionMark
     { j2735DataFrames 73 },  -- LocationAccuracy
     { j2735DataFrames 172 },  -- VehicleMovement
     { j2735DataFrames 1 },  -- Acceleration4Way
     { j2735DataFrames 164 },  -- VehicleBrakeSystemStatus
     { j2735DataFrames 177 }  -- VehicleSize  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 44 },  -- DSRCMessage-sequence-number
     { j2735DataElements 236 },  -- Vehicle-temporary-identifier
     { j2735DataElements 213 },  -- Vehicle-heading
     { j2735DataElements 234 }  -- Vehicle-steering-wheel-angle  }
DATA-TYPE "
    BSMPart1Verbose ::= SEQUENCE {
    msgCnt     DSRCMessage-sequence-number,
    id  Vehicle-temporary-identifier,
    position   VehiclePositionMark,
    accuracy   LocationAccuracy,
    movement   VehicleMovement,
    heading    Vehicle-heading,
    angle      Vehicle-steering-wheel-angle,
    accelSet   Acceleration4Way,
    brakes     VehicleBrakeSystemStatus,
    size       VehicleSize }"}
```

5.3.1.9 bSMSafetyExtension

```
bSMSafetyExtension ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "BSMSafetyExtension:frame"
ASN-NAME "BSMSafetyExtension"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 9 }
DEFINITION     "A data frame used to send various additional details about the vehicle.
This data frame is used for vehicle safety applications to exchange safety information
such as event flag and detailed positional information.  This data frame is typically sent
in conjunction with basicSafetyMessage Part I at the same or reduced frequency (it is not
present in every basicSafetyMessage)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 173 },  -- VehiclePathHistory
     { j2735DataFrames 174 },  -- VehiclePathPrediction
     { j2735DataFrames 169 },  -- VehicleLocationCorrection
     { localDataFrames bSMSafetyExtension(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 209 }  -- Vehicle-events  }
DATA-TYPE "
    BSMSafetyExtension ::= SEQUENCE {
    events     Vehicle-events OPTIONAL,
    pathHistoryVehiclePathHistory OPTIONAL,
    pathPrediction     VehiclePathPrediction OPTIONAL,
    theRTCM    VehicleLocationCorrection OPTIONAL,
    localBSMSafetyExtension    LOCAL.BSMSafetyExtension OPTIONAL,    ... }  "}
```

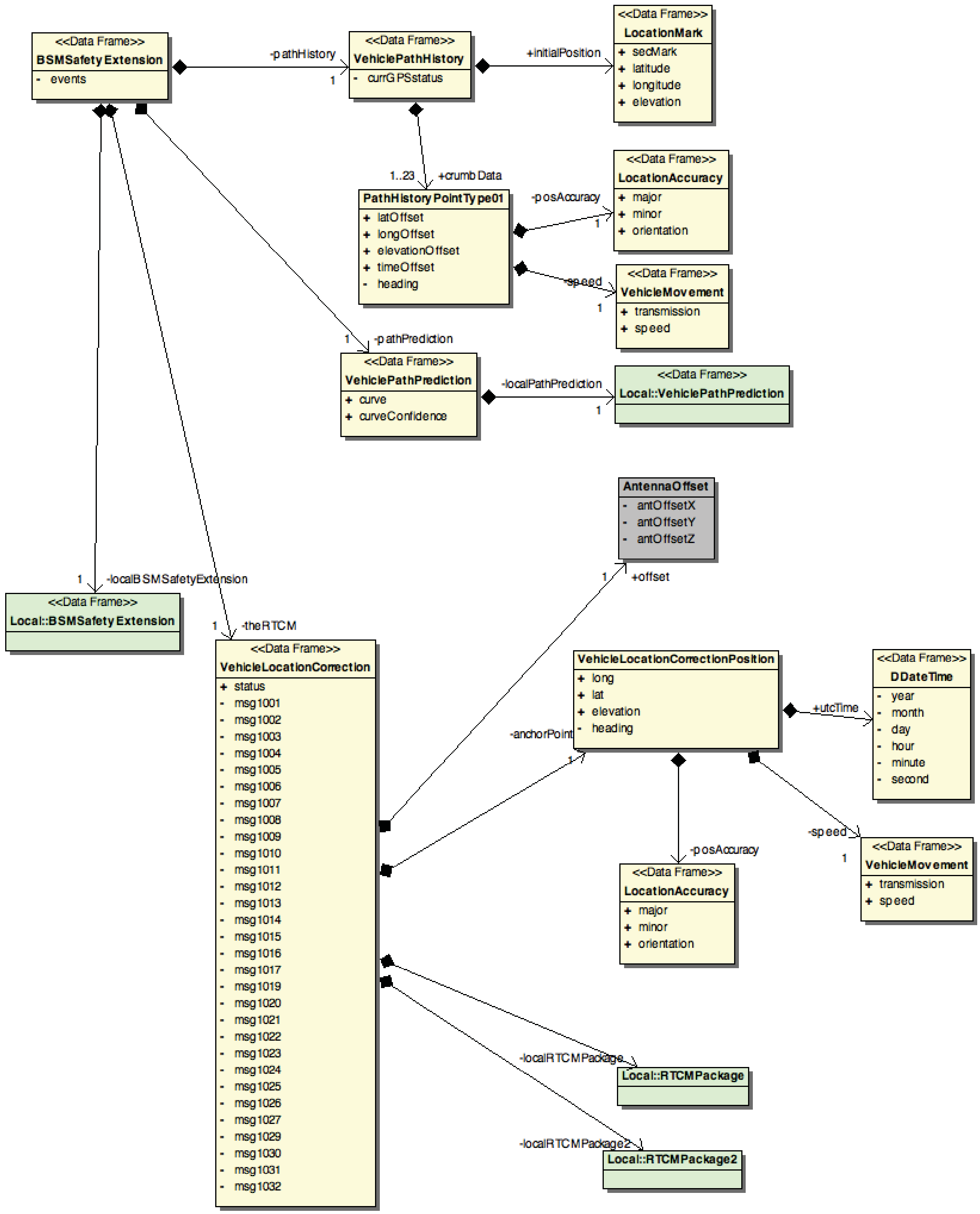


FIGURE 25 - DATA MODEL - bSMSafetyExtension

5.3.1.10 bSMStatus

```
bSMStatus ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "BSMStatus:frame"
ASN-NAME "BSMStatus"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 10 }
DEFINITION     "A data frame that is used to relate specific items of the vehicle's
status.  This structure relates all the different types of information that can be related
about the vehicle inside a probe message or in the basicSafetyMessage Part II  section.
Typically these are used in data event snapshots which are gathered and periodically
reported to an RSU or as part of the basicSafetyMessage Part II content.
Observe that this data structure makes use of other defined data elements and data frames,
enclosing them in a sequence structure so that a number of such items can be sent within
the data frame and that this data follows the definition of each defined elsewhere."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "See also the bSMSafetyExtension data frame for additional content."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 180 },  -- WiperStatus
     { j2735DataFrames 87 },  -- Obstacle
     { j2735DataFrames 166 },  -- VehicleIdentification
     { localDataFrames vehicleStatus(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 221 },  -- Vehicle-lights
     { j2735DataElements 220 },  -- Vehicle-lightbar
     { j2735DataElements 197 },  -- Vehicle-brake-applied-pressure
     { j2735DataElements 261 },  -- VehicleEnvironment-temperature-air
     { j2735DataElements 256 },  -- VehicleEnvironment-air-pressure
     { j2735DataElements 235 },  -- Vehicle-steering-wheel-angle-change
     { j2735DataElements 208 },  -- Vehicle-driving-wheel-angle
     { j2735DataElements 262 },  -- VehicleEnvironment-vertical-acceleration-flag
     { j2735DataElements 215 },  -- Vehicle-height
     { j2735DataElements 202 },  -- Vehicle-bumper-height-front
     { j2735DataElements 203 },  -- Vehicle-bumper-height-rear
     { j2735DataElements 223 },  -- Vehicle-mass-gross
     { j2735DataElements 183 },  -- Trailer-weight
     { j2735DataElements 257 },  -- VehicleEnvironment-precipitation-rate
     { j2735DataElements 258 },  -- VehicleEnvironment-precipitation-situation
     { j2735DataElements 260 },  -- VehicleEnvironment-sunlight
     { j2735DataElements 259 },  -- VehicleEnvironment-roadway-friction
     { j2735DataElements 60 }  -- GPSUnit-status  }
DATA-TYPE "
    BSMStatus ::= SEQUENCE {
    lights     Vehicle-lights OPTIONAL,
    lightbar   Vehicle-lightbar OPTIONAL,
    wipers     WiperStatus OPTIONAL,
    brakePressure      Vehicle-brake-applied-pressure OPTIONAL,
    airTemp    VehicleEnvironment-temperature-air OPTIONAL,
    airPres    VehicleEnvironment-air-pressure OPTIONAL,
    rate       Vehicle-steering-wheel-angle-change OPTIONAL,
    wheels     Vehicle-driving-wheel-angle OPTIONAL,
    vertAccelThres     VehicleEnvironment-vertical-acceleration-flag OPTIONAL,
    object     Obstacle OPTIONAL,
    height     Vehicle-height OPTIONAL,
    bumperFront Vehicle-bumper-height-front OPTIONAL,
    bumperRear Vehicle-bumper-height-rear OPTIONAL,
    mass       Vehicle-mass-gross OPTIONAL,
    trailerWeight      Trailer-weight OPTIONAL,
    vehicleIdent       VehicleIdentification OPTIONAL,
    precipRate VehicleEnvironment-precipitation-rate OPTIONAL,
    precipSituation    VehicleEnvironment-precipitation-situation OPTIONAL,
```

```
    solarRadiation     VehicleEnvironment-sunlight OPTIONAL,
    roadFriction       VehicleEnvironment-roadway-friction OPTIONAL,
    gpsStatus  GPSUnit-status OPTIONAL,
    localVehicleStatus LOCAL.VehicleStatus OPTIONAL,    ... }  "}
```

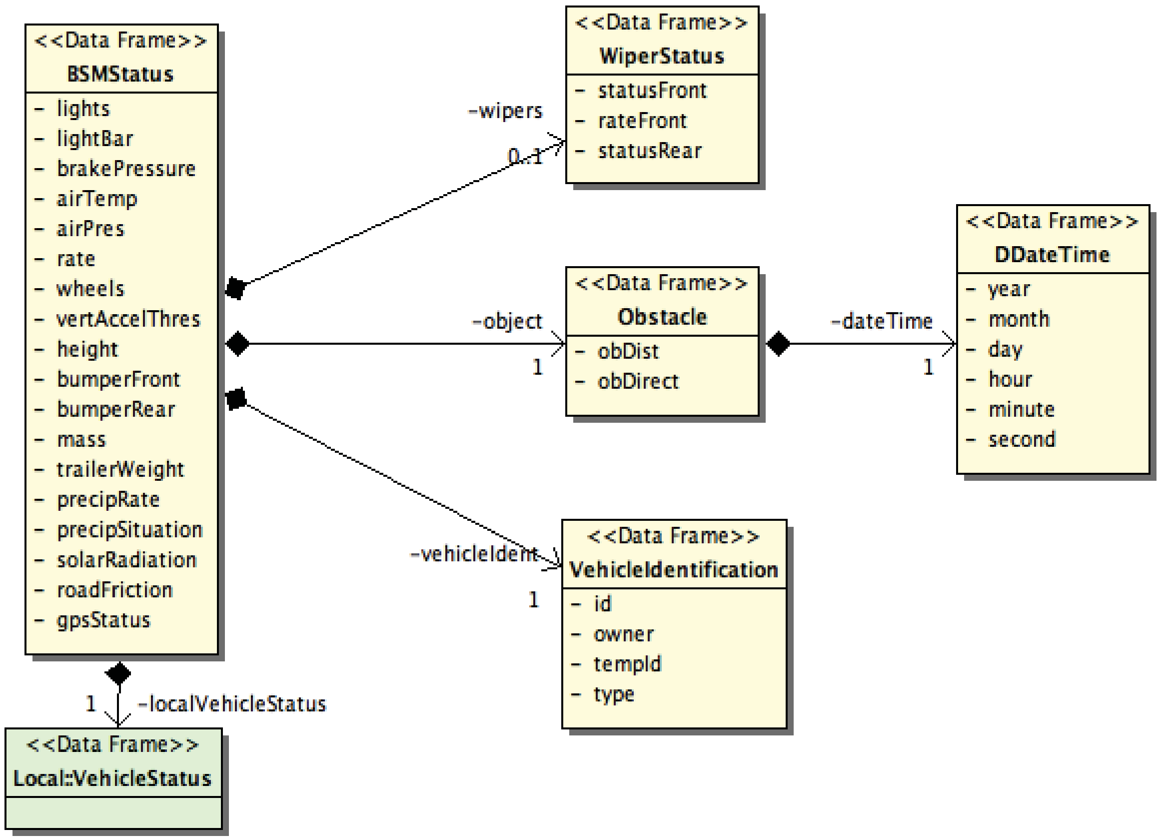


FIGURE 26 - DATA MODEL - bSMStatus

5.3.1.11 circle

```
circle ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Circle:frame"
ASN-NAME "Circle"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 11 }
DEFINITION     "A data frame used to define a circular geometric area, defined by a
circle centered at a given point and extended to the given radius, within which a message
or traveler information item is valid."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 12 }  -- CircleAnchor  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 11 }  -- Circle-radius  }
DATA-TYPE "
    Circle ::= SEQUENCE {
    anchor     CircleAnchor OPTIONAL,
    radius     Circle-radius,    ... }  "}
```

5.3.1.12 circleAnchor

```
circleAnchor ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CircleAnchor:frame"
ASN-NAME "CircleAnchor"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 12 }
DEFINITION     "This data frame is the OER-encoding of the location data frame defining a
location in the WGS-84 coordinate system that is used as the center point for a circular
geometric area within which a message or traveler information item is valid.   The
elevation is included, while the date, time, secMark, and accuracy fields of the location
data frame shall not be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
    CircleAnchor ::= Location-oer  "}
```

5.3.1.13 cmvEncounter

```
cmvEncounter ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvEncounter:frame"
ASN-NAME "CmvEncounter"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 13 }
DEFINITION     "A data frame used to provide the results of a screening activity of a
commercial motor vehicle by a commercial vehicle agency.  Types of screening activities
include safety inspections or a weight inspections.  Information provided by the data
frame include the location of the screening activity, status of the brakes, axle weights,
etc..."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 19 },  -- CmvEncounterTime
     { j2735DataFrames 17 },  -- CmvEncounterPollTime
     { j2735DataFrames 15 },  -- CmvEncounterLocation
     { j2735DataFrames 23 },  -- CmvStatus
     { j2735DataFrames 37 }  -- DriverLog  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 16 },  -- CmvEncounter-identifier
     { j2735DataElements 19 }  -- CmvEncounter-type  }
DATA-TYPE "
    CmvEncounter ::= SEQUENCE {
    encounterId CmvEncounter-identifier,
    time        CmvEncounterTime,
    pollTime    CmvEncounterPollTime OPTIONAL,
    location    CmvEncounterLocation,
    type        CmvEncounter-type,
    vehicleStatus      CmvStatus OPTIONAL,
    driverLog   DriverLog OPTIONAL,    ... }  "}
```

5.3.1.14 cmvEncounterInstructions

```
cmvEncounterInstructions ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvEncounterInstructions:frame"
ASN-NAME "CmvEncounterInstructions"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 14 }
DEFINITION     "A data frame used by a commercial vehicle agency to provide instructions
to a commercial vehicle on where to pull-into a roadside check station."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 16 }  -- CmvEncounterLocationOer  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 18 },  -- CmvEncounter-station
     { j2735DataElements 17 }  -- CmvEncounter-location-description  }
DATA-TYPE "
    CmvEncounterInstructions ::= SEQUENCE {
    coordinates CmvEncounterLocationOer,
    station     CmvEncounter-station OPTIONAL,
    description CmvEncounter-location-description OPTIONAL,    ... }  "}
```

5.3.1.15 cmvEncounterLocation

```
cmvEncounterLocation ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvEncounterLocation:frame"
ASN-NAME "CmvEncounterLocation"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 15 }
DEFINITION     "A data frame that provides the location where a previous screening
activity took place.  The location is defined by the geographic position and optionally,
the identifier of the roadside check station.  Types of screening activities include
safety inspections or a weight inspections."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 16 }  -- CmvEncounterLocationOer  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 18 }  -- CmvEncounter-station  }
DATA-TYPE "
    CmvEncounterLocation ::= SEQUENCE {
    coordinates CmvEncounterLocationOer,
    station     CmvEncounter-station OPTIONAL,    ... }  "}
```

5.3.1.16 cmvEncounterLocationOer

```
cmvEncounterLocationOer ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvEncounterLocationOer:frame"
ASN-NAME "CmvEncounterLocationOer"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 16 }
DEFINITION     "This data frame is the OER-encoding of the location data frame defining
the precise location of the roadside check station, using the WGS-84 coordinate system.
The elevation is optional, while the date, time, secMark, and accuracy fields of the
location data frame shall not be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
```

```
    CmvEncounterLocationOer ::= Location-oer  "}
```

5.3.1.17 cmvEncounterPollTime

```
cmvEncounterPollTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvEncounterPollTime:frame"
ASN-NAME "CmvEncounterPollTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 17 }
DEFINITION     "A data frame identifying the date and time the measurements of a
commercial vehicle was taken, which may be a different date and time identified in the
data element CmvEncounter-time.  This data element is typically transmitted with the
results of a roadside check of a commercial vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 34 }  -- DDateTime  }
DATA-TYPE "
    CmvEncounterPollTime ::= DDateTime  "}
```

5.3.1.18 cmvEncounters

```
cmvEncounters ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvEncounters:frame"
ASN-NAME "CmvEncounters"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 18 }
DEFINITION     "A data frame that contains a series of screening activity results of a
commercial vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 13 }  -- CmvEncounter   }
DATA-TYPE "
    CmvEncounters ::= SEQUENCE (SIZE(1..4)) OF CmvEncounter"}
```

5.3.1.19 cmvEncounterTime

```
cmvEncounterTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvEncounterTime:frame"
ASN-NAME "CmvEncounterTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 19 }
DEFINITION     "This data frame identifies the date and time that a roadside check of a
commercial vehicle was performed.  This is the date and time that the roadside check
activity begins, such as when the commercial vehicle pulls into the roadside check
station.  This data frame describes the date and time as a compound value consisting of
finite-length sequences of integers (not characters) of the form: 'yyyy, mm, dd, hh, mm,
ss'."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 34 }  -- DDateTime  }
DATA-TYPE "
    CmvEncounterTime ::= DDateTime  "}
```

5.3.1.20 cmvRequestAnchor

```
cmvRequestAnchor ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvRequestAnchor:frame"
ASN-NAME "CmvRequestAnchor"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 20 }
DEFINITION     "This data frame is the OER-encoding of the location data frame defining a
location in the WGS-84 coordinate system that is used as a default reference point for
geometric areas within which a commercial vehicle information request is valid.  The
elevation is included, while the date, time, secMark, and accuracy fields of the location
data frame shall not be present.  Unless otherwise specified, this default reference point
is used."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
    CmvRequestAnchor ::= Location-oer  "}
```

5.3.1.21 cmvRequestRegions

```
cmvRequestRegions ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvRequestRegions:frame"
ASN-NAME "CmvRequestRegions"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 21 }
DEFINITION     "A data frame that provides a series of valid geographic locations to
which a commercial vehicle information request is considered valid."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 111 }  -- Region  }
DATA-TYPE "
    CmvRequestRegions ::= SEQUENCE (SIZE(1..16)) OF Region"}
```

5.3.1.22 cmvRequestTarget

```
cmvRequestTarget ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvRequestTarget:frame"
ASN-NAME "CmvRequestTarget"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 22 }
DEFINITION     "This data element is the unique identification number (normally the
vehicle identification number) of the individual commercial motor vehicle for which the
message is intended."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 241 }  -- Vehicle-vin  }
DATA-TYPE "
    CmvRequestTarget ::= Vehicle-vin  "}
```

5.3.1.23 cmvStatus

```
cmvStatus ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvStatus:frame"
ASN-NAME "CmvStatus"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 23 }
DEFINITION     "A data frame used by commercial vehicles and commercial vehicle agencies
to exchange the results of a screening activity.  These results might be used by a
commercial vehicle agency to transmit to a vehicle the results of its inspection; or by a
commercial vehicle to transmit its measurements or the results of a previous screening
activity to a commercial vehicle agency."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 179 },  -- VehicleTires
     { j2735DataFrames 162 }  -- VehicleAxles  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 223 },  -- Vehicle-mass-gross
     { j2735DataElements 229 }  -- Vehicle-safety-belt  }
DATA-TYPE "
    CmvStatus ::= SEQUENCE {
    tires      VehicleTires OPTIONAL,
    axles      VehicleAxles,
    mass       Vehicle-mass-gross OPTIONAL,
    safetyBelt Vehicle-safety-belt OPTIONAL,    ... }  "}
```

5.3.1.24 cmvTrip

```
cmvTrip ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CmvTrip:frame"
ASN-NAME "CmvTrip"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 24 }
DEFINITION     "This data frame is used by commercial motor vehicles to provide
information about its current trip, such as its bill of lading and the type of hazardous
materials it is currently carrying."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 52 },  -- HazmatList
     { j2735DataFrames 102 }  -- PlacardList  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 25 }  -- CmvTrip-shipping-identifier  }
DATA-TYPE "
    CmvTrip ::= SEQUENCE {
    shippingID CmvTrip-shipping-identifier,
    hazmatNumbers      HazmatList OPTIONAL,
    placardNumbers     PlacardList OPTIONAL,    ... }  "}
```

5.3.1.25 commercialScreeningAcknowledgement

```
commercialScreeningAcknowledgement ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CommercialScreeningAcknowledgement:frame"
ASN-NAME "CommercialScreeningAcknowledgement"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 25 }
DEFINITION     "A data frame used by a commercial motor vehicle to acknowledge the
receipt of a commercial screening message from a commercial vehicle agency.  This data
frame typically shall be contained within a dSRCMessage.  The commercial screening message
contains the results of the screening activity of the commercial motor vehicle from the
commercial vehicle agency.  Screening activities, such as safety inspections or weight
inspections, involve examining the condition of a commercial motor vehicle and driver, and
includes a small set of vehicle measurement data and selected vehicle status information."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the commercialScreeningAcknowledgement message when contained within a
dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 19 }  -- CmvEncounterTime  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 241 },  -- Vehicle-vin
     { j2735DataElements 16 },  -- CmvEncounter-identifier
     { j2735DataElements 24 }  -- CmvScreeningAck-encounter-crc  }
DATA-TYPE "
    CommercialScreeningAcknowledgement ::= SEQUENCE {
    vehicleVIN  Vehicle-vin,
    encounterId CmvEncounter-identifier,
    encounterTime       CmvEncounterTime,
    encounterCrc        CmvScreeningAck-encounter-crc,    ... }  "}
```

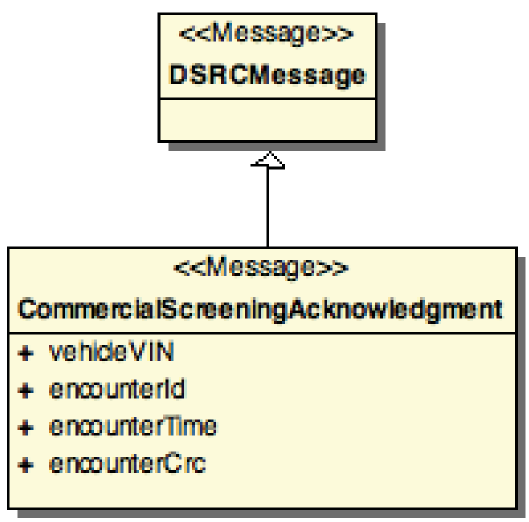


FIGURE 27 - DATA MODEL - commercialScreeningAcknowledgement

5.3.1.26 commercialScreeningData

```
commercialScreeningData ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CommercialScreeningData:frame"
ASN-NAME "CommercialScreeningData"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 26 }
DEFINITION     "A data frame used by commercial vehicle agencies to transmit the results
of its screening activity of a commercial motor vehicle, back to the commercial motor
vehicle.  This data frame typically shall be contained within a dSRCMessage.  If this data
frame is contained within a dSRCMessage, the crc field shall be present.  Screening
activities, such as safety inspections or weight inspections, involve examining the
condition of a commercial motor vehicle and driver. Information collected from the vehicle
and the driver includes a small set of vehicle measurement data and selected vehicle
status information."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the commercialScreeningData message when contained within a dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 13 }  -- CmvEncounter  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 241 },  -- Vehicle-vin
     { j2735DataElements 230 },  -- Vehicle-size-per
     { j2735DataElements 215 }  -- Vehicle-height  }
DATA-TYPE "
    CommercialScreeningData ::= SEQUENCE {
    target     Vehicle-vin,
    size       Vehicle-size-per OPTIONAL,
    height     Vehicle-height OPTIONAL,
    encounter  CmvEncounter,    ... }  "}
```

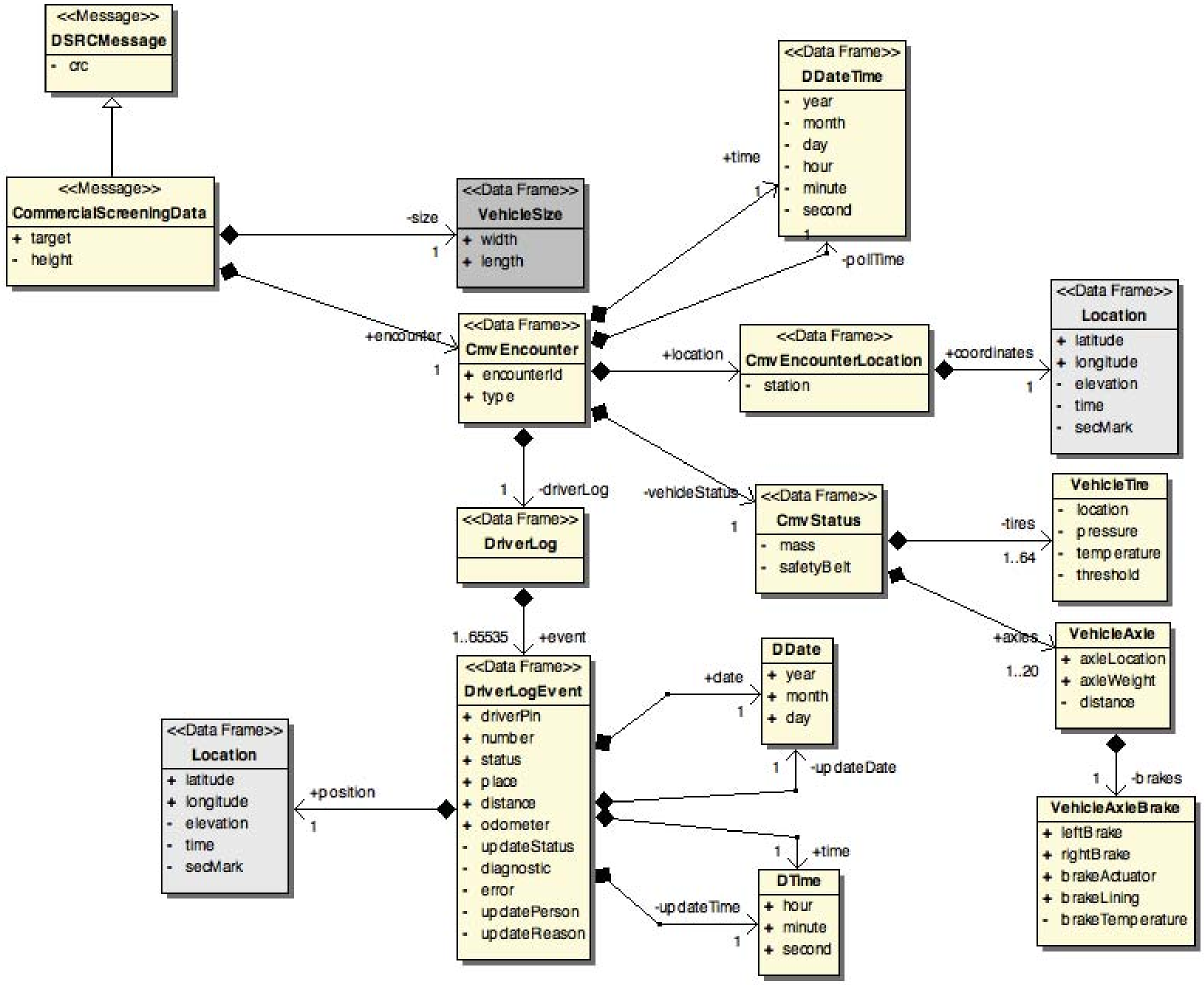


FIGURE 28 - DATA MODEL - commercialScreeningData

5.3.1.27 commercialScreeningResults

```
commercialScreeningResults ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CommercialScreeningResults:frame"
ASN-NAME "CommercialScreeningResults"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 27 }
DEFINITION     "A data frame used by a commercial motor vehicles to transmit the results
of previous screening activities performed on the commercial motor vehicle to other
entities, such as a commercial vehicle agency.  This data frame typically shall be
contained within a dSRCMessage."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the commercialScreeningResults message when contained within a
dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 18 }  -- CmvEncounters  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 241 },  -- Vehicle-vin
     { j2735DataElements 230 },  -- Vehicle-size-per
     { j2735DataElements 215 }  -- Vehicle-height  }
```

```
DATA-TYPE "
    CommercialScreeningResults ::= SEQUENCE {
    vehicleVIN Vehicle-vin OPTIONAL,
    size       Vehicle-size-per OPTIONAL,
    height     Vehicle-height OPTIONAL,
    encounters CmvEncounters,    ... }  "}
```

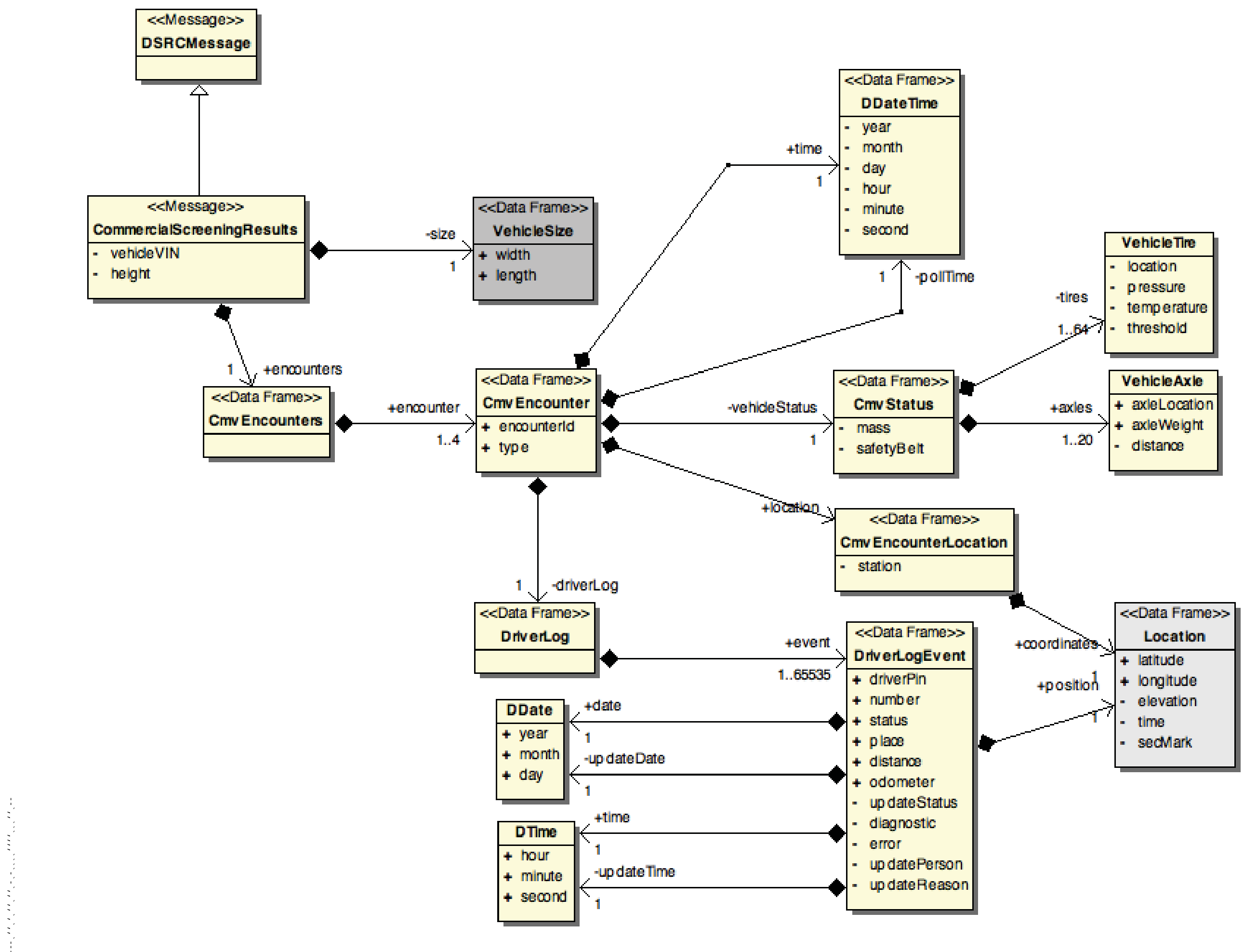


FIGURE 29 - DATA MODEL - commercialScreeningResults

5.3.1.28 commercialVehicleAcknowledgement

```
commercialVehicleAcknowledgement ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CommercialVehicleAcknowledgement:frame"
ASN-NAME "CommercialVehicleAcknowledgement"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 28 }
DEFINITION     "A data frame used by a commercial motor vehicle to confirm the
instructions it has received from the commercial vehicle agency.  This data frame
typically shall be contained within a dSRCMessage.  If the commercial motor vehicle is
instructed to pull into a roadside check station, it will resend the name or the
coordinates of the roadside check station to the commercial vehicle agency."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the commercialVehicleAcknowledgement message when contained within a
dSRCMessage."
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 14 }  -- CmvEncounterInstructions   }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 241 }  -- Vehicle-vin  }
DATA-TYPE "
    CommercialVehicleAcknowledgement ::= SEQUENCE {
    vehicleVIN Vehicle-vin,
    location   CmvEncounterInstructions OPTIONAL,    ... }  "}
```

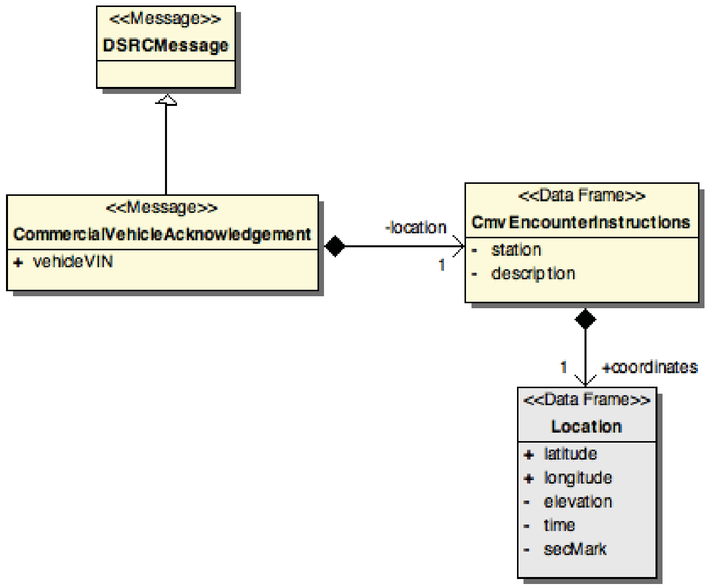


FIGURE 30 - DATA MODEL - commercialVehicleAcknowledgement

5.3.1.29 commercialVehicleClearance

```
commercialVehicleClearance ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CommercialVehicleClearance:frame"
ASN-NAME "CommercialVehicleClearance"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 29 }
DEFINITION     "A data frame used by commercial vehicle agencies to provide instructions
to a commercial motor vehicle.  This data frame typically shall be contained within a
dSRCMessage.  The instructions are to either bypass, or to pull into a roadside check
station.  If a commercial motor vehicle is to pull into a roadside check station, either
the name of the roadside check station or the location (by longitude and latitude) will be
provided to the commercial motor vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the commercialVehicleClearance message when contained within a
dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 14 }  -- CmvEncounterInstructions   }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 241 },  -- Vehicle-vin
     { j2735DataElements 14 }  -- Cmv-instructions   }
DATA-TYPE "
    CommercialVehicleClearance ::= SEQUENCE {
    target     Vehicle-vin,
    instructions       Cmv-instructions,
    location   CmvEncounterInstructions OPTIONAL,    ... }  "}
```

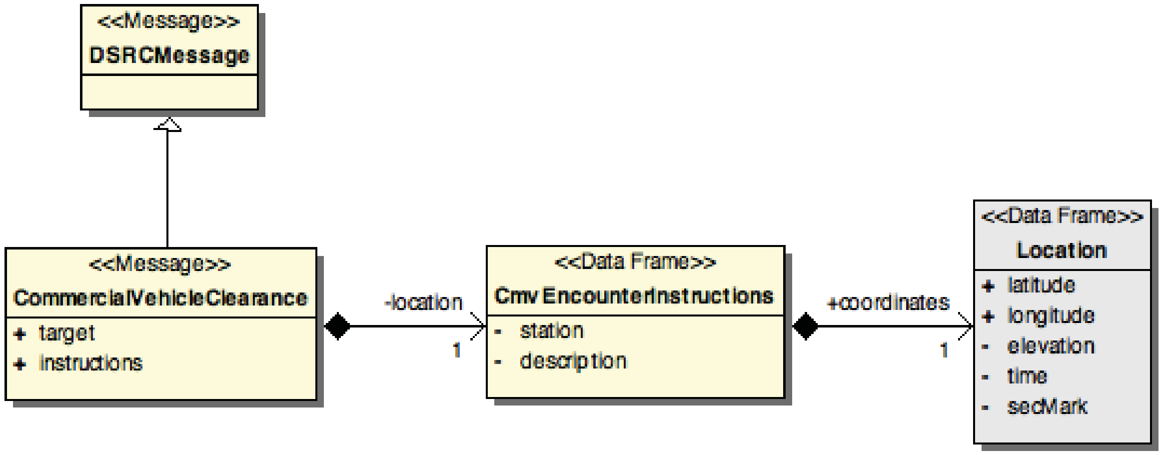


FIGURE 31 - DATA MODEL - commercialVehicleClearance

5.3.1.30 commercialVehicleData

```
commercialVehicleData ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CommercialVehicleData:frame"
ASN-NAME "CommercialVehicleData"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 30 }
DEFINITION     "A data frame used by commercial motor vehicles to provide its
credentialing and sensor measurement information.  This data frame typically shall be
contained within a dSRCMessage.  This data frame contains a commercial vehicle's
identification information, its position, information about the trip and cargo, trailer
data, and driver identification.  If a commercial motor vehicle receives a request for a
data element it does not understand or support, then the request for that item is simply
ignored."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the commercialVehicleData message when contained within a dSRCMessage.
This data frame is typically used for commercial vehicle purposes only for roadside
checks.  The driver must opt-in to allow this data frame to be transmitted."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 175 },  -- VehiclePositionMark
     { j2735DataFrames 73 },  -- LocationAccuracy
     { j2735DataFrames 167 },  -- VehicleLicenseInformation
     { j2735DataFrames 153 },  -- Trailers
     { j2735DataFrames 44 }  -- Drivers  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 241 },  -- Vehicle-vin
     { j2735DataElements 242 },  -- Vehicle-vin-source
     { j2735DataElements 225 },  -- Vehicle-movement-per
     { j2735DataElements 213 },  -- Vehicle-heading
     { j2735DataElements 12 }  -- Cmv-current-trip-oer  }
DATA-TYPE "
    CommercialVehicleData ::= SEQUENCE {
    vehicleVIN Vehicle-vin,
    vehicleVinSource   Vehicle-vin-source OPTIONAL,
    position   VehiclePositionMark OPTIONAL,
    accuracy   LocationAccuracy OPTIONAL,
    speed      Vehicle-movement-per OPTIONAL,
    heading    Vehicle-heading OPTIONAL,
    licenseInformation VehicleLicenseInformation,
    currentTrip Cmv-current-trip-oer OPTIONAL,
    trailers   Trailers OPTIONAL,
    drivers    Drivers OPTIONAL,    ... }   "}
```

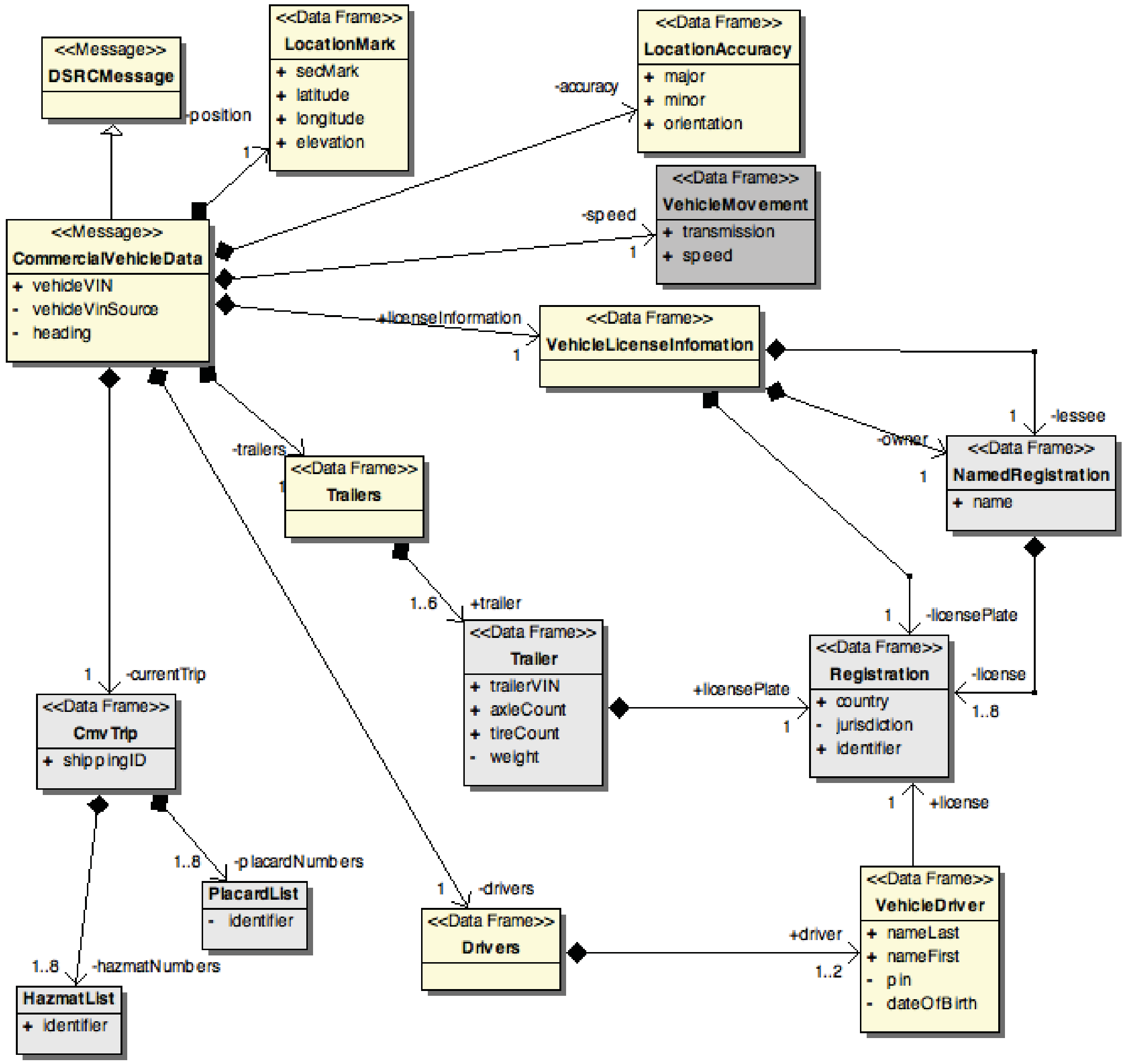


FIGURE 32 - DATA MODEL - commercialVehicleData

5.3.1.31 commercialVehicleRequest

```
commercialVehicleRequest ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CommercialVehicleRequest:frame"
ASN-NAME "CommercialVehicleRequest"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 31 }
DEFINITION     "A data frame that provides a means by which a commercial vehicle agency
can broadcast or unicast requests to commercial vehicles for information which it requires
for the credentialing and safety inspection applications it is actively running.  This
data frame typically shall be contained within a dSRCMessage.  Responding commercial motor
vehicles will (or may) provide this information back to the commercial vehicle agency."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the commercialVehicleRequest message when contained within a
dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 22 },   -- CmvRequestTarget
     { j2735DataFrames 20 },   -- CmvRequestAnchor
     { j2735DataFrames 21 },   -- CmvRequestRegions
     { localDataFrames commercialVehicleRequest(1) }  }
```

```
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 23 },  -- CmvRequest-item
     { j2735DataElements 21 },  -- CmvRequest-default-width
     { j2735DataElements 20 },  -- CmvRequest-default-direction
     { j2735DataElements 22 }  -- CmvRequest-encounter-identifier  }
DATA-TYPE "
    CommercialVehicleRequest ::= SEQUENCE {
    requestItem CmvRequest-item,
    target      CmvRequestTarget,
    commonAnchor       CmvRequestAnchor OPTIONAL,
    commonWidth CmvRequest-default-width OPTIONAL,
    commonDirectionality       CmvRequest-default-direction OPTIONAL,
    regions     CmvRequestRegions OPTIONAL,
    encounterId CmvRequest-encounter-identifier OPTIONAL,
    localCommercialVehicleRequest     LOCAL.CommercialVehicleRequest OPTIONAL,    ... }
"}
```

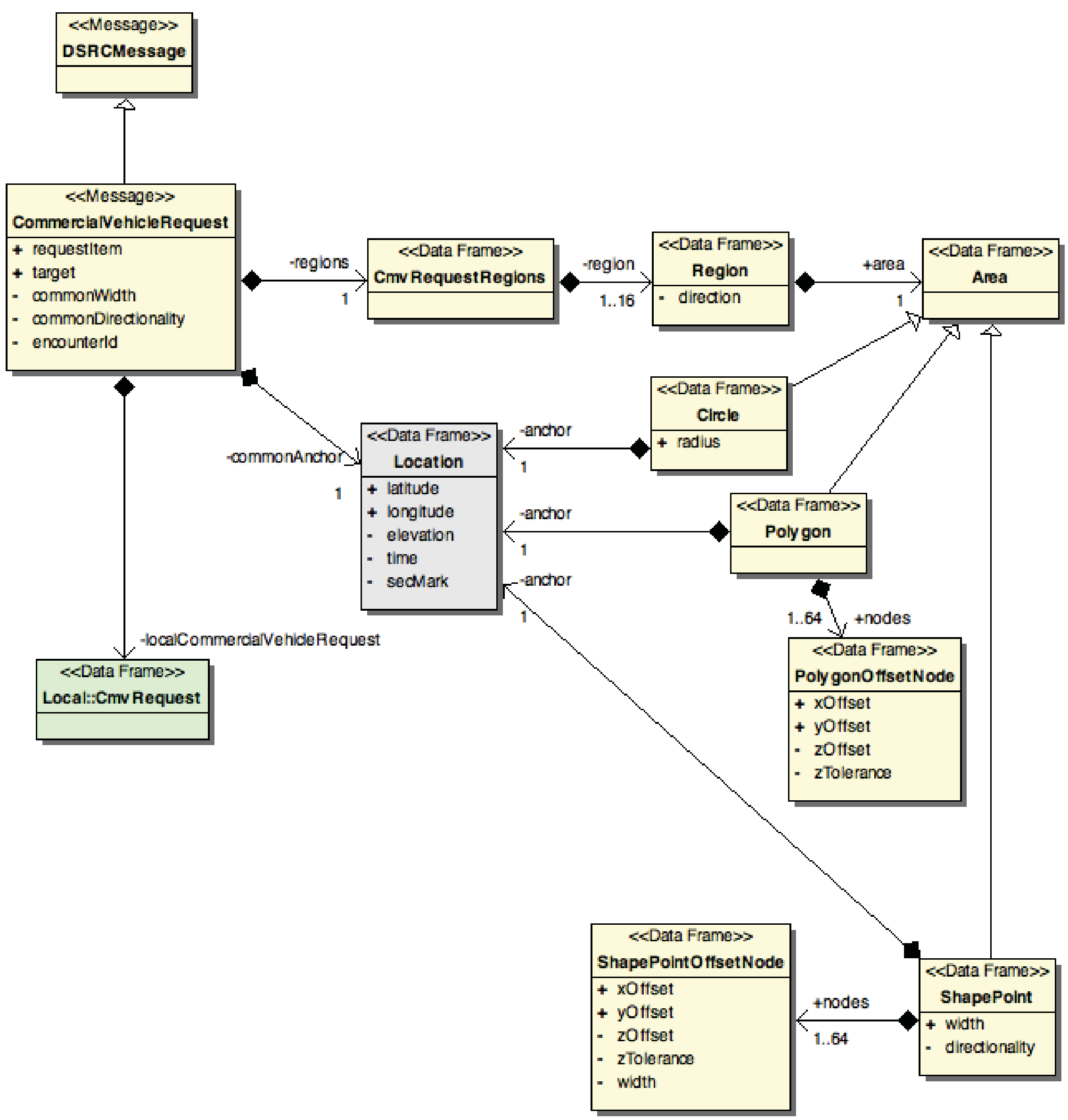


FIGURE 33 - DATA MODEL - commercialVehicleRequest

5.3.1.32 commonSafetyRequest

```
commonSafetyRequest ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "CommonSafetyRequest:frame"
ASN-NAME "CommonSafetyRequest"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 32 }
DEFINITION     "A data frame that consists of the vehicle status information requested by
a connected device from a connected vehicle.  The data frame typically shall be contained
within a dSRCMessage."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the commonSafetyRequest (CSR) message when contained with in a
dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 176 },  -- VehicleRequestItems
     { localDataFrames commonSafetyRequest(1) }   }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 236 }  -- Vehicle-temporary-identifier  }
DATA-TYPE "
    CommonSafetyRequest ::= SEQUENCE {
    id  Vehicle-temporary-identifier OPTIONAL,
    requests   VehicleRequestItems,
    localCommonSafetyRequest   LOCAL.CommonSafetyRequest OPTIONAL,    ... }  "}
```

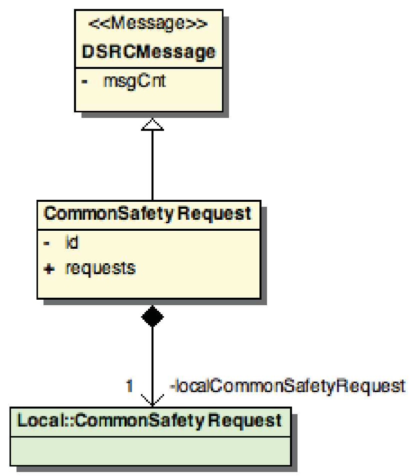


FIGURE 34 - DATA MODEL - commonSafetyRequest

5.3.1.33 dDate

```
dDate ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DDate:frame"
ASN-NAME "DDate"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 33 }
DEFINITION     "A data frame describing the date as a compound value consisting of
finite-length sequences of integers (not characters) of the form: 'yyyy, mm, dd'."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 45 },  -- DYear
     { j2735DataElements 30 },  -- DMonth
     { j2735DataElements 27 }  -- DDay  }
```

```
DATA-TYPE "
    DDate ::= SEQUENCE {
    year        DYear,
    month       DMonth,
    day DDay }"}
```

5.3.1.34 dDateTime

```
dDateTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DDateTime:frame"
ASN-NAME "DDateTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 34 }
DEFINITION     "A data frame describing the date as a compound value consisting of
finite-length sequences of integers (not characters) of the form: 'yyyy, mm, dd, hh, mm,
ss (sss+)'."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Note that some elements of this structure may not be sent when not needed.  At
least one element shall be present."
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 45 },  -- DYear
     { j2735DataElements 30 },  -- DMonth
     { j2735DataElements 27 },  -- DDay
     { j2735DataElements 28 },  -- DHour
     { j2735DataElements 29 },  -- DMinute
     { j2735DataElements 42 }  -- DSecond  }
DATA-TYPE "
    DDateTime ::= SEQUENCE {
    year        DYear OPTIONAL,
    month       DMonth OPTIONAL,
    day DDay OPTIONAL,
    hour        DHour OPTIONAL,
    minute      DMinute OPTIONAL,
    second      DSecond OPTIONAL }"}
```

5.3.1.35 dFullTime

```
dFullTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DFullTime:frame"
ASN-NAME "DFullTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 35 }
DEFINITION     "A data frame that is an alternative representation of date and time which
is derived from complete entry date-time but with the seconds and fraction of a second
removed (these are typically sent in another part of the same message).  The full time is
defined as a compound value consisting of finite-length sequences of integers (not
characters) of the form: 'yyyy, mm, dd, hh, mm'."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "year      -- 2 bytes
  month     -- 1 byte
  day       -- 1 byte
  hour      -- 1 byte
  minute    -- 1 byte  "
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 45 },  -- DYear
     { j2735DataElements 30 },  -- DMonth
     { j2735DataElements 27 },  -- DDay
     { j2735DataElements 28 },  -- DHour
     { j2735DataElements 29 }  -- DMinute  }
```

```
DATA-TYPE "
    DFullTime ::= SEQUENCE {
    year        DYear,
    month       DMonth,
    day DDay,
    hour        DHour,
    minute      DMinute }"}
```

5.3.1.36 driverLicense

```
driverLicense ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DriverLicense:frame"
ASN-NAME "DriverLicense"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 36 }
DEFINITION     "A data frame containing a driver's driver license information.  The
driver must opt-in for this data frame to be transmitted.  This information is typically
used with commercial vehicles for driver safety inspections and for security purposes."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 129 }  -- Registration-oer  }
DATA-TYPE "
    DriverLicense ::= Registration-oer  "}
```

5.3.1.37 driverLog

```
driverLog ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DriverLog:frame"
ASN-NAME "DriverLog"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 37 }
DEFINITION     "A data frame that contains a series of driver log records."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 38 }  -- DriverLogEvent  }
DATA-TYPE "
    DriverLog ::= SEQUENCE (SIZE(1..65535)) OF DriverLogEvent"}
```

5.3.1.38 driverLogEvent

```
driverLogEvent ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DriverLogEvent:frame"
ASN-NAME "DriverLogEvent"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 38 }
DEFINITION     "A data frame containing a driver log record from a commercial vehicle's
on board recorder regarding a driver's hours of service.  Each data frame consists of one
record from the on board recorder."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 39 },  -- DriverLogEventDate
     { j2735DataFrames 42 },  -- DriverLogEventTime
     { j2735DataFrames 41 },  -- DriverLogEventPosition
     { j2735DataFrames 40 },  -- DriverLogEventDateUpdate
     { j2735DataFrames 43 }  -- DriverLogEventTimeUpdate  }
```

```
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 31 },  -- Driver-pin
     { j2735DataElements 37 },  -- DriverLogEvent-sequence-number
     { j2735DataElements 38 },  -- DriverLogEvent-status
     { j2735DataElements 36 },  -- DriverLogEvent-place
     { j2735DataElements 33 },  -- DriverLogEvent-distance
     { j2735DataElements 35 },  -- DriverLogEvent-odometer
     { j2735DataElements 39 },  -- DriverLogEvent-status-update
     { j2735DataElements 32 },  -- DriverLogEvent-diagnostic
     { j2735DataElements 34 },  -- DriverLogEvent-error
     { j2735DataElements 40 },  -- DriverLogEvent-update-person
     { j2735DataElements 41 }  -- DriverLogEvent-update-reason  }
DATA-TYPE "
    DriverLogEvent ::= SEQUENCE {
    driverPin  Driver-pin,
    number     DriverLogEvent-sequence-number,
    status     DriverLogEvent-status,
    date       DriverLogEventDate,
    time       DriverLogEventTime,
    position   DriverLogEventPosition,
    place      DriverLogEvent-place,
    distance   DriverLogEvent-distance,
    odometer   DriverLogEvent-odometer,
    updateStatus       DriverLogEvent-status-update OPTIONAL,
    diagnostic DriverLogEvent-diagnostic OPTIONAL,
    error      DriverLogEvent-error OPTIONAL,
    updateDate DriverLogEventDateUpdate OPTIONAL,
    updateTime DriverLogEventTimeUpdate OPTIONAL,
    updatePerson       DriverLogEvent-update-person OPTIONAL,
    updateReason       DriverLogEvent-update-reason OPTIONAL,    ... }  "}
```

5.3.1.39 driverLogEventDate

```
driverLogEventDate ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DriverLogEventDate:frame"
ASN-NAME "DriverLogEventDate"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 39 }
DEFINITION     "This data frame represents the date when an event occurred.  Typically,
this data frame is associated with on board recording devices for commercial vehicle
drivers.  This data frame describes the date as a compound value consisting of finite-
length sequences of integers (not characters) of the form: 'yyyy, mm, dd'."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 33 }  -- DDate  }
DATA-TYPE "
    DriverLogEventDate ::= DDate  "}
```

5.3.1.40 driverLogEventDateUpdate

```
driverLogEventDateUpdate ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DriverLogEventDateUpdate:frame"
ASN-NAME "DriverLogEventDateUpdate"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 40 }
DEFINITION     "This data frame represents the date when an event record was last updated
or edited.  Typically, this data frame is associated with on board recording devices for
commercial vehicle drivers.  This data frame describes the date as a compound value
consisting of finite-length sequences of integers (not characters) of the form: 'yyyy, mm,
dd'."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "year      -- 1 byte
  month    -- 1 byte
  day      -- 2 byte  "
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 33 }  -- DDate  }
DATA-TYPE "
    DriverLogEventDateUpdate ::= DDate  "}
```

5.3.1.41 driverLogEventPosition

```
driverLogEventPosition ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DriverLogEventPosition:frame"
ASN-NAME "DriverLogEventPosition"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 41 }
DEFINITION     "A data element that provides a definitive and precise location of the
vehicle in the WGS-84 coordinate system where an event occurred.  This data frame is a
collection of the two 4 byte lat-long information elements to build a 2-dimensional
position in 8 bytes."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 85 },  -- Location-latitude
     { j2735DataElements 86 }  -- Location-longitude  }
DATA-TYPE "
    DriverLogEventPosition ::= SEQUENCE {
    latitude   Location-latitude,
    longitude  Location-longitude,    ... }  "}
```

5.3.1.42 driverLogEventTime

```
driverLogEventTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DriverLogEventTime:frame"
ASN-NAME "DriverLogEventTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 42 }
DEFINITION     "This data frame represents the time when an event occurred.  Typically,
this data frame is associated with on board recording devices for commercial vehicle
drivers.  This data frame is a compound value consisting of finite-length sequences of
integers (not characters) of the form: 'hh, mm, ss' - as defined below."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "hour      -- 1 byte
  minute  -- 1 byte
  second  -- 2 byte  "
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 46 }  -- DTime  }
DATA-TYPE "
```

```
    DriverLogEventTime ::= DTime  "}
```

5.3.1.43 driverLogEventTimeUpdate

```
driverLogEventTimeUpdate ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DriverLogEventTimeUpdate:frame"
ASN-NAME "DriverLogEventTimeUpdate"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 43 }
DEFINITION     "This data frame represents the time when an event was last updated or
edited.  Typically, this data frame is associated with on board recording devices for
commercial vehicle drivers.  This data frame is a compound value consisting of finite-
length sequences of integers (not characters) of the form: 'hh, mm, ss' -  as defined
below."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "hour       -- 1 byte
  minute  -- 1 byte
  second  -- 2 byte  "
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 46 }  -- DTime  }
DATA-TYPE "
    DriverLogEventTimeUpdate ::= DTime  "}
```

5.3.1.44 drivers

```
drivers ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Drivers:frame"
ASN-NAME "Drivers"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 44 }
DEFINITION     "A data frame that contains identifying information for the drivers of a
motor vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 165 }  -- VehicleDriver  }
DATA-TYPE "
    Drivers ::= SEQUENCE (SIZE(1..2)) OF VehicleDriver"}
```

5.3.1.45 dSRCMessageContents

```
dSRCMessageContents ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DSRCMessageContents:frame"
ASN-NAME "DSRCMessageContents"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 45 }
DEFINITION     "A choice of the various DSRC message types."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 2 },  -- AlaCarte
     { j2735DataFrames 5 },  -- BasicSafetyMessage
     { j2735DataFrames 6 },  -- BasicSafetyMessageVerbose
     { j2735DataFrames 32 },  -- CommonSafetyRequest
     { j2735DataFrames 58 },  -- IntersectionInfringement
     { j2735DataFrames 77 },  -- MapData
     { j2735DataFrames 86 },  -- NMEACorrections
     { j2735DataFrames 107 },  -- ProbeDataManagement
     { j2735DataFrames 110 },  -- ProbeVehicleData
     { j2735DataFrames 115 },  -- RTCMCorrections
     { j2735DataFrames 142 },  -- Spat
```

```
     { j2735DataFrames 128 },  -- SignalRequestMessage
     { j2735DataFrames 129 },  -- SignalStatusMessage
     { j2735DataFrames 154 },  -- TravelerInformation
     { j2735DataFrames 25 },  -- CommercialScreeningAcknowledgement
     { j2735DataFrames 26 },  -- CommercialScreeningData
     { j2735DataFrames 27 },  -- CommercialScreeningResults
     { j2735DataFrames 28 },  -- CommercialVehicleAcknowledgement
     { j2735DataFrames 29 },  -- CommercialVehicleClearance
     { j2735DataFrames 30 },  -- CommercialVehicleData
     { j2735DataFrames 31 },  -- CommercialVehicleRequest
     { j2735DataFrames 80 },  -- MaydayMessage
     { j2735DataFrames 47 }  -- ForwardedMessage  }
DATA-TYPE "
    DSRCMessageContents ::= CHOICE
{
    alacarte   AlaCarte,
    bsm BasicSafetyMessage,
    bsmVerbose BasicSafetyMessageVerbose,
    commonSafetyRequest       CommonSafetyRequest,
    isInfringeAlert    IntersectionInfringement,
    map MapData,
    nmea        NMEACorrections,
    probeMgmt  ProbeDataManagement,
    probeVehicleData   ProbeVehicleData,
    rtcmCorrections    RTCMCorrections,
    spat        Spat,
    signalRequest      SignalRequestMessage,
    signalStatus       SignalStatusMessage,
    travelerInfo       TravelerInformation,
    cmvScreenAck       CommercialScreeningAcknowledgement,
    cmvScreenMsg       CommercialScreeningData,
    cmvScreenResults   CommercialScreeningResults,
    cmvAck     CommercialVehicleAcknowledgement,
    cmvClearance       CommercialVehicleClearance,
    cmv CommercialVehicleData,
    cmvRequest CommercialVehicleRequest,
    mayday     MaydayMessage,
    forwardedMessage   ForwardedMessage}  "}
```

5.3.1.46 dTime

```
dTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DTime:frame"
ASN-NAME "DTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 46 }
DEFINITION     "A data frame that is the basic representation of time which is described
as a compound value consisting of finite-length sequences of integers (not characters) of
the form: 'hh, mm, ss (sss+) (offset)' - as defined below.  Because the length of each
element is known, no inner element tagging is used in some forms of transmission.  Tagging
is used in this instance.  In DSRC applications there is no need to send the offset
representing the local time zone, so the most common representation for the data frame
occupies 4 payload bytes (12 bytes with all tagging) and provides a resolution of one
millisecond over a range of one day."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "hour       -- 1 byte
minute    -- 1 byte
second  -- 2 byte  "
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 28 },  -- DHour
     { j2735DataElements 29 },  -- DMinute
     { j2735DataElements 42 }  -- DSecond  }
DATA-TYPE "
```

```
    DTime ::= SEQUENCE {
    hour        DHour,
    minute      DMinute,
    second      DSecond }"}
```

5.3.1.47 forwardedMessage

```
forwardedMessage ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ForwardedMessage:frame"
ASN-NAME "ForwardedMessage"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 47 }
DEFINITION     "A data frame used by a connected device to forward a message that was
previously received by the connected device to a defined recipient.  This data frame shall
be contained within a dSRCMessage with the same information as in the message to be
forwarded but includes the date and time that the connected device first received the
forwarded message."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the forwardedMessage when contained within a dSRCMessage.  Although
intended only for forwarding mayday messages, the structure of this data frame allows for
the forwarding of other messages.  When a connected device receives a mayday message, the
recipient is a publicsafetyagency (defined in forwardedMessageDestination)."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 50 },  -- ForwardedMessageReceiptTime
     { j2735DataFrames 48 },  -- ForwardedMessageDestination
     { j2735DataFrames 49 }  -- ForwardedMessageEmbeddedContent  }
DATA-TYPE "
    ForwardedMessage ::= SEQUENCE {
    receiptTime ForwardedMessageReceiptTime,
    destination ForwardedMessageDestination,
    embeddedMessage    ForwardedMessageEmbeddedContent,    ... }  "}
```

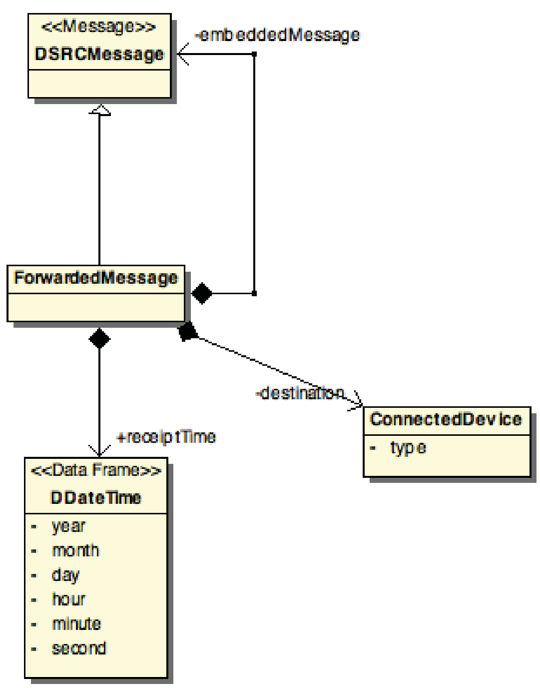


FIGURE 35 - DATA MODEL - forwardedMessage

5.3.1.48 forwardedMessageDestination

```
forwardedMessageDestination ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ForwardedMessageDestination:frame"
ASN-NAME "ForwardedMessageDestination"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 48 }
DEFINITION     "A data frame used to identify a destination connected device for the forwarded message."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 26 }  -- ConnectedDevice-type  }
DATA-TYPE "
    ForwardedMessageDestination ::= ConnectedDevice-type  "}
```

5.3.1.49 forwardedMessageEmbeddedContent

```
forwardedMessageEmbeddedContent ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ForwardedMessageEmbeddedContent:frame"
ASN-NAME "ForwardedMessageEmbeddedContent"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 49 }
DEFINITION     "This data frame contains the message data frame that is being forwarded from a remote connected device."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 45 }  -- DSRCMessageContents  }
DATA-TYPE "
    ForwardedMessageEmbeddedContent ::= DSRCMessageContents  "}
```

5.3.1.50 forwardedMessageReceiptTime

```
forwardedMessageReceiptTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ForwardedMessageReceiptTime:frame"
ASN-NAME "ForwardedMessageReceiptTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 50 }
DEFINITION     "A data frame to indicate the date and time at which the connected device first received the request to forward the attached message."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 34 }  -- DDateTime  }
DATA-TYPE "
    ForwardedMessageReceiptTime ::= DDateTime  "}
```

5.3.1.51 fullPositionVector

```
fullPositionVector ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "FullPositionVector:frame"
ASN-NAME "FullPositionVector"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 51 }
DEFINITION     "A data frame used to provide a complete report of the vehicle's position, speed, and heading at a particular instant in time (also defined in the data frame).  Used in the probe vehicle message (and elsewhere) as the initial position information.  Often followed by other data frames that may provide offset path data."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
```

```
REMARKS  "In a previous version of the standard the first 2 bytes were a Dsecond follow by
DFullTime in 6 bytes.  This produced a complete time value in 8 bytes.  In this version,
these have been re-ordered into a single value, that of DDateTime.  This changed the
ordering encoded over the air, and the ordering and tags when expressed in ASN."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 34 },  -- DDateTime
     { j2735DataFrames 73 }  -- LocationAccuracy  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 86 },  -- Location-longitude
     { j2735DataElements 85 },  -- Location-latitude
     { j2735DataElements 84 },  -- Location-elevation
     { j2735DataElements 213 },  -- Vehicle-heading
     { j2735DataElements 239 },  -- Vehicle-transmission
     { j2735DataElements 231 }  -- Vehicle-speed  }
DATA-TYPE "
        FullPositionVector ::= SEQUENCE {
    utcTime    DDateTime,
    long       Location-longitude,
    lat Location-latitude,
    elevation  Location-elevation,
    heading    Vehicle-heading OPTIONAL,
    transmission       Vehicle-transmission OPTIONAL,
    speed      Vehicle-speed OPTIONAL,
    posAccuracy LocationAccuracy OPTIONAL,    ... }  "}
```

5.3.1.52 hazmatList

```
hazmatList ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "HazmatList:frame"
ASN-NAME "HazmatList"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 52 }
DEFINITION     "A data frame that provides a series of hazmat codes, which identifies the
hazardous materials currently being carried on the vehicle.  Typically transmitted by a
commercial motor vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 13 }  -- Cmv-hazmat-identifier  }
DATA-TYPE "
        HazmatList ::= SEQUENCE (SIZE(1..8)) OF Cmv-hazmat-identifier"}
```

5.3.1.53 intersection

```
intersection ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Intersection:frame"
ASN-NAME "Intersection"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 53 }
DEFINITION     "A data frame providing a complete description of an intersection's
roadway geometry and its allowed navigational paths (independent of any additional
regulatory restrictions that may apply over time or from user classification)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "The preemptZones and priorityZones are used to relate signal preempt and
priority zones to specific request values."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 54 },  -- IntersectionAnchor
     { j2735DataFrames 60 },  -- IntersectionReference
     { j2735DataFrames 57 },  -- IntersectionEgresses
     { j2735DataFrames 55 },  -- IntersectionApproaches
     { j2735DataFrames 56 },  -- IntersectionCrossings
```

```
     { j2735DataFrames 59 },  -- IntersectionPrioritySchemes
     { localDataFrames intersection(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 62 },  -- Intersection-identifier
     { j2735DataElements 65 },  -- Intersection-version
     { j2735DataElements 61 }  -- Intersection-default-lane-width  }
DATA-TYPE "
        Intersection ::= SEQUENCE {
    id  Intersection-identifier,
    intersectionVersion       Intersection-version OPTIONAL,
    refPoint   IntersectionAnchor,
    refInt     IntersectionReference OPTIONAL,
    laneWidth  Intersection-default-lane-width,
    egresses   IntersectionEgresses,
    approaches IntersectionApproaches,
    crossings  IntersectionCrossings OPTIONAL,
    signalControlZone  IntersectionPrioritySchemes OPTIONAL,
    local      LOCAL.Intersection OPTIONAL,    ... }  "}
```

5.3.1.54 intersectionAnchor

```
intersectionAnchor ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionAnchor:frame"
ASN-NAME "IntersectionAnchor"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 54 }
DEFINITION     "This data frame is the OER-encoding of the location data frame in the
WGS-84 coordinate system that is used when defining all location attributes of an
intersection.  The elevation is included, while the date, time, secMark, and accuracy
fields of the location data frame shall not be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
        IntersectionAnchor ::= Location-oer  "}
```

5.3.1.55 intersectionApproaches

```
intersectionApproaches ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionApproaches:frame"
ASN-NAME "IntersectionApproaches"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 55 }
DEFINITION     "This data frame defines the lanes serving as an approach to the
intersection. The connections field of the lane data frame shall be present within each
instance of this sequence.  The lane-vehicle-attributes and/or lane-special-attributes in
the laneAttributes data frame is included."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 77 }  -- Lane-oer  }
DATA-TYPE "
        IntersectionApproaches ::= SEQUENCE (SIZE(1..32)) OF Lane-oer"}
```

5.3.1.56 intersectionCrossings

```
intersectionCrossings ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionCrossings:frame"
ASN-NAME "IntersectionCrossings"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 56 }
DEFINITION     "This data frame defines all crossings at the intersection.  Crossings can
generally be considered bi-directional and do not have approaches or egresses.  The users
or crossings are typically not vehicles.  The connections field of the lane data frame
shall be absent within each instance of this sequence since it is not applicable.  The
lane-crosswalk-attributes in the laneAttributes data frame is included."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 77 }  -- Lane-oer  }
DATA-TYPE "
        IntersectionCrossings ::= SEQUENCE (SIZE(1..32)) OF Lane-oer"}
```

5.3.1.57 intersectionEgresses

```
intersectionEgresses ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionEgresses:frame"
ASN-NAME "IntersectionEgresses"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 57 }
DEFINITION     "This data frame defines all egresses from the intersection. The
connections field of the lane data frame shall be absent within each instance of this
sequence since it is not applicable.  The lane-vehicle-attributes and/or lane-special-
attributes in the laneAttributes data frame is included."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 77 }  -- Lane-oer  }
DATA-TYPE "
        IntersectionEgresses ::= SEQUENCE (SIZE(1..32)) OF Lane-oer"}
```

5.3.1.58 intersectionInfringement

```
intersectionInfringement ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionInfringement:frame"
ASN-NAME "IntersectionInfringement"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 58 }
DEFINITION     "A data frame that provides information from a connected vehicle to build
intersection collision avoidance systems with.  It identifies the intersection being
reported on and the recent path and accelerations of the vehicle.  This data frame
typically shall be contained within a dSRCMessage.  If this data frame is contained within
a dSRCMessage, the msgCnt field shall be present.
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the intersectionInfringement (ICA) message when contained within a
dSRCMessage.  Formerly called the IntersectionCollisionAvoidance message."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 173 },  -- VehiclePathHistory
     { localDataFrames intersectionInfringement(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 236 },  -- Vehicle-temporary-identifier
     { j2735DataElements 62 },  -- Intersection-identifier
     { j2735DataElements 76 },  -- Lane-number
     { j2735DataElements 209 }  -- Vehicle-events  }
```

```
DATA-TYPE "
        IntersectionInfringement ::= SEQUENCE {
    id  Vehicle-temporary-identifier,
    path       VehiclePathHistory,
    intersectionIdentifier    Intersection-identifier,
    laneNumber Lane-number,
    vehicleEvents      Vehicle-events,
    localIntersectionInfringement     LOCAL.IntersectionInfringement OPTIONAL,    ... }
"}
```

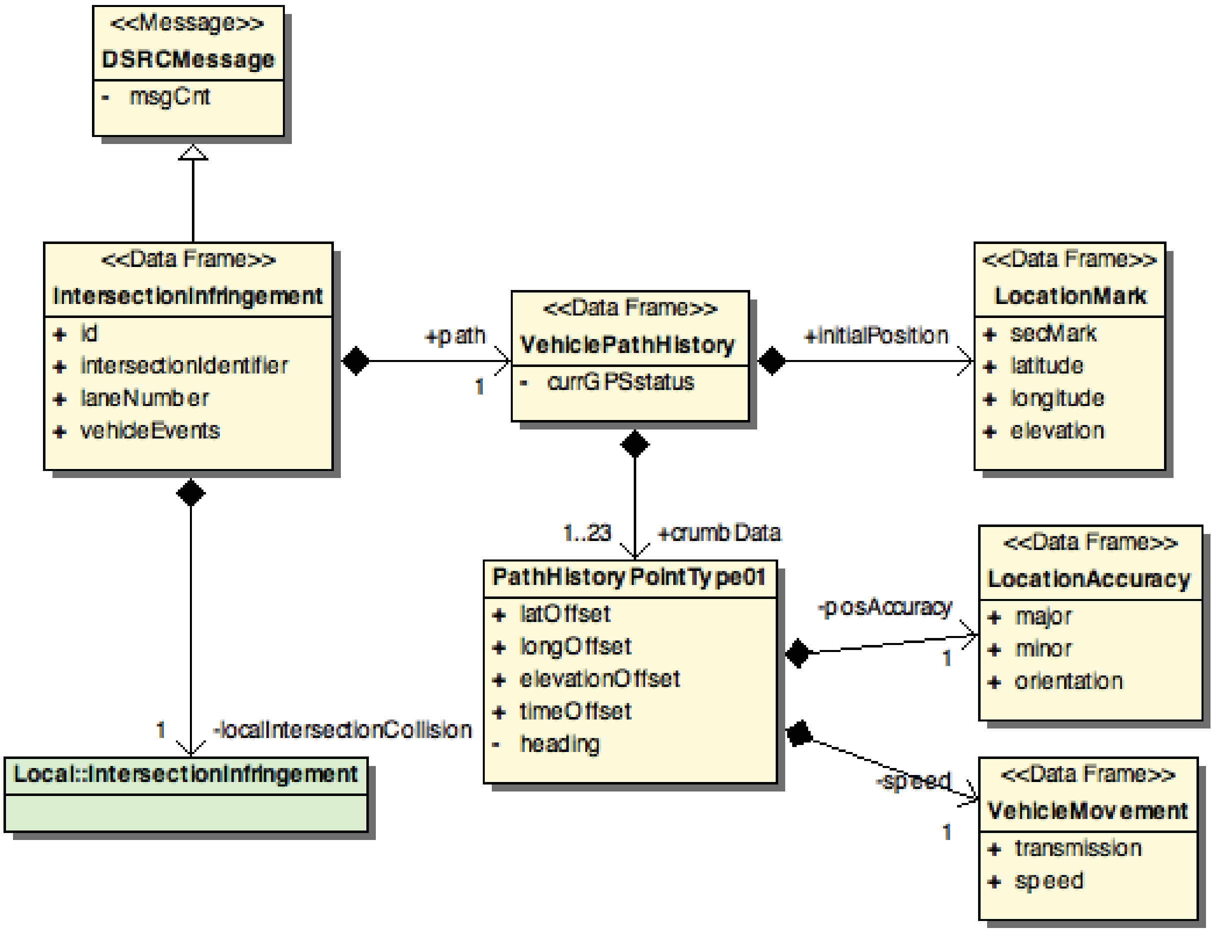


FIGURE 36 - DATA MODEL - intersectionInfringement

5.3.1.59 intersectionPrioritySchemes

```
intersectionPrioritySchemes ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionPrioritySchemes:frame"
ASN-NAME "IntersectionPrioritySchemes"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 59 }
DEFINITION     "A data frame defining all preferential treatment schemes supported by the
intersection.  This data frame contains a series of zones for an intersection.  Each zone
is used to define a geo-physical region where an approaching vehicle may request
preferential treatment at a traffic signal."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 147 }  -- TrafficSignalPriority  }
DATA-TYPE "
        IntersectionPrioritySchemes ::= SEQUENCE (SIZE(1..32)) OF TrafficSignalPriority"}
```

5.3.1.60 intersectionReference

```
intersectionReference ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionReference:frame"
ASN-NAME "IntersectionReference"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 60 }
DEFINITION     "A data frame defining the attributes of a computed intersection based on
a referenced intersection.  For an intersection with similar geometric features as the
referenced intersection, citing a referenced intersection instead of detailing the
geometric information significantly reduces the amount of data to be broadcasted.  This
data frame contains the intersection-identifier of the referenced intersection and the
orientation (rotation) relative to the referenced intersection."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "For computed intersections, the parent data frame (intersection) only needs to
include the intersection-identifer of the computed intersection, the reference point of
the computed intersection, and this IntersectionReference data frame."
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 63 },  -- Intersection-identifier-referenced
     { j2735DataElements 64 }  -- Intersection-orientation  }
DATA-TYPE "
        IntersectionReference ::= SEQUENCE {
    refInterNum Intersection-identifier-referenced,
    orientation Intersection-orientation,    ... }  "}
```

5.3.1.61 intersectionSignalized

```
intersectionSignalized ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionSignalized:frame"
ASN-NAME "IntersectionSignalized"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 61 }
DEFINITION     "A data frame used to define the control status for a signalized
intersection.  This data frame conveys the signal phase and timing information for the
intersection."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 62 },  -- IntersectionSignalizedActiveMovements
     { localDataFrames intersectionState(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 62 },  -- Intersection-identifier
     { j2735DataElements 68 },  -- IntersectionSignalized-state
     { j2735DataElements 69 },  -- IntersectionSignalized-time
     { j2735DataElements 67 },  -- IntersectionSignalized-priority
     { j2735DataElements 66 }  -- IntersectionSignalized-preempt  }
DATA-TYPE "
        IntersectionSignalized ::= SEQUENCE {
    id  Intersection-identifier,
    status     IntersectionSignalized-state,
    timeStamp  IntersectionSignalized-time,
    states     IntersectionSignalizedActiveMovements,
    priority   IntersectionSignalized-priority OPTIONAL,
    preempt    IntersectionSignalized-preempt OPTIONAL,
    localIntersectionState     LOCAL.IntersectionState OPTIONAL,    ... }  "}
```

5.3.1.62 intersectionSignalizedActiveMovements

```
intersectionSignalizedActiveMovements ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedActiveMovements:frame"
ASN-NAME "IntersectionSignalizedActiveMovements"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 62 }
DEFINITION     "A data frame defining the status for all active movements that are
currently being timed at the signalized intersection."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 143 }  -- TrafficSignalMovement  }
DATA-TYPE "
        IntersectionSignalizedActiveMovements ::= SEQUENCE (SIZE(1..255)) OF
TrafficSignalMovement"}
```

5.3.1.63 intersectionSignalizedPreempts

```
intersectionSignalizedPreempts ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedPreempts:frame"
ASN-NAME "IntersectionSignalizedPreempts"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 63 }
DEFINITION     "A data frame containing a sequence indicating the current preemption
state(s) of a traffic signal controller."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 66 }  -- IntersectionSignalized-preempt  }
DATA-TYPE "
        IntersectionSignalizedPreempts ::= SEQUENCE (SIZE(1..8)) OF
IntersectionSignalized-preempt"}
```

5.3.1.64 intersectionSignalizedPriorities

```
intersectionSignalizedPriorities ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedPriorities:frame"
ASN-NAME "IntersectionSignalizedPriorities"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 64 }
DEFINITION     "A data frame containing a sequence indicating the current priority
state(s) of a traffic signal controller."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 67 }  -- IntersectionSignalized-priority  }
DATA-TYPE "
        IntersectionSignalizedPriorities ::= SEQUENCE (SIZE(1..8)) OF
IntersectionSignalized-priority"}
```

5.3.1.65 intersectionSignalizedRequest

```
intersectionSignalizedRequest ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedRequest:frame"
ASN-NAME "IntersectionSignalizedRequest"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 65 }
DEFINITION     "A data frame used to request either a priority or a preemption service
from a traffic signal controller.  It relates the intersection identifier as well as the
specific request (a value of 0-7 for the request and a value of 0-7 for the strategy
requested).  Additional optional information includes the approach and egress lanes to be
used."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 62 },  -- Intersection-identifier
     { j2735DataElements 71 },  -- IntersectionSignalizedRequest-cancel
     { j2735DataElements 74 },  -- IntersectionSignalizedRequest-number
     { j2735DataElements 70 },  -- IntersectionSignalizedRequest-approach
     { j2735DataElements 73 },  -- IntersectionSignalizedRequest-egress
     { j2735DataElements 205 },  -- Vehicle-class
     { j2735DataElements 72 }  -- IntersectionSignalizedRequest-codeword  }
DATA-TYPE "
        IntersectionSignalizedRequest ::= SEQUENCE {
    id  Intersection-identifier,
    isCancel   IntersectionSignalizedRequest-cancel OPTIONAL,
    requestedAction    IntersectionSignalizedRequest-number,
    inLane     IntersectionSignalizedRequest-approach OPTIONAL,
    outLane    IntersectionSignalizedRequest-egress OPTIONAL,
    type       Vehicle-class OPTIONAL,
    codeword   IntersectionSignalizedRequest-codeword OPTIONAL,    ... }  "}
```

5.3.1.66 intersectionSignalizedRequestEnd

```
intersectionSignalizedRequestEnd ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedRequestEnd:frame"
ASN-NAME "IntersectionSignalizedRequestEnd"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 66 }
DEFINITION     "A data frame that represents the time in the near future when
preferential service at a signalized intersection is requested to end.  This is typically
the approximate time that the requester expects to have exited the intersection.  This
data frame is a compound representation of time consisting of finite-length sequences of
integers (not characters) of the form: 'hh, mm, ss (sss+) (offset)' - as defined below.
Because the length of each element is known, no inner element tagging is used in some
forms of transmission.  Tagging is used in this instance.  In DSRC applications there is
no need to send the offset representing the local time zone, so the most common
representation for the data frame occupies 4 payload bytes (12 bytes with all tagging) and
provides a resolution of one millisecond over a range of one day."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "This data frame is represented as follows:
  -- hour    -- 1 byte
  -- minute  -- 1 byte
  -- second  -- 2 bytes"
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 46 }  -- DTime   }
DATA-TYPE "
        IntersectionSignalizedRequestEnd ::= DTime  "}
```

5.3.1.67 intersectionSignalizedRequestTime

```
intersectionSignalizedRequestTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedRequestTime:frame"
ASN-NAME "IntersectionSignalizedRequestTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 67 }
DEFINITION     "A data frame that represents the time in the near future when
preferential service at a signalized intersection is requested to begin.  This is
typically approximately the time before the requester expects to enter the intersection.
This data frame is a compound representation of time consisting of finite-length sequences
of integers (not characters) of the form: 'hh, mm, ss (sss+) (offset)' - as defined below.
 Because the length of each element is known, no inner element tagging is used in some
forms of transmission.  Tagging is used in this instance.  In DSRC applications there is
no need to send the offset representing the local time zone, so the most common
representation for the data frame occupies 4 payload bytes (12 bytes with all tagging) and
provides a resolution of one millisecond over a range of one day."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "This data frame is represented as follows:
  -- hour    -- 1 byte
  -- minute  -- 1 byte
  -- second  -- 2 bytes"
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 46 }  -- DTime  }
DATA-TYPE "
        IntersectionSignalizedRequestTime ::= DTime  "}
```

5.3.1.68 lane

```
lane ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Lane:frame"
ASN-NAME "Lane"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 68 }
DEFINITION     "A data frame that describes a travel lane, including its identifier, its
path and its characteristics.  It includes the node list that provides a detailed set of
offset values to map the path of the lane.  The lane width shall be absent if the width of
the lane is defined by the default lane width in the parent structure (e.g., the
intersection data frame)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 69 },  -- LaneAttributes
     { j2735DataFrames 96 },  -- Path
     { j2735DataFrames 71 },  -- LaneConnections
     { localDataFrames lane(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 76 },  -- Lane-number
     { j2735DataElements 81 }  -- Lane-width  }
DATA-TYPE "
        Lane ::= SEQUENCE {
    laneNumber Lane-number,
    laneWidth  Lane-width OPTIONAL,
    laneAttributes     LaneAttributes,
    nodeList   Path,
    connectsTo LaneConnections OPTIONAL,
    locallane  LOCAL.Lane OPTIONAL,    ... }  "}
```

5.3.1.69 laneAttributes

```
laneAttributes ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "LaneAttributes:frame"
ASN-NAME "LaneAttributes"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 69 }
DEFINITION     "A data frame used to define the type of lane, such as if there are
restrictions on vehicle type, type of pedestrians, or type of movements allowed."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 80 },  -- Lane-vehicle-attributes
     { j2735DataElements 78 },  -- Lane-segment-attributes
     { j2735DataElements 75 },  -- Lane-crosswalk-attributes
     { j2735DataElements 79 }  -- Lane-special-attributes  }
DATA-TYPE "
        LaneAttributes ::= CHOICE
{
    vehicleAttributes  Lane-vehicle-attributes,
    segmentAttributes  Lane-segment-attributes,
    crosswalkAttributes       Lane-crosswalk-attributes,
    specialAttributes  Lane-special-attributes}  "}
```

5.3.1.70 laneConnection

```
laneConnection ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "LaneConnection:frame"
ASN-NAME "LaneConnection"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 70 }
DEFINITION     "A data frame used in lane descriptions to provide a sequence of other
defined lanes to which this lane connects.  The cited lane (a byte) must be of the same
general type (vehicle lanes connect to other vehicle lanes, pedestrian lanes connect to
other pedestrian lanes, etc.).  Each lane number is followed by a data element (also a
byte) which defines how this lane is used by the subject lane (i.e., it is the lane one
would turn into when making a left hand turn lane).  The transmitted number of octets is
always an even number."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "The assignment of lanes in this data frame shall start with the left most lane
from the vehicle perspective (the u-turn lane in some cases) followed by subsequent lanes
in a clockwise assignment order.  Therefore, the right most lane to which this lane
connects would always be listed last.  Note that this order is observed regardless of
which side of the road vehicles use.  If this structure is used in the lane description,
then all valid lanes to which the subject lane connects shall be listed."
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 82 },  -- LaneConnection-destination-lane
     { j2735DataElements 83 }  -- LaneConnection-maneuver  }
DATA-TYPE "
        LaneConnection ::= SEQUENCE {
    destination LaneConnection-destination-lane,
    maneuver    LaneConnection-maneuver,    ... }  "}
```

5.3.1.71 laneConnections

```
laneConnections ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "LaneConnections:frame"
ASN-NAME "LaneConnections"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 71 }
DEFINITION     "This data frame defines the possible destination lanes for each given
maneuver from an approach lane at an intersection."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 70 }  -- LaneConnection  }
DATA-TYPE "
        LaneConnections ::= SEQUENCE (SIZE(1..32)) OF LaneConnection"}
```

5.3.1.72 location

```
location ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Location:frame"
ASN-NAME "Location"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 72 }
DEFINITION     "This data frame provides a geographic location with a timestamp to the
millisecond and accuracy.  The calling data frame should specify which optional fields
should be included."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 76 },  -- LocationTime
     { j2735DataFrames 73 }  -- LocationAccuracy  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 85 },  -- Location-latitude
     { j2735DataElements 86 },  -- Location-longitude
     { j2735DataElements 84 },  -- Location-elevation
     { j2735DataElements 88 }  -- Location-secMark  }
DATA-TYPE "
        Location ::= SEQUENCE {
    latitude   Location-latitude,
    longitude  Location-longitude,
    elevation  Location-elevation OPTIONAL,
    time       LocationTime OPTIONAL,
    secMark    Location-secMark OPTIONAL,
    accuracy   LocationAccuracy OPTIONAL,    ... }  "}
```

5.3.1.73 locationAccuracy

```
locationAccuracy ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "LocationAccuracy:frame"
ASN-NAME "LocationAccuracy"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 73 }
DEFINITION     "A data frame consisting of various parameters of quality used to model
the accuracy of the positional determination with respect to each given axis."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 89 },  -- LocationAccuracy-major
     { j2735DataElements 90 },  -- LocationAccuracy-minor
     { j2735DataElements 91 }  -- LocationAccuracy-orientation  }
```

```
DATA-TYPE "
        LocationAccuracy ::= SEQUENCE {
    major      LocationAccuracy-major,
    minor      LocationAccuracy-minor,
    orientation LocationAccuracy-orientation }"}
```

5.3.1.74 locationMark

```
locationMark ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "LocationMark:frame"
ASN-NAME "LocationMark"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 75 }
DEFINITION     "A data frame that defines a definitive and precise location with a
second-based timestamp."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 88 },  -- Location-secMark
     { j2735DataElements 85 },  -- Location-latitude
     { j2735DataElements 86 },  -- Location-longitude
     { j2735DataElements 84 }  -- Location-elevation  }
DATA-TYPE "
        LocationMark ::= SEQUENCE {
    secMark    Location-secMark,
    latitude   Location-latitude,
    longitude  Location-longitude,
    elevation  Location-elevation }"}
```

5.3.1.75 locationTime

```
locationTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "LocationTime:frame"
ASN-NAME "LocationTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 76 }
DEFINITION     "This data frame is a timestamp indicating the time to the second that the
location was determined."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 46 }  -- DTime  }
DATA-TYPE "
        LocationTime ::= DTime  "}
```

5.3.1.76 mapData

```
mapData ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "MapData:frame"
ASN-NAME "MapData"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 77 }
DEFINITION     "A data frame is used to describe some portion of the transportation
network.  This includes such items as complex intersection descriptions (used with the
sPAT message), high speed curve outlines (used in curve safety alerts), and segment of
roadway (used in platoon applications).  This data frame typically shall be contained
within a dSRCMessage.  If this data frame is contained within a dSRCMessage, the msgCnt
field shall be present.  The data frame shall include the intersection and segment fields
as needed to accurately describe the intended map."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the mapData (MAP) message when contained within a dSRCMessage."
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 78 },  -- MapIntersections
     { j2735DataFrames 79 },  -- MapSegments
     { localDataFrames mapData(1) }  }
DATA-TYPE "
        MapData ::= SEQUENCE {
    intersections      MapIntersections OPTIONAL,
    segments   MapSegments OPTIONAL,
    localMapdata       LOCAL.MapData OPTIONAL,    ... }  "}
```

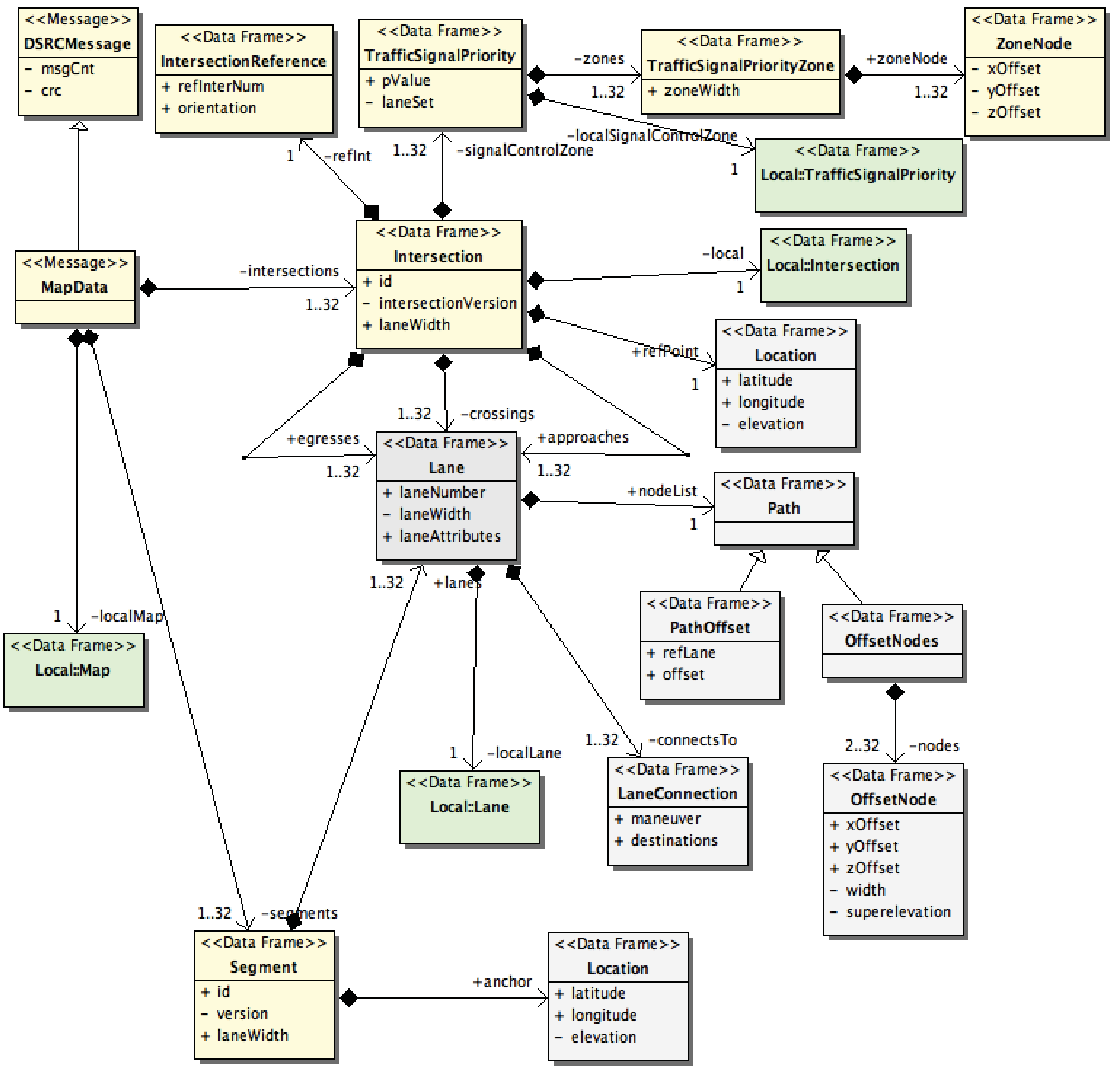


FIGURE 37 - DATA MODEL - mapData

5.3.1.77 mapIntersections

```
mapIntersections ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "MapIntersections:frame"
ASN-NAME "MapIntersections"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 78 }
DEFINITION     "A data frame that defines the physical attributes of the intersections
included in a single mapData message."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 53 }  -- Intersection  }
DATA-TYPE "
        MapIntersections ::= SEQUENCE (SIZE(1..32)) OF Intersection"}
```

5.3.1.78 mapSegments

```
mapSegments ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "MapSegments:frame"
ASN-NAME "MapSegments"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 79 }
DEFINITION     "A data frame the defines the physical attributes of the roadway segments
included in a single mapData message."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 119 }  -- Segment  }
DATA-TYPE "
        MapSegments ::= SEQUENCE (SIZE(1..32)) OF Segment"}
```

5.3.1.79 maydayMessage

```
maydayMessage ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "MaydayMessage:frame"
ASN-NAME "MaydayMessage"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 80 }
DEFINITION     "A data frame containing the contents of a vehicle's mayday message
indicating that the vehicle and/or its occupant(s) are in distress and may be in need of
assistance.  This data frame is contained within a dSRCMessage and includes the location
of the distressed vehicle, the time the vehicle first detected the distress and the sensor
reading(s) that may indicate the type of incident or assistance needed."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the mayday message when contained within a dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 81 },  -- MaydayPosition
     { j2735DataFrames 82 },  -- MaydayTime
     { j2735DataFrames 171 },  -- VehicleModel
     { j2735DataFrames 52 },  -- HazmatList
     { j2735DataFrames 102 },  -- PlacardList
     { localDataFrames maydayMessage(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 92 },  -- Mayday-identifier
     { j2735DataElements 93 },  -- Mayday-type
     { j2735DataElements 194 }  -- Vehicle-airbags-deployed  }
```

```
DATA-TYPE "
        MaydayMessage ::= SEQUENCE {
    id  Mayday-identifier,
    position    MaydayPosition,
    time        MaydayTime,
    type        Mayday-type,
    airbags     Vehicle-airbags-deployed OPTIONAL,
    model       VehicleModel OPTIONAL,
    hazmat      HazmatList OPTIONAL,
    placards    PlacardList OPTIONAL,
    localMaydayMessage LOCAL.MaydayMessage OPTIONAL,    ... }  "}
```

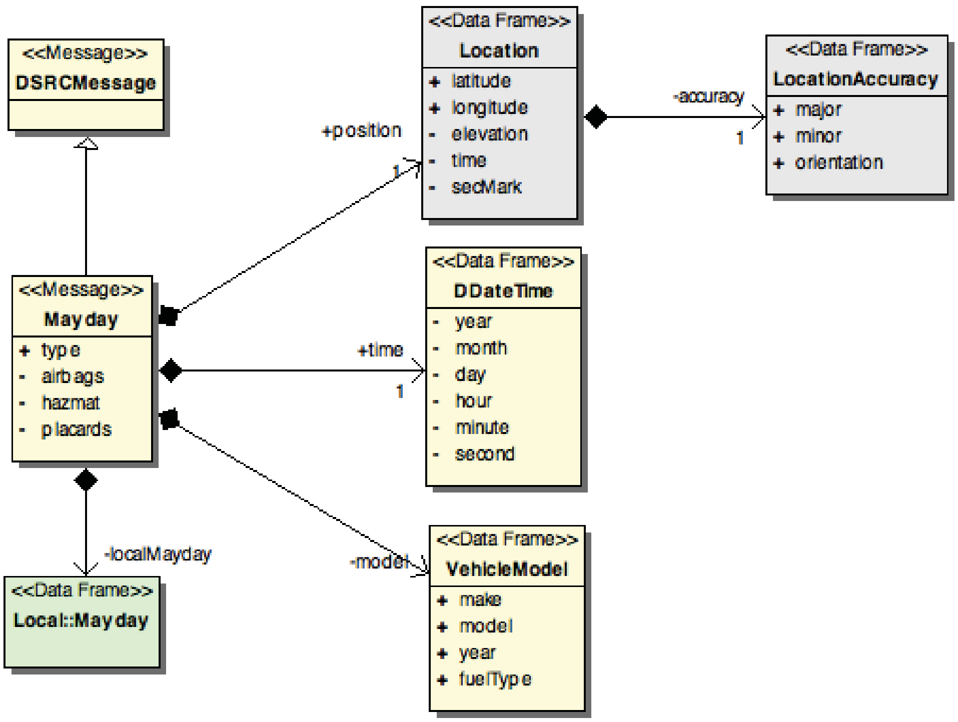


FIGURE 38 - DATA MODEL - maydayMessage

5.3.1.80 maydayPosition

```
maydayPosition ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "MaydayPosition:frame"
ASN-NAME "MaydayPosition"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 81 }
DEFINITION     "This data frame is the OER-encoding of the location data frame in the
WGS-84 coordinate system that is used to define the location of the vehicle that is
transmitting the mayday message.  The elevation is included, while the date, time and
secMark fields of the location data frame shall not be present.  The accuracy field of the
location data frame is optional."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer   }
DATA-TYPE "
        MaydayPosition ::= Location-oer  "}
```

5.3.1.81 maydayTime

```
maydayTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "MaydayTime:frame"
ASN-NAME "MaydayTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 82 }
DEFINITION     "This data frame indicates the date and time that a connected device
begins to broadcast a mayday message.  All elements of the DDateTime data frame shall be
present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 34 }  -- DDateTime  }
DATA-TYPE "
        MaydayTime ::= DDateTime  "}
```

5.3.1.82 motorCarrierLicense

```
motorCarrierLicense ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "MotorCarrierLicense:frame"
ASN-NAME "MotorCarrierLicense"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 83 }
DEFINITION     "This data frame defines a registered license for the entity that owns the
vehicle, or the entity that is leasing and is responsible for the vehicle.  The entity may
be a company or a person."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "In the United States, companies that operate commercial vehicles transporting
passengers or hauling cargo in interstate commerce must be registered with the FMCSA and
must have a USDOT Number.  In addition, in some states, all registrants of commercial
motor vehicles, even intrastate and non-Motor Carrier registrants, are required to obtain
a USDOT Number as a necessary condition for commercial vehicle registration."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 112 }  -- Registration  }
DATA-TYPE "
        MotorCarrierLicense ::= Registration  "}
```

5.3.1.83 motorCarrierLicenses

```
motorCarrierLicenses ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "MotorCarrierLicenses:frame"
ASN-NAME "MotorCarrierLicenses"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 84 }
DEFINITION     "This data frame defines a list of registered licenses for the motor
carrier.  The registration may be the owner of the commercial motor vehicle or the
lessee."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 83 }  -- MotorCarrierLicense  }
DATA-TYPE "
        MotorCarrierLicenses ::= SEQUENCE (SIZE(1..8)) OF MotorCarrierLicense"}
```

5.3.1.84 namedRegistration

```
namedRegistration ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "NamedRegistration:frame"
ASN-NAME "NamedRegistration"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 85 }
DEFINITION     "This data frame defines a name coupled with a list of registered licenses
for the named entity."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 84 }  -- MotorCarrierLicenses  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 226 }  -- Vehicle-owner-name  }
DATA-TYPE "
        NamedRegistration ::= SEQUENCE {
    name       Vehicle-owner-name,
    license    MotorCarrierLicenses OPTIONAL,    ... }  "}
```

5.3.1.85 nMEACorrections

```
nMEACorrections ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "NMEACorrections:frame"
ASN-NAME "NMEACorrections"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 86 }
DEFINITION     "A data frame used to encapsulate NMEA 183 style differential corrections
for GPS radio navigation signals as defined by the NMEA (National Marine Electronics
Association) committee in its Protocol 0183 standard.   Here, in the work of DSRC, these
messages are 'wrapped' for transport on the DSRC media, and then can be re-constructed
back into the final expected formats defined by the NMEA standard and used directly by GPS
positioning systems to increase the absolute and relative accuracy estimates produced.
This data frame typically shall be contained within a dSRCMessage."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the nMEA_Corrections (NMEA) message when contained within a dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 97 },  -- NMEA-Revision
     { j2735DataElements 95 },  -- NMEA-MsgType
     { j2735DataElements 271 },  -- WdCount
     { j2735DataElements 96 }  -- NMEA-Payload  }
DATA-TYPE "
        NMEACorrections ::= SEQUENCE {
    rev NMEA-Revision,
    msg NMEA-MsgType,
    wdCount    WdCount,
    payload    NMEA-Payload,    ... }  "}
```

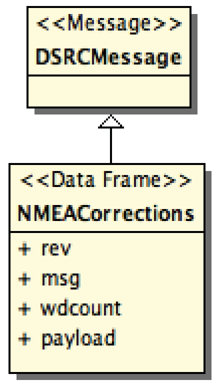


FIGURE 39 - DATA MODEL - nMEACorrections

5.3.1.86 obstacle

```
obstacle ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Obstacle:frame"
ASN-NAME "Obstacle"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 87 }
DEFINITION     "A data frame that provides information about obstacles in the roadway
that may be detected by a device's sensors."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 34 }  -- DDateTime  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 99 },  -- Obstacle-distance
     { j2735DataElements 98 }  -- Obstacle-direction  }
DATA-TYPE "
        Obstacle ::= SEQUENCE {
    obDist     Obstacle-distance,
    obDirect   Obstacle-direction,
    dateTime   DDateTime,    ... }  "}
```

5.3.1.87 parkingInformation

```
parkingInformation ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ParkingInformation:frame"
ASN-NAME "ParkingInformation"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 88 }
DEFINITION     "A data frame containing parking availability information at a parking
facility.  Typically used for commercial motor vehicles, this data frame provides parking
information such as number of parking spaces available by size, and availability time."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 89 },  -- ParkingInformationTimeUpdate
     { j2735DataFrames 90 },  -- ParkingLocation
     { j2735DataFrames 93 }  -- ParkingSpacesList  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 100 }  -- ParkingInformation-description  }
```

```
DATA-TYPE "
        ParkingInformation ::= SEQUENCE {
    timeUpdate  ParkingInformationTimeUpdate,
    location    ParkingLocation,
    description ParkingInformation-description OPTIONAL,
    spaces      ParkingSpacesList,    ... }  "}
```

5.3.1.88 parkingInformationTimeUpdate

```
parkingInformationTimeUpdate ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ParkingInformationTimeUpdate:frame"
ASN-NAME "ParkingInformationTimeUpdate"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 89 }
DEFINITION     "A data frame representing the date and time the parking information was
last updated.  This data frame is sent so the receiver of the information may know the
timeliness of the parking information received.  The full time is defined as a compound
value consisting of finite-length sequences of integers (not characters) of the form:
'yyyy, mm, dd, hh, mm'."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "year       -- 2 bytes
  month   -- 1 byte
  day     -- 1 byte
  hour    -- 1 byte
  minute  -- 1 byte"
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 35 }  -- DFullTime  }
DATA-TYPE "
        ParkingInformationTimeUpdate ::= DFullTime  "}
```

5.3.1.89 parkingLocation

```
parkingLocation ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ParkingLocation:frame"
ASN-NAME "ParkingLocation"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 90 }
DEFINITION     "This data frame is the OER-encoding of the location data frame in the
WGS-84 coordinate system that is used to define the location of the parking facility.  The
elevation field is of the location data frame is optional, while the date, time, secMark
and accuracy fields of the location data frame shall not be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
        ParkingLocation ::= Location-oer  "}
```

5.3.1.90 parkingSpaces

```
parkingSpaces ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ParkingSpaces:frame"
ASN-NAME "ParkingSpaces"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 91 }
DEFINITION     "A data frame to indicate the number of parking spaces available for a
specific parking space size."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 94 },  -- ParkingSpacesSize
     { j2735DataFrames 92 },  -- ParkingSpacesFromTime
     { j2735DataFrames 95 }  -- ParkingSpacesToTime  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 101 }  -- ParkingSpaces-available  }
DATA-TYPE "
        ParkingSpaces ::= SEQUENCE {
    numberAvailable    ParkingSpaces-available,
    size        ParkingSpacesSize,
    fromTime    ParkingSpacesFromTime OPTIONAL,
    toTime      ParkingSpacesToTime OPTIONAL,    ... }  "}
```

5.3.1.91 parkingSpacesFromTime

```
parkingSpacesFromTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ParkingSpacesFromTime:frame"
ASN-NAME "ParkingSpacesFromTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 92 }
DEFINITION     "A data frame that provides the time one or more parking spaces, by
maximum vehicle size, will be available.  This may be the time a parking facility opens,
or if a reservation for a parking space expires."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 35 }  -- DFullTime  }
DATA-TYPE "
        ParkingSpacesFromTime ::= DFullTime  "}
```

5.3.1.92 parkingSpacesList

```
parkingSpacesList ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ParkingSpacesList:frame"
ASN-NAME "ParkingSpacesList"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 93 }
DEFINITION     "A data frame indicating the number of parking spaces available based on
the parking space size."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 91 }  -- ParkingSpaces  }
DATA-TYPE "
        ParkingSpacesList ::= SEQUENCE (SIZE(1..32)) OF ParkingSpaces"}
```

5.3.1.93 parkingSpacesSize

```
parkingSpacesSize ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ParkingSpacesSize:frame"
ASN-NAME "ParkingSpacesSize"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 94 }
DEFINITION     "A data frame representing the parking space size, by length and width in
a three byte value.  This data frame is typically used with traveler information messages
providing parking space availability information at a parking facility."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 103 },  -- ParkingSpace-width
     { j2735DataElements 102 }  -- ParkingSpace-length  }
```

```
DATA-TYPE "
        ParkingSpacesSize ::= SEQUENCE {
    width       ParkingSpace-width,
    length      ParkingSpace-length,    ... }  "}
```

5.3.1.94 parkingSpacesToTime

```
parkingSpacesToTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ParkingSpacesToTime:frame"
ASN-NAME "ParkingSpacesToTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 95 }
DEFINITION     "A data frame that provides the time one or more parking spaces, by
maximum vehicle size, will no longer be available.  This may be the time a parking
facility closes, or a reservation for a parking space begins."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 35 }  -- DFullTime  }
DATA-TYPE "
        ParkingSpacesToTime ::= DFullTime  "}
```

5.3.1.95 path

```
path ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Path:frame"
ASN-NAME "Path"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 96 }
DEFINITION     "This data frame defines the precise path of a travel lane in one of two
formats; either as a sequence of nodes or an offset from a previously defined path."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 100 },  -- PathNodes
     { j2735DataFrames 101 }  -- PathOffset  }
DATA-TYPE "
        Path ::= CHOICE
{
    nodes       PathNodes,
    parallel    PathOffset}  "}
```

5.3.1.96 pathHistoryPointType01

```
pathHistoryPointType01 ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "PathHistoryPointType01:frame"
ASN-NAME "PathHistoryPointType01"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 97 }
DEFINITION     "A data frame containing a connected device's prior position data.  In
use, sequences of this data set are sent (one per data point),  In this data frame each
element is delimited by tags, in other variants the data is expressed in a single octet
blob.  See vehiclePathHistory for a complete definition."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "PathHistoryPointType-01 ::= SEQUENCE {
  vehiclePathPoint-latitude-offset  INTEGER (-131072..131071),
  vehiclePathPoint-longitude-offset INTEGER (-131072..131071),
  vehiclePathPoint-elevation-offset INTEGER (-2048..2047),
  time-offset INTEGER (1..65535),
  locationAccuracy OPTIONAL,
    -- four packed bytes
  vehicle-heading-history    INTEGER (-128..127) OPTIONAL,
```

```
    -- not an offset value
  vehicleMovement OPTIONAL
    -- upper bits encode transmission
    -- where the LSB is in units of 0.02 m/s
    -- not an offset value
   }"
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 73 },  -- LocationAccuracy
     { j2735DataFrames 172 }  -- VehicleMovement  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 264 },  -- VehiclePathPoint-latitude-offset
     { j2735DataElements 265 },  -- VehiclePathPoint-longitude-offset
     { j2735DataElements 263 },  -- VehiclePathPoint-elevation-offset
     { j2735DataElements 167 },  -- Time-offset
     { j2735DataElements 214 }  -- Vehicle-heading-history  }
DATA-TYPE "
        PathHistoryPointType01 ::= SEQUENCE {
    latOffset  VehiclePathPoint-latitude-offset,
    longOffset VehiclePathPoint-longitude-offset,
    elevationOffset    VehiclePathPoint-elevation-offset,
    timeOffset Time-offset,
    posAccuracy LocationAccuracy OPTIONAL,
    heading    Vehicle-heading-history OPTIONAL,
    speed      VehicleMovement OPTIONAL,    ... }  "}
```

5.3.1.97 pathHistoryPointType01List

```
pathHistoryPointType01List ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "PathHistoryPointType01List:frame"
ASN-NAME "PathHistoryPointType01List"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 98 }
DEFINITION     "A data frame that is a set of points containing the connected device's
prior position data.  See vehiclePathHistory for a complete definition."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 97 }  -- PathHistoryPointType01  }
DATA-TYPE "
        PathHistoryPointType01List ::= SEQUENCE (SIZE(1..23)) OF PathHistoryPointType01"}
```

5.3.1.98 pathNode

```
pathNode ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "PathNode:frame"
ASN-NAME "PathNode"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 99 }
DEFINITION     "This data frame defines a point along the centerline of a travel lane.
Each point is a set of signed offset values for determining the latitude and longitude
(and, optionally elevation) using the then current reference point.   Each subsequent set
of offset values (node) is additive and is the offset from the last point.  The offset
values (nodes) representing the path of the travel lane shall be selected such that the
perpendicular distance between the centerline of the travel lane and the straight line
connecting the two consecutive nodes is less than 1 meter.  This data frame optionally
includes the superelevation, or the slope across the width of the lane."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Note that while latitude and longitude and elevation values are provided in the
reference point with respect to the common geoid, these offsets are given in absolute
distance (units of 1.0 cm) of offset.  When a value for pathNode-width is given, that
value persists until changed again for additional nodes in the list."
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 106 },  -- PathNode-x-offset
     { j2735DataElements 107 },  -- PathNode-y-offset
     { j2735DataElements 108 },  -- PathNode-z-offset
     { j2735DataElements 105 },  -- PathNode-width
     { j2735DataElements 104 }  -- PathNode-superelevation  }
DATA-TYPE "
        PathNode ::= SEQUENCE {
    xOffset    PathNode-x-offset,
    yOffset    PathNode-y-offset,
    zOffset    PathNode-z-offset,
    width      PathNode-width OPTIONAL,
    superelevation     PathNode-superelevation OPTIONAL,    ... }  "}
```

5.3.1.99 pathNodes

```
pathNodes ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "PathNodes:frame"
ASN-NAME "PathNodes"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 100 }
DEFINITION     "This data frame consists of a sequence of offset values used to describe
a precise path of a travel lane, which may include crossings."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 99 }  -- PathNode  }
DATA-TYPE "
        PathNodes ::= SEQUENCE (SIZE(1..64)) OF PathNode"}
```

5.3.1.100 pathOffset

```
pathOffset ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "PathOffset:frame"
ASN-NAME "PathOffset"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 101 }
DEFINITION     "This data frame defines the precise path of a parallel travel lane by
defining an offset from a previously defined travel lane (reference lane)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 110 },  -- PathOffset-reference-lane
     { j2735DataElements 109 }  -- PathOffset-lateral-offset  }
DATA-TYPE "
        PathOffset ::= SEQUENCE {
    refLane    PathOffset-reference-lane,
    offset     PathOffset-lateral-offset,    ... }  "}
```

5.3.1.101 placardList

```
placardList ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "PlacardList:frame"
ASN-NAME "PlacardList"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 102 }
DEFINITION     "A data frame that provides a series of placard codes, which identifies
the placards currently being displayed on the vehicle.  Typically transmitted by a
commercial motor vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 15 }  -- Cmv-placard-identifier  }
DATA-TYPE "
        PlacardList ::= SEQUENCE (SIZE(1..8)) OF Cmv-placard-identifier"}
```

5.3.1.102 polygon

```
polygon ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Polygon:frame"
ASN-NAME "Polygon"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 103 }
DEFINITION     "A data frame used to define a geographic area in the form of a polygon
within which a message or traveler information item is valid.  The polygon area is defined
by a series of offset points that together form the boundary of the geographic area."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 104 },  -- PolygonAnchor
     { j2735DataFrames 106 }  -- PolygonOffsetNodes  }
DATA-TYPE "
        Polygon ::= SEQUENCE {
    anchor     PolygonAnchor OPTIONAL,
    nodes      PolygonOffsetNodes,    ... }  "}
```

5.3.1.103 polygonAnchor

```
polygonAnchor ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "PolygonAnchor:frame"
ASN-NAME "PolygonAnchor"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 104 }
DEFINITION     "This data frame is the OER-encoding of the location data frame in the
WGS-84 coordinate system that is used to define a point from which offset values are used
to create additional points that define the boundaries of a geometric area within which a
message or traveler information item is valid.  The elevation field is of the location
data frame shall be present.  The date, time, secMark and accuracy fields of the location
data frame shall not be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
        PolygonAnchor ::= Location-oer  "}
```

5.3.1.104 polygonOffsetNode

```
polygonOffsetNode ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "PolygonOffsetNode:frame"
ASN-NAME "PolygonOffsetNode"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 105 }
DEFINITION     "A data frame that provides one set of signed offset values (and
optionally elevation) that defines one point of the perimeter of a geographic area within
which a message or traveler information item is valid.  This set of offset values are the
offset from an anchor point."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 114 },  -- PolygonOffsetNode-x-offset
     { j2735DataElements 115 },  -- PolygonOffsetNode-y-offset
     { j2735DataElements 116 },  -- PolygonOffsetNode-z-offset
     { j2735DataElements 117 }  -- PolygonOffsetNode-z-tolerance  }
DATA-TYPE "
        PolygonOffsetNode ::= SEQUENCE {
    xOffset    PolygonOffsetNode-x-offset,
    yOffset    PolygonOffsetNode-y-offset,
    zOffset    PolygonOffsetNode-z-offset OPTIONAL,
    zTolerance PolygonOffsetNode-z-tolerance OPTIONAL,    ... }  "}
```

5.3.1.105 polygonOffsetNodes

```
polygonOffsetNodes ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "PolygonOffsetNodes:frame"
ASN-NAME "PolygonOffsetNodes"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 106 }
DEFINITION     "A data frame that provides a sequence of signed offset values to define a
geographic area within which a message or traveler information item is valid.  Each set of
signed offset value (and optionally, elevation) represents a point (node) on the perimeter
of the geographic area.  The vertices between this sequence of nodes defines the perimeter
of the polygon that forms the geographic area.  Each set of offset values are the offset
from an anchor point."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 105 }  -- PolygonOffsetNode  }
DATA-TYPE "
        PolygonOffsetNodes ::= SEQUENCE (SIZE(1..64)) OF PolygonOffsetNode"}
```

5.3.1.106 probeDataManagement

```
probeDataManagement ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ProbeDataManagement:frame"
ASN-NAME "ProbeDataManagement"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 107 }
DEFINITION     "A data frame used to temporarily control the data collection policies of
connected devices to the local RSU.  This data frame typically shall be contained within a
dSRCMessage."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the probeDataManagement (PDM) message when contained within a
dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 108 },  -- ProbeSample
     { j2735DataFrames 109 },  -- ProbeTermination
     { j2735DataFrames 131 },  -- SnapshotControl
     { j2735DataFrames 139 },  -- SnapshotStop
     { j2735DataFrames 137 }  -- SnapshotRequests  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 118 },  -- Probe-orientation
     { j2735DataElements 120 }  -- Probe-transmission-interval  }
DATA-TYPE "
        ProbeDataManagement ::= SEQUENCE {
    sample     ProbeSample,
    directions Probe-orientation OPTIONAL,
    term       ProbeTermination,
    snapshot   SnapshotControl,
    txInterval Probe-transmission-interval OPTIONAL,
    stopThreshold      SnapshotStop OPTIONAL,
    dataElements       SnapshotRequests,    ... }  "}
```

5.3.1.107 probeSample

```
probeSample ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ProbeSample:frame"
ASN-NAME "ProbeSample"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 108 }
DEFINITION     "A data frame that allows the probeDataManagement message to apply its
settings to a random sample of connected devices (all devices within the stated range).
This uses the last two digits of the connected device's MAC address.  If the current PSN
falls between these two (2) values, then the Probe Data Management policy should be
applied.   The numbers are inclusive, e.g., using 0x10 and 0x20 would provide a 1/16th
sample and the values 0x00 and 0x80 would provide a 50% sample."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 122 },  -- ProbeSample-start
     { j2735DataElements 121 }  -- ProbeSample-end  }
DATA-TYPE "
        ProbeSample ::= SEQUENCE {
    sampleStart ProbeSample-start,
    sampleEnd   ProbeSample-end,    ... }  "}
```

5.3.1.108 probeTermination

```
probeTermination ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ProbeTermination:frame"
ASN-NAME "ProbeTermination"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 109 }
DEFINITION     "A data frame to ensure that the data collection policies set by a probe
data management message to a connected device revert back from managed settings to the
default settings.  This data frame sets the termination policy based either on distance or
time."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 124 },  -- ProbeTermination-time
     { j2735DataElements 123 }  -- ProbeTermination-distance  }
DATA-TYPE "
        ProbeTermination ::= CHOICE
{
    termTime   ProbeTermination-time,
    termDistance       ProbeTermination-distance}  "}
```

5.3.1.109 probeVehicleData

```
probeVehicleData ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ProbeVehicleData:frame"
ASN-NAME "ProbeVehicleData"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 110 }
DEFINITION     "A data frame used to transmit vehicle status to an RSU to allow the
collection of information about typical vehicle traveling behaviors.  This data frame
typically shall be contained within a dSRCMessage.  In typical use the reporting vehicle
has collected one or more snapshots which it will send to a receiving RSU along with
information (the vector) about the point in time and space when the snapshot occurred.
Because any sequence of snapshots are related within a limit range of time and space, some
data compression may be used in the message to reduce redundant information."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the probeVehicleData (PVD) message when contained within a dSRCMessage."
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 166 },  -- VehicleIdentification
     { j2735DataFrames 175 },  -- VehiclePositionMark
     { j2735DataFrames 138 },  -- Snapshots
     { localDataFrames probeVehicleData(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 119 },  -- Probe-segment-number
     { j2735DataElements 240 }  -- Vehicle-type  }
DATA-TYPE "
        ProbeVehicleData ::= SEQUENCE {
    probeSegmentNumber Probe-segment-number,
    vehicleIdent       VehicleIdentification OPTIONAL,
    position   VehiclePositionMark,
    vehicleType Vehicle-type OPTIONAL,
    snapshots  Snapshots,
    localProbeVehicleData      LOCAL.ProbeVehicleData OPTIONAL,    ... }  "}
```

5.3.1.110 region

```
region ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Region:frame"
ASN-NAME "Region"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 111 }
DEFINITION     "A data frame used to define a geographic area and orientation of the
connected device that a message or traveler information item is valid for."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 4 }  -- Area  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 125 }  -- Region-orientation  }
DATA-TYPE "
        Region ::= SEQUENCE {
    direction  Region-orientation OPTIONAL,
    area       Area,    ... }  "}
```

5.3.1.111 registration

```
registration ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Registration:frame"
ASN-NAME "Registration"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 112 }
DEFINITION     "A data frame used to indicate a globally unique identifier based on a
country, jurisdiction, and registration number. The jurisdiction shall always be included
where applicable, but shall be omitted if the country assigns the identifier directly
without any jurisdictional code."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 127 },  -- Registration-identifier
     { j2735DataElements 128 },  -- Registration-jurisdiction
     { j2735DataElements 126 }  -- Registration-country  }
DATA-TYPE "
        Registration ::= SEQUENCE {
    identifier Registration-identifier,
    jurisdiction       Registration-jurisdiction OPTIONAL,
    country    Registration-country,    ... }  "}
```

5.3.1.112 roadsignIdentifier

```
roadsignIdentifier ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "RoadsignIdentifier:frame"
ASN-NAME "RoadsignIdentifier"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 113 }
DEFINITION     "A data frame used as a message identifier for a roadsign message, and
consists of the physical roadsign's geographic location, orientation and optionally, an
MUTCD code."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 114 }  -- RoadsignLocation  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 130 },  -- Roadsign-orientation
     { j2735DataElements 131 }  -- Roadsign-type  }
DATA-TYPE "
        RoadsignIdentifier ::= SEQUENCE {
    position   RoadsignLocation,
    viewAngle  Roadsign-orientation,
    mutcdCode  Roadsign-type OPTIONAL,    ... }  "}
```

5.3.1.113 roadsignLocation

```
roadsignLocation ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "RoadsignLocation:frame"
ASN-NAME "RoadsignLocation"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 114 }
DEFINITION     "This data frame is the OER-encoding of the location data frame in the
WGS-84 coordinate system that is used to define the location of the physical road sign
that the roadsign message represents.  The date, time, secMark, and accuracy fields of the
location data frame shall not be present.  The elevation field of the location data frame
shall be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
        RoadsignLocation ::= Location-oer  "}
```

5.3.1.114 rTCMCorrections

```
rTCMCorrections ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "RTCMCorrections:frame"
ASN-NAME "RTCMCorrections"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 115 }
DEFINITION     "A data frame encapsulating RTCM differential corrections for GPS and
other radio navigation signals as defined by the RTCM (Radio Technical Commission For
Maritime Services) special committee number 104 in its various standards.  These messages
are 'wrapped' for transport, and then can be re-constructed back into the final expected
formats defined by the RTCM standard and used directly by various positioning systems to
increase the absolute and relative accuracy estimates produced.  This data frame typically
shall be contained within a dSRCMessage.  If this data frame is contained within a
dSRCMessage, the msgCnt field shall be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the rTCMCorrections (RTCM) message when contained within a dSRCMessage."
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 51 },  -- FullPositionVector
     { j2735DataFrames 118 },  -- RTCMmsgs
     { localDataFrames rTCM-Corrections(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 135 },  -- RTCM-Revision
     { j2735DataElements 132 }  -- RTCM-header-oer  }
DATA-TYPE "
        RTCMCorrections ::= SEQUENCE {
    rev RTCM-Revision,
    anchorPoint FullPositionVector OPTIONAL,
    rtcmHeader  RTCM-header-oer,
    rtcmSets    RTCMmsgs,
    localrTCM-Corrections      LOCAL.RTCM-Corrections OPTIONAL,     ... }  "}
```

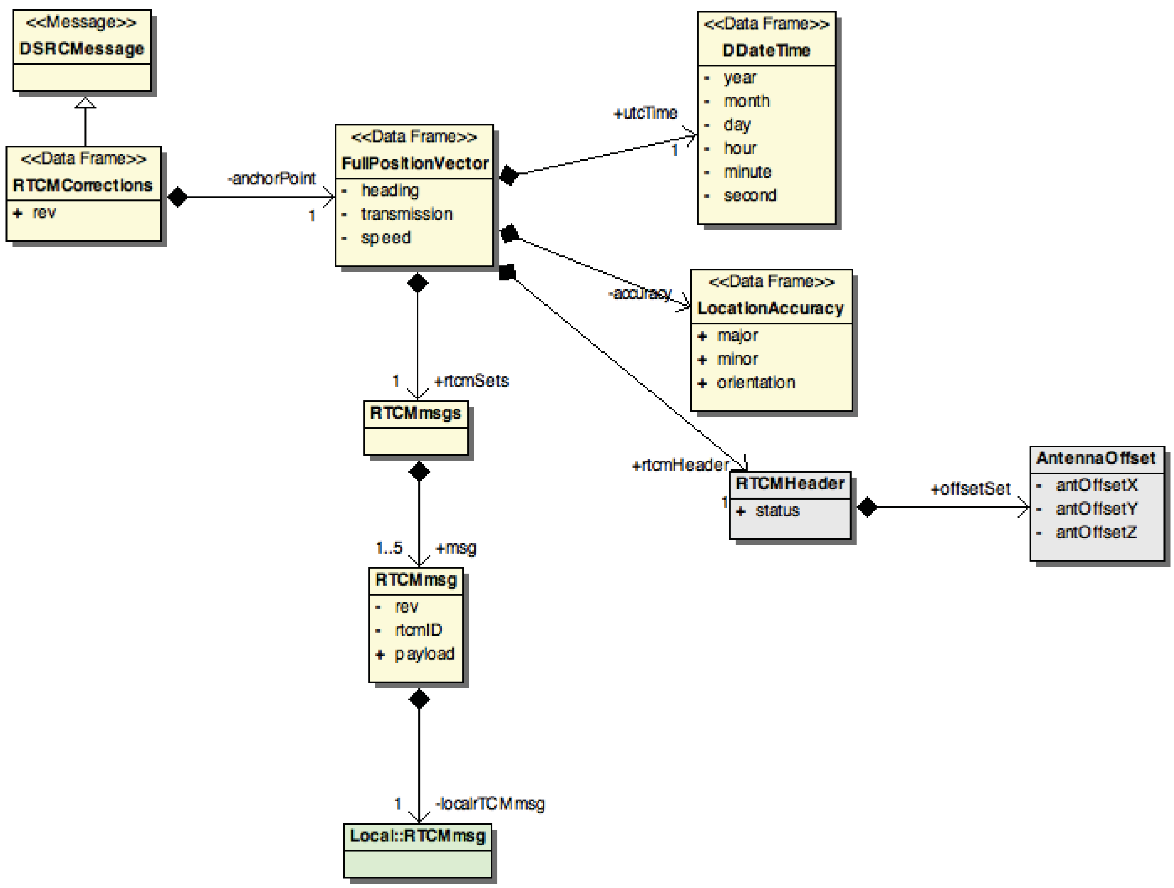


FIGURE 40 - DATA MODEL – rTCMCorrections

5.3.1.115 rTCMHeader

```
rTCMHeader ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "RTCMHeader:frame"
ASN-NAME "RTCMHeader"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 116 }
DEFINITION     "A data frame that is a collection of data values used to convey RTCM
information between users.  It is encoded as an octet blob string."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 3 }  -- AntennaOffset  }
```

```
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 60 }  -- GPSUnit-status  }
DATA-TYPE "
        RTCMHeader ::= SEQUENCE {
    status     GPSUnit-status,
    offsetSet  AntennaOffset,    ... }  "}
```

5.3.1.116 rTCMmsg

```
rTCMmsg ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "RTCMmsg:frame"
ASN-NAME "RTCMmsg"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 117 }
DEFINITION     "A data frame that holds a single complete RTCM message.  The specific
type and structure is provided by the RTCM Revision and RTCM ID data elements, which are
followed by the actual message payload. This data frame is typically used (in a sequence
of) in the RTCM-Corrections message."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { localDataFrames rTCMmsg(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 135 },  -- RTCM-Revision
     { j2735DataElements 133 },  -- RTCM-ID
     { j2735DataElements 134 }  -- RTCM-Payload  }
DATA-TYPE "
        RTCMmsg ::= SEQUENCE {
    rev RTCM-Revision OPTIONAL,
    rtcmID     RTCM-ID OPTIONAL,
    payload    RTCM-Payload,
    localrTCMmsg       LOCAL.RTCMmsg OPTIONAL,    ... }  "}
```

5.3.1.117 rTCMmsgs

```
rTCMmsgs ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "RTCMmsgs:frame"
ASN-NAME "RTCMmsgs"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 118 }
DEFINITION     "A data frame containing a sequence of up to 5 complete RTCM messages
(rTCMmsg)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 117 }  -- RTCMmsg  }
DATA-TYPE "
        RTCMmsgs ::= SEQUENCE (SIZE(1..5)) OF RTCMmsg"}
```

5.3.1.118 segment

```
segment ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Segment:frame"
ASN-NAME "Segment"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 119 }
DEFINITION     "A data frame used to describe the attributes of a roadway segment.  This
includes the roadway segment identifier, and information about the lanes that make up the
roadway segment."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 120 },  -- SegmentAnchor
     { j2735DataFrames 121 }  -- SegmentLanes  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 137 },  -- Segment-identifier
     { j2735DataElements 138 },  -- Segment-version
     { j2735DataElements 136 }  -- Segment-default-lane-width  }
DATA-TYPE "
        Segment ::= SEQUENCE {
    id  Segment-identifier,
    version     Segment-version OPTIONAL,
    refPoint    SegmentAnchor,
    laneWidth   Segment-default-lane-width,
    lanes       SegmentLanes,    ... }  "}
```

5.3.1.119 segmentAnchor

```
segmentAnchor ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SegmentAnchor:frame"
ASN-NAME "SegmentAnchor"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 120 }
DEFINITION     "This data frame is the OER-encoding of the location data frame in the
WGS-84 coordinate system that is used to define the reference point used when defining the
location attributes of a roadway segment.  The date, time, secMark, and accuracy fields of
the location data frame shall not be present. The elevation field of the location data
frame shall be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
        SegmentAnchor ::= Location-oer  "}
```

5.3.1.120 segmentLanes

```
segmentLanes ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SegmentLanes:frame"
ASN-NAME "SegmentLanes"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 121 }
DEFINITION     "This data frame defines the lanes of a roadway segment. The CHOICE lane-
segment-attributes is to be selected in the lane-attributes data frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 77 }  -- Lane-oer  }
DATA-TYPE "
        SegmentLanes ::= SEQUENCE (SIZE(1..32)) OF Lane-oer"}
```

5.3.1.121 serviceAdvertisement

```
serviceAdvertisement ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ServiceAdvertisement:frame"
ASN-NAME "ServiceAdvertisement"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 122 }
DEFINITION     "A data frame containing information including the announcement of the
availability of a service.  Typically broadcasted by an RSU, this data frame indicates
what services are available by the RSU, the location of the RSU, and in the future
instructions to the connected device on how to provide the service information (e.g.,
communications addresses, channels, etc..)."
DESCRIPTIVE-NAME-CONTEXT {""}
```

```
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 123 }  -- ServicePosition  }
REFERENCED-DATA-ELEMENTS {
     { ieeeDataElements iEEEProviderServiceIdentifier(1) }  }
DATA-TYPE "
        ServiceAdvertisement ::= SEQUENCE {
    id  IEEE.IEEEProviderServiceIdentifier,
    position   ServicePosition,    ... }  "}
```

5.3.1.122 servicePosition

```
servicePosition ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ServicePosition:frame"
ASN-NAME "ServicePosition"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 123 }
DEFINITION     "This data frame is the OER-encoding of the location data frame in the
WGS-84 coordinate system that is used to define the geometric center of the RSU, or the
communications radio, transmitting the service advertisement message.  The elevation field
of the location data frame shall be included and the accuracy field is optional.  The
date, time and secMark of the location data frame shall not be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
        ServicePosition ::= Location-oer  "}
```

5.3.1.123 shapePoint

```
shapePoint ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ShapePoint:frame"
ASN-NAME "ShapePoint"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 124 }
DEFINITION     "A data frame used to define a spline-like geographic area within which a
message or traveler information item is valid.  The geographic area is defined by a series
of nodes that define the center line of the geographic area, along with the width of
geographic area.  This geographic area generally encapsulates a roadway segment, or one or
more lanes."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 125 },  -- ShapePointAnchor
     { j2735DataFrames 127 }  -- ShapePointOffsetNodes  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 140 },  -- ShapePoint-width
     { j2735DataElements 139 }  -- ShapePoint-direction  }
DATA-TYPE "
        ShapePoint ::= SEQUENCE {
    anchor      ShapePointAnchor OPTIONAL,
    width       ShapePoint-width,
    directionality     ShapePoint-direction OPTIONAL,
    nodes       ShapePointOffsetNodes,    ... }  "}
```

5.3.1.124 shapePointAnchor

```
shapePointAnchor ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ShapePointAnchor:frame"
ASN-NAME "ShapePointAnchor"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 125 }
DEFINITION     "This data frame is the OER-encoding of the location data frame in the
WGS-84 coordinate system defining the anchor point from which offset values are computed
from to define points along the center line of a geometric area within which a message or
traveler information item is valid.  The elevation field of the location data frame shall
be included and the accuracy field is optional.  The date, time and secMark of the
location data frame shall not be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
        ShapePointAnchor ::= Location-oer  "}
```

5.3.1.125 shapePointOffsetNode

```
shapePointOffsetNode ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ShapePointOffsetNode:frame"
ASN-NAME "ShapePointOffsetNode"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 126 }
DEFINITION     "A data frame that provides one set of signed offset values for
determining the geographic location (and optionally, elevation) of a node and a width
defining a geographic area,"
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 142 },  -- ShapePointOffsetNode-x-offset
     { j2735DataElements 143 },  -- ShapePointOffsetNode-y-offset
     { j2735DataElements 144 },  -- ShapePointOffsetNode-z-offset
     { j2735DataElements 145 },  -- ShapePointOffsetNode-z-tolerance
     { j2735DataElements 141 }  -- ShapePointOffsetNode-width  }
DATA-TYPE "
        ShapePointOffsetNode ::= SEQUENCE {
    xOffset    ShapePointOffsetNode-x-offset,
    yOffset    ShapePointOffsetNode-y-offset,
    zOffset    ShapePointOffsetNode-z-offset OPTIONAL,
    zTolerance ShapePointOffsetNode-z-tolerance OPTIONAL,
    width      ShapePointOffsetNode-width OPTIONAL,    ... }  "}
```

5.3.1.126 shapePointOffsetNodes

```
shapePointOffsetNodes ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ShapePointOffsetNodes:frame"
ASN-NAME "ShapePointOffsetNodes"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 127 }
DEFINITION     "A data frame that provides a sequence of signed offset values, and
optionally a width, for determining a geographic area within which a message or traveler
information item is valid.  Each set of signed offset values (and optionally elevation)
represents a point (node) along the center line of the geographic area.  This sequence of
nodes, along with the width, defines the geographic area.  The first node represents the
offset value from the anchor point.  Each subsequent set of offset values is additive and
is the offset from the last point."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
```

```
REMARKS  "If no value for width is provided, the shapePointOffset-default-width persists."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 126 }  -- ShapePointOffsetNode  }
DATA-TYPE "
        ShapePointOffsetNodes ::= SEQUENCE (SIZE(1..64)) OF ShapePointOffsetNode"}
```

5.3.1.127 signalRequestMessage

```
signalRequestMessage ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SignalRequestMessage:frame"
ASN-NAME "SignalRequestMessage"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 128 }
DEFINITION     "A data frame that represents the information transmitted from a connected
vehicle to request preferential treatment from a signalized intersection.  This data frame
typically shall be contained within a dSRCMessage.  If this data frame is contained within
a dSRCMessage, the msgCnt field shall be present.  The vehicle identifies itself (using
its VIN or another method supported by the vehicleIdentification data frame), its current
speed, heading and location, and makes a specific request for service as well as an
anticipated time of service (a start time and end time)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the signalRequest message when contained within a dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 65 },  -- IntersectionSignalizedRequest
     { j2735DataFrames 67 },  -- IntersectionSignalizedRequestTime
     { j2735DataFrames 66 },  -- IntersectionSignalizedRequestEnd
     { j2735DataFrames 166 }  -- VehicleIdentification  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 201 },  -- Vehicle-bsm-part1-oer
     { j2735DataElements 228 }  -- Vehicle-request-status  }
DATA-TYPE "
        SignalRequestMessage ::= SEQUENCE {
    request    IntersectionSignalizedRequest,
    timeOfService      IntersectionSignalizedRequestTime OPTIONAL,
    endOfService       IntersectionSignalizedRequestEnd OPTIONAL,
    vehicleID  VehicleIdentification OPTIONAL,
    vehicleData Vehicle-bsm-part1-oer OPTIONAL,
    status     Vehicle-request-status OPTIONAL,    ... }  "}
```

5.3.1.128 signalStatusMessage

```
signalStatusMessage ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SignalStatusMessage:frame"
ASN-NAME "SignalStatusMessage"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 129 }
DEFINITION     "A data frame used to relate the current status of a traffic signal
controller and any collection of pending or active preemption or priority events
acknowledged by the controller.  This data frame typically shall be contained within a
dSRCMessage.  If this data frame is contained within a dSRCMessage, the msgCnt field shall
be present.  The data contained in this data frame allows users to see the preemption or
priority currently being serviced."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the signalStatus message when contained within a dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 64 },  -- IntersectionSignalizedPriorities
     { j2735DataFrames 166 },  -- VehicleIdentification
     { j2735DataFrames 63 }  -- IntersectionSignalizedPreempts  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 62 },  -- Intersection-identifier
     { j2735DataElements 68 }  -- IntersectionSignalized-state  }
```

```
DATA-TYPE "
        SignalStatusMessage ::= SEQUENCE {
    id  Intersection-identifier,
    status     IntersectionSignalized-state,
    priorities IntersectionSignalizedPriorities OPTIONAL,
    priorityCause      VehicleIdentification OPTIONAL,
    preempts   IntersectionSignalizedPreempts OPTIONAL,    ... }  "}
```

5.3.1.129 snapshot

```
snapshot ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Snapshot:frame"
ASN-NAME "Snapshot"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 130 }
DEFINITION     "A data frame reporting on one or more status elements in the connected
device along with a set of position and heading elements representing the location where
the readings were recorded.  Each reading can contain status information from a number of
defined sensors in the connected device.  All available sensors should report."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Either the vehicle-safety-extension or the vehicle-status must be present in the
message. "
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 135 },  -- SnapshotLocation
     { j2735DataFrames 1 },  -- Acceleration4Way
     { j2735DataFrames 180 },  -- WiperStatus
     { j2735DataFrames 87 },  -- Obstacle
     { j2735DataFrames 166 },  -- VehicleIdentification
     { j2735DataFrames 141 },  -- SnapshotWeather
     { j2735DataFrames 134 },  -- SnapshotFuel
     { j2735DataFrames 133 },  -- SnapshotEmissions
     { localDataFrames snapshot(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 225 },  -- Vehicle-movement-per
     { j2735DataElements 213 },  -- Vehicle-heading
     { j2735DataElements 200 },  -- Vehicle-brake-system-status-per
     { j2735DataElements 221 },  -- Vehicle-lights
     { j2735DataElements 197 },  -- Vehicle-brake-applied-pressure
     { j2735DataElements 261 },  -- VehicleEnvironment-temperature-air
     { j2735DataElements 256 },  -- VehicleEnvironment-air-pressure
     { j2735DataElements 262 },  -- VehicleEnvironment-vertical-acceleration-flag
     { j2735DataElements 257 },  -- VehicleEnvironment-precipitation-rate
     { j2735DataElements 260 },  -- VehicleEnvironment-sunlight
     { j2735DataElements 259 },  -- VehicleEnvironment-roadway-friction
     { j2735DataElements 209 }  -- Vehicle-events  }
DATA-TYPE "
        Snapshot ::= SEQUENCE {
    location   SnapshotLocation,
    movement   Vehicle-movement-per,
    heading    Vehicle-heading,
    accelSet   Acceleration4Way,
    brakes     Vehicle-brake-system-status-per,
    lights     Vehicle-lights OPTIONAL,
    wipers     WiperStatus OPTIONAL,
    brakePressure      Vehicle-brake-applied-pressure OPTIONAL,
    airTemp    VehicleEnvironment-temperature-air OPTIONAL,
    airPres    VehicleEnvironment-air-pressure OPTIONAL,
    vertAccelThres     VehicleEnvironment-vertical-acceleration-flag OPTIONAL,
    object     Obstacle OPTIONAL,
    vehicleIdent       VehicleIdentification OPTIONAL,
    precipRate VehicleEnvironment-precipitation-rate OPTIONAL,
    solarRadiation     VehicleEnvironment-sunlight OPTIONAL,
    roadFriction       VehicleEnvironment-roadway-friction OPTIONAL,
```

```
    vehicleEvents      Vehicle-events OPTIONAL,
    weather    SnapshotWeather OPTIONAL,
    fuel       SnapshotFuel OPTIONAL,
    emissions  SnapshotEmissions OPTIONAL,
    localSnapshot      LOCAL.Snapshot OPTIONAL,    ... }  "}
```

5.3.1.130 snapshotControl

```
snapshotControl ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SnapshotControl:frame"
ASN-NAME "SnapshotControl"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 131 }
DEFINITION     "A data frame to set the snapshot generation policies of a connected
device by a probe data management message.  This data frame sets the snapshot generation
policy based either on distance or time."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 140 },  -- SnapshotTime
     { j2735DataFrames 132 }  -- SnapshotDistance  }
DATA-TYPE "
        SnapshotControl ::= CHOICE
{
    snapshotTime       SnapshotTime,
    snapshotDistance   SnapshotDistance}  "}
```

5.3.1.131 snapshotDistance

```
snapshotDistance ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SnapshotDistance:frame"
ASN-NAME "SnapshotDistance"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 132 }
DEFINITION     "A data frame used to allow network users to change the snapshot
collection policy based on speed and distance.  Two distances and two speeds are included
in this data frame, to be used by the connected vehicle as follows:
- If speed is less than or equal to snapshotSpeed-threshold-lower, then the distance
(traveled) to generate the next snapshot is defined in snapshotDistance-interval-lower.
- If speed is greater than or equal to snapshotSpeed-threshold-higher, then the distance
(traveled) to generate the next snapshot is defined in snapshotDistance-interval-higher.
- If speed is greater than snapshotSpeed-threshold-lower but less than snapshotSpeed-
threshold-higher, then the distance (traveled) to generate the next snapshot is linearly
interpolated between snapshotDistance-interval-lower and snapshotDistance-interval-higher.
If snapshotSpeed-threshold-lower is set to zero then the distance (traveled) to generate
the next snapshot is defined in snapshotDistance-interval-lower."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 147 },  -- SnapshotDistance-interval-lower
     { j2735DataElements 152 },  -- SnapshotSpeed-threshold-lower
     { j2735DataElements 146 },  -- SnapshotDistance-interval-higher
     { j2735DataElements 151 }  -- SnapshotSpeed-threshold-higher  }
DATA-TYPE "
        SnapshotDistance ::= SEQUENCE {
    lowerDistance      SnapshotDistance-interval-lower,
    lowerSpeed SnapshotSpeed-threshold-lower,
    higherDistance     SnapshotDistance-interval-higher,
    higherSpeed SnapshotSpeed-threshold-higher,    ... }  "}
```

5.3.1.132 snapshotEmissions

```
snapshotEmissions ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SnapshotEmissions:frame"
ASN-NAME "SnapshotEmissions"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 133 }
DEFINITION     "A data frame containing the emissions sensor readings as measured by the
connected vehicle at a location."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "The maximum values for the emissions data elements were based on average long-
haul truck emission levels, taken from the United States Federal Motor Carrier Safety
Administration (FMCSA) Hours-of-Service Regulation, Appendix A, Environmental Assessment.
 The emissions levels for each pollutant or greenhouse gas (GHG) were multiplied by 10 and
rounded up to the nearest power of ten to allow for emissions far above the average. It is
assumed the emissions from other vehicle types will not exceed emissions from long-haul
trucks. The measurement of GHG and pollutants by grams/mile (or its metric equivalent) and
grams/hour is consistent with use by the EPA Motor Vehicle Emissions Simulator (MOVES)
model for vehicle emissions."
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 47 },  -- Emissions-carbonmonoxide-running
     { j2735DataElements 46 },  -- Emissions-carbonmonoxide-idling
     { j2735DataElements 51 },  -- Emissions-nox-running
     { j2735DataElements 50 },  -- Emissions-nox-idling
     { j2735DataElements 57 },  -- Emissions-so2-running
     { j2735DataElements 56 },  -- Emissions-so2-idling
     { j2735DataElements 49 },  -- Emissions-co2-running
     { j2735DataElements 48 },  -- Emissions-co2-idling
     { j2735DataElements 53 },  -- Emissions-pm10-running
     { j2735DataElements 52 },  -- Emissions-pm10-idling
     { j2735DataElements 55 },  -- Emissions-pm25-running
     { j2735DataElements 54 },  -- Emissions-pm25-idling
     { j2735DataElements 59 },  -- Emissions-voc-running
     { j2735DataElements 58 }  -- Emissions-voc-idling  }
DATA-TYPE "
        SnapshotEmissions ::= SEQUENCE {
    coRunning  Emissions-carbonmonoxide-running OPTIONAL,
    coIdling   Emissions-carbonmonoxide-idling OPTIONAL,
    noxRunning Emissions-nox-running OPTIONAL,
    noxIdling  Emissions-nox-idling OPTIONAL,
    so2Running Emissions-so2-running OPTIONAL,
    so2Idling  Emissions-so2-idling OPTIONAL,
    co2Running Emissions-co2-running OPTIONAL,
    co2Idling  Emissions-co2-idling OPTIONAL,
    pm10Running Emissions-pm10-running OPTIONAL,
    pm10Idling Emissions-pm10-idling OPTIONAL,
    pm25Running Emissions-pm25-running OPTIONAL,
    pm25Idling Emissions-pm25-idling OPTIONAL,
    vocRunning Emissions-voc-running OPTIONAL,
    vocIdling  Emissions-voc-idling OPTIONAL,    ... }  "}
```

5.3.1.133 snapshotFuel

```
snapshotFuel ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SnapshotFuel:frame"
ASN-NAME "SnapshotFuel"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 134 }
DEFINITION     "A data frame containing fuel information for a connected device that may
be included in the generation of snapshots."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
```

```
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 212 },  -- Vehicle-fuel-type
     { j2735DataElements 210 },  -- Vehicle-fuel-economy
     { j2735DataElements 211 },  -- Vehicle-fuel-remaining
     { j2735DataElements 204 }  -- Vehicle-charge-remaining  }
DATA-TYPE "
        SnapshotFuel ::= SEQUENCE {
    type        Vehicle-fuel-type OPTIONAL,
    economy     Vehicle-fuel-economy OPTIONAL,
    remaining   Vehicle-fuel-remaining OPTIONAL,
    charge      Vehicle-charge-remaining OPTIONAL,    ... }  "}
```

5.3.1.134 snapshotLocation

```
snapshotLocation ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SnapshotLocation:frame"
ASN-NAME "SnapshotLocation"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 135 }
DEFINITION     "This data frame is the OER-encoding of the location data frame in the
WGS-84 coordinate system defining the precise location and time when the snapshot was
generated.  The elevation, date, time and accuracy fields of the location data frame shall
be present, while the secMark field of the location data frame shall not be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
        SnapshotLocation ::= Location-oer  "}
```

5.3.1.135 snapshotRequest

```
snapshotRequest ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SnapshotRequest:frame"
ASN-NAME "SnapshotRequest"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 136 }
DEFINITION     "A data frame used to request a status element along with threshold
settings in the vehicle probe management process."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Range settings must match the range allowed by the subject data item.  Units are
as defined by the subject data item."
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 233 },  -- Vehicle-status-type-tag
     { j2735DataElements 150 },  -- SnapshotRequest-threshold-lower
     { j2735DataElements 149 },  -- SnapshotRequest-threshold-greater
     { j2735DataElements 148 }  -- SnapshotRequest-all  }
DATA-TYPE "
        SnapshotRequest ::= SEQUENCE {
    dataType   Vehicle-status-type-tag,
    sendOnLessThenValue       SnapshotRequest-threshold-lower OPTIONAL,
    sendOnMoreThenValue       SnapshotRequest-threshold-greater OPTIONAL,
    sendAll    SnapshotRequest-all OPTIONAL,    ... }  "}
```

5.3.1.136 snapshotRequests

```
snapshotRequests ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SnapshotRequests:frame"
ASN-NAME "SnapshotRequests"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 137 }
```

```
DEFINITION     "A data frame used to request complex content along with threshold
settings in the vehicle probe management process."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 136 }  -- SnapshotRequest  }
DATA-TYPE "
        SnapshotRequests ::= SEQUENCE (SIZE(1..32)) OF SnapshotRequest"}
```

5.3.1.137 snapshots

```
snapshots ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Snapshots:frame"
ASN-NAME "Snapshots"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 138 }
DEFINITION     "A data frame containing one or more snapshots from a connected device.
Each snapshot contains accumulated data from the connected device's sensors and readings."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 130 }  -- Snapshot  }
DATA-TYPE "
        Snapshots ::= SEQUENCE (SIZE(1..32)) OF Snapshot"}
```

5.3.1.138 snapshotStop

```
snapshotStop ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SnapshotStop:frame"
ASN-NAME "SnapshotStop"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 139 }
DEFINITION     "A data frame to temporarily set the start and stop snapshot thresholds of
a connected vehicle by a probe data management message.  These thresholds define the
parameters for which start and stop snapshots are generated in a connected vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 155 },  -- SnapshotStop-time
     { j2735DataElements 153 },  -- SnapshotStop-last
     { j2735DataElements 154 }  -- SnapshotStop-start  }
DATA-TYPE "
        SnapshotStop ::= SEQUENCE {
    thresholdTime      SnapshotStop-time OPTIONAL,
    thresholdLast      SnapshotStop-last OPTIONAL,
    thresholdStart     SnapshotStop-start OPTIONAL,    ... }  "}
```

5.3.1.139 snapshotTime

```
snapshotTime ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SnapshotTime:frame"
ASN-NAME "SnapshotTime"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 140 }
DEFINITION     "A data frame to allow transportation network users to change the snapshot
collection policy based on elapsed time.  Two times and two speeds are included in the
data frame, to be used by the connected vehicle as follows:
- If speed is less than or equal to snapshotSpeed-threshold-lower, then the time
(interval) to generate the next snapshot is defined in snapshotTime-interval-lower.
- If speed is greater than or equal to snapshotSpeed-threshold-higher, then the time
(interval) to generate the next snapshot is defined in snapshotTime-interval-higher.
```

```
- If speed is less than snapshotSpeed-threshold-lower and greater than snapshotSpeed-
threshold-higher, then the time (interval) to generate the next snapshot is linearly
interpolated between snapshotTime-interval-lower and snapshotTime-interval-higher.
If snapshotSpeed-threshold-lower is set to zero then the time interval between generated
snapshots is defined in snapshotTime-interval-lower."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 157 },  -- SnapshotTime-interval-lower
     { j2735DataElements 152 },  -- SnapshotSpeed-threshold-lower
     { j2735DataElements 156 },  -- SnapshotTime-interval-higher
     { j2735DataElements 151 }  -- SnapshotSpeed-threshold-higher  }
DATA-TYPE "
        SnapshotTime ::= SEQUENCE {
    lowerTime  SnapshotTime-interval-lower,
    lowerSpeed SnapshotSpeed-threshold-lower,
    higherTime SnapshotTime-interval-higher,
    higherSpeed SnapshotSpeed-threshold-higher,    ... }  "}
```

5.3.1.140 snapshotWeather

```
snapshotWeather ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "SnapshotWeather:frame"
ASN-NAME "SnapshotWeather"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 141 }
DEFINITION     "A data frame containing additional weather and environmental data
elements collected by a connected device that may be included in the generation of
snapshots."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 160 },  -- SnapshotWeather-radiation
     { j2735DataElements 165 },  -- SnapshotWeather-wind-direction
     { j2735DataElements 166 },  -- SnapshotWeather-wind-speed
     { j2735DataElements 158 },  -- SnapshotWeather-dewpoint
     { j2735DataElements 164 },  -- SnapshotWeather-visibility
     { j2735DataElements 163 },  -- SnapshotWeather-surface-temperature
     { j2735DataElements 159 },  -- SnapshotWeather-precipitation-depth
     { j2735DataElements 161 },  -- SnapshotWeather-snow-depth
     { j2735DataElements 162 }  -- SnapshotWeather-snow-depth-adjacent  }
DATA-TYPE "
        SnapshotWeather ::= SEQUENCE {
    radiationTotal     SnapshotWeather-radiation OPTIONAL,
    windDirection      SnapshotWeather-wind-direction OPTIONAL,
    windSpeed  SnapshotWeather-wind-speed OPTIONAL,
    dewpoint   SnapshotWeather-dewpoint OPTIONAL,
    visibility SnapshotWeather-visibility OPTIONAL,
    surfaceTemp SnapshotWeather-surface-temperature OPTIONAL,
    precipDepth SnapshotWeather-precipitation-depth OPTIONAL,
    snowDepth  SnapshotWeather-snow-depth OPTIONAL,
    adjSnowDepth       SnapshotWeather-snow-depth-adjacent OPTIONAL,    ... }  "}
```

5.3.1.141 spat

```
spat ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Spat:frame"
ASN-NAME "Spat"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 142 }
DEFINITION     "A data frame that conveys the current status of a signalized
intersection.  This data frame typically shall be contained within a dSRCMessage.  The
receiver of this data frame can determine the state of the signal phasing and when the
expected next phase will occur.  The contents may include what movements through the
signalized intersection are currently permitted (values of what signal indications are
active) and when those movements will change.  The state of unpermitted movements is not
normally transmitted.  Movements are mapped to specific lanes by use of the lane numbers
present in the message.  These lane numbers correspond to the specific lanes described in
the mapData message for that intersection.  The current signal preemption and priority
status values (when present or active) are also sent."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the signalPhaseAndTiming (SPAT) message or sPAT message when contained
within a dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 61 },  -- IntersectionSignalized
     { localDataFrames sPAT(1) }  }
DATA-TYPE "
        Spat ::= SEQUENCE {
    signal     IntersectionSignalized,
    localSPAT  LOCAL.SPAT OPTIONAL,    ... }  "}
```

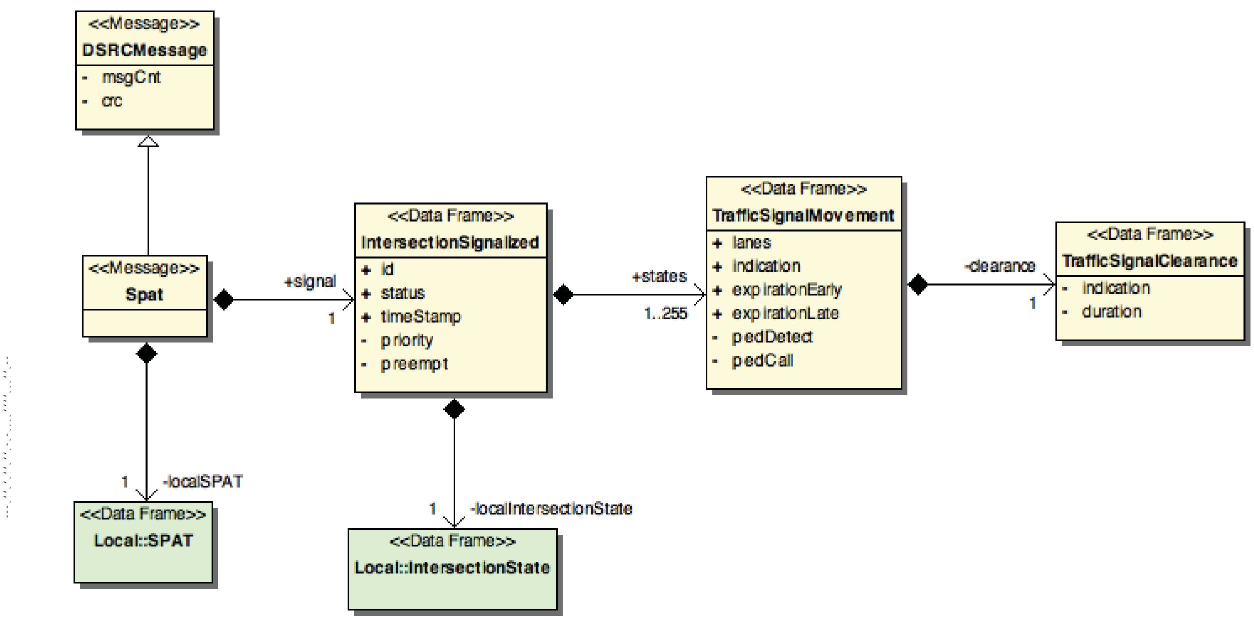


FIGURE 41 - DATA MODEL - sPAT

5.3.1.142 trafficSignalMovement

```
trafficSignalMovement ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TrafficSignalMovement:frame"
ASN-NAME "TrafficSignalMovement"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 143 }
DEFINITION     "A data frame used to convey information about the current signal state of
a designated collection of one or more lanes of a common type (i.e., a group of permitted
movements).  Note that lane types supported include both motorized vehicle lanes as well
as pedestrian lanes and specialized vehicle lanes, such as dedicated train and transit
lanes.  Of the reported data elements, the time when the current permitted movements is
expected to change is often of the most of value.   This data frame is used in the sPAT
data frame to convey every movement in the approaches at a given intersection so that
vehicles and travelers, when combined with certain roadway geometric (map) information,
can determine the state of the signal indications.
Note that the value given for the trafficSignalMovement-expiration-early and
trafficSignalMovement-expiration-late data elements for actuated signalized intersection
indicates the range of times that the movement is expected to change based on the sensor
data received.  The trafficSignalMovement-expiration-early element can generally be
regarded as the earliest time before the movement ends unless a preemption event occurs."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Note: the movement number is contained in the enclosing data frame."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 146 },  -- TrafficSignalMovementIndication
     { j2735DataFrames 144 }  -- TrafficSignalMovementClearance  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 176 },  -- TrafficSignalMovementLanes
     { j2735DataElements 169 },  -- TrafficSignalMovement-expiration-early
     { j2735DataElements 170 },  -- TrafficSignalMovement-expiration-late
     { j2735DataElements 175 },  -- TrafficSignalMovement-pedestrian-detect
     { j2735DataElements 174 }  -- TrafficSignalMovement-pedestrian-call  }
DATA-TYPE "
        TrafficSignalMovement ::= SEQUENCE {
    lanes      TrafficSignalMovementLanes,
    indication TrafficSignalMovementIndication,
    expirationEarly    TrafficSignalMovement-expiration-early,
    expirationLate     TrafficSignalMovement-expiration-late,
    clearance  TrafficSignalMovementClearance OPTIONAL,
    pedDetect  TrafficSignalMovement-pedestrian-detect OPTIONAL,
    pedCall    TrafficSignalMovement-pedestrian-call OPTIONAL,    ... }  "}
```

5.3.1.143 trafficSignalMovementClearance

```
trafficSignalMovementClearance ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TrafficSignalMovementClearance:frame"
ASN-NAME "TrafficSignalMovementClearance"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 144 }
DEFINITION     "This data frame indicates the clearance data for a traffic signal
movement."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 145 }  -- TrafficSignalMovementClearanceIndication  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 168 }  -- TrafficSignalMovement-clearance-duration  }
DATA-TYPE "
        TrafficSignalMovementClearance ::= SEQUENCE {
    indication TrafficSignalMovementClearanceIndication OPTIONAL,
    duration   TrafficSignalMovement-clearance-duration OPTIONAL,    ... }  "}
```

5.3.1.144 trafficSignalMovementClearanceIndication

```
trafficSignalMovementClearanceIndication ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TrafficSignalMovementClearanceIndication:frame"
ASN-NAME "TrafficSignalMovementClearanceIndication"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 145 }
DEFINITION     "This data frame indicates the next signal state and signal indications
pertaining to a specific lane or movement (set of lanes). Used in the sPAT data frame,
this data frame is an integer value which is typically encoded with only the necessary
lower bits of significance being sent, therefore allowing shorter payload byte counts when
used.   Observe that soft right and left arrows and U-turn indications will require 3 and
4 bytes, while simple balls require only 1 byte, and left, right and through arrows will
require 2 bytes.  A dark state would be indicated by the value zero.
Note that when used in the trafficSignalMovement data frames the signal state appears
twice for motorized vehicle lanes, once for the current state, and once for the next
'clearance' phase (usually a yellow indication and the current state is not simply red).
For stopped signals (red states) no yellow phase data is needed, nor is it present for
lane states which deal with trains."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 146 }  -- TrafficSignalMovementIndication  }
DATA-TYPE "
        TrafficSignalMovementClearanceIndication ::= SEQUENCE {
    trafficSignalMovementIndication   TrafficSignalMovementIndication,    ... }  "}
```

5.3.1.145 trafficSignalMovementIndication

```
trafficSignalMovementIndication ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TrafficSignalMovementIndication:frame"
ASN-NAME "TrafficSignalMovementIndication"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 146 }
DEFINITION     "This data frame describes the current movement states.  This data frame
describes the (current) signal indications for the current movement.  Three types of
signal states and indications at the intersection are currently supported: for travelers
in motorized vehicles, for pedestrians (including non-motorized vehicles), and specialized
motor vehicles (such as transit vehicles)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 173 },  -- TrafficSignalMovement-indication-vehicle
     { j2735DataElements 171 },  -- TrafficSignalMovement-indication-crosswalk
     { j2735DataElements 172 }  -- TrafficSignalMovement-indication-special  }
DATA-TYPE "
        TrafficSignalMovementIndication ::= CHOICE
{
    currState  TrafficSignalMovement-indication-vehicle,
    pedState   TrafficSignalMovement-indication-crosswalk,
    specialState       TrafficSignalMovement-indication-special}  "}
```

5.3.1.146 trafficSignalPriority

```
trafficSignalPriority ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TrafficSignalPriority:frame"
ASN-NAME "TrafficSignalPriority"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 147 }
DEFINITION     "A data frame used to relate the geographic areas of an intersection for
an approaching vehicle to assert a preempt to a signal system or to assert a priority
request for a signal.  These geographic areas together with the mapIntersection data frame
```

```
to describe the intersection and what preferential strategies (schemes) are available for
a given movement state."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Note that both a preempt to a signal system and a priority for a signal system
are described in the same terms here. The term zone was created to cover both uses."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 148 },  -- TrafficSignalPriorityLanes
     { j2735DataFrames 150 },  -- TrafficSignalPriorityZones
     { localDataFrames signalControlZone(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 178 }  -- TrafficSignalPriority-number  }
DATA-TYPE "
        TrafficSignalPriority ::= SEQUENCE {
    pValue     TrafficSignalPriority-number,
    laneSet    TrafficSignalPriorityLanes OPTIONAL,
    zones      TrafficSignalPriorityZones OPTIONAL,
    localSignalControlZone    LOCAL.SignalControlZone OPTIONAL,    ... }  "}
```

5.3.1.147 trafficSignalPriorityLanes

```
trafficSignalPriorityLanes ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TrafficSignalPriorityLanes:frame"
ASN-NAME "TrafficSignalPriorityLanes"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 148 }
DEFINITION     "This data frame consists of the identifiers of the lanes for which the
signal priority or signal preemption scheme applies."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 177 }  -- TrafficSignalPriority-lane  }
DATA-TYPE "
        TrafficSignalPriorityLanes ::= SEQUENCE (SIZE(1..32)) OF TrafficSignalPriority-
lane"}
```

5.3.1.148 trafficSignalPriorityZone

```
trafficSignalPriorityZone ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TrafficSignalPriorityZone:frame"
ASN-NAME "TrafficSignalPriorityZone"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 149 }
DEFINITION     "A data frame describing a zone in which an authorized vehicle may request
preferential treatment from a signalized intersection.  The zone is defined by a series of
individual nodes in conjunction with a zone width to define the width of the zone."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 182 }  -- ZoneNodes  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 272 }  -- Zone-width  }
DATA-TYPE "
        TrafficSignalPriorityZone ::= SEQUENCE {
    zoneWidth  Zone-width,
    zoneNode   ZoneNodes,    ... }  "}
```

5.3.1.149 trafficSignalPriorityZones

```
trafficSignalPriorityZones ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TrafficSignalPriorityZones:frame"
ASN-NAME "TrafficSignalPriorityZones"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 150 }
DEFINITION     "A data frame describing the geographic areas in which an authorized
vehicle may request preferential treatment from a signalized intersection.  Each area is
defined by a series of individual nodes in conjunction with a zone width to define the
width of the zone."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 149 }  -- TrafficSignalPriorityZone  }
DATA-TYPE "
        TrafficSignalPriorityZones ::= SEQUENCE (SIZE(1..32)) OF
TrafficSignalPriorityZone"}
```

5.3.1.150 trailer

```
trailer ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Trailer:frame"
ASN-NAME "Trailer"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 151 }
DEFINITION     "A data frame that provides a variety of information about a trailer being
towed by a vehicle.  The data frame includes license information, axle counts, tire
counts, and trailer weight.  This data frame is primarily used for commercial motor
vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 152 }  -- TrailerLicensePlate  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 182 },  -- Trailer-vin
     { j2735DataElements 179 },  -- Trailer-count-axle
     { j2735DataElements 180 },  -- Trailer-count-tire
     { j2735DataElements 183 }  -- Trailer-weight  }
DATA-TYPE "
        Trailer ::= SEQUENCE {
    trailerVIN Trailer-vin,
    licensePlate       TrailerLicensePlate,
    axleCount  Trailer-count-axle,
    tireCount  Trailer-count-tire,
    weight     Trailer-weight OPTIONAL,    ... }  "}
```

5.3.1.151 trailerLicensePlate

```
trailerLicensePlate ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TrailerLicensePlate:frame"
ASN-NAME "TrailerLicensePlate"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 152 }
DEFINITION     "A data frame providing information about a trailer's license plate,
including country and jurisdiction of issue, and the license plate number.  Intended for
commercial vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 129 }  -- Registration-oer  }
DATA-TYPE "
        TrailerLicensePlate ::= Registration-oer  "}
```

5.3.1.152 trailers

```
trailers ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "Trailers:frame"
ASN-NAME "Trailers"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 153 }
DEFINITION     "A data frame that contains a variety of information about each trailer
being towed by a motor vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 181 }  -- Trailer-oer  }
DATA-TYPE "
        Trailers ::= SEQUENCE (SIZE(1..6)) OF Trailer-oer"}
```

5.3.1.153 travelerInformation

```
travelerInformation ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TravelerInformation:frame"
ASN-NAME "TravelerInformation"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 154 }
DEFINITION     "A data frame that contains various types of traveler information items
(advisory and road sign types) broadcasted from an RSU to connected devices in a single
message.  This data frame typically shall be contained within a dSRCMessage.  It makes
heavy use of the ITIS encoding system to send well known phrases, but allows limited text
for local place names.  The expressed content can be set to be active at a precise start
and duration period, which can be specified to a resolution of a minute.  Optionally, the
affected local area can be expressed using either a radius system or a system of short
defined regions which is similar to the way roadway geometry is defined in the roadway
geometrics messages."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Called the travelerInformation (TIM) message when contained within a
dSRCMessage."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 160 },  -- TravelerInformationItems
     { localDataFrames travelerInformation(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 184 },  -- TravelerInformation-identifier
     { j2735DataElements 192 }  -- TravelerInformation-url-base  }
DATA-TYPE "
        TravelerInformation ::= SEQUENCE {
    packetID   TravelerInformation-identifier,
    urlB       TravelerInformation-url-base OPTIONAL,
    dataFrames TravelerInformationItems,
    localTravelerInformation   LOCAL.TravelerInformation OPTIONAL,    ... }  "}
```

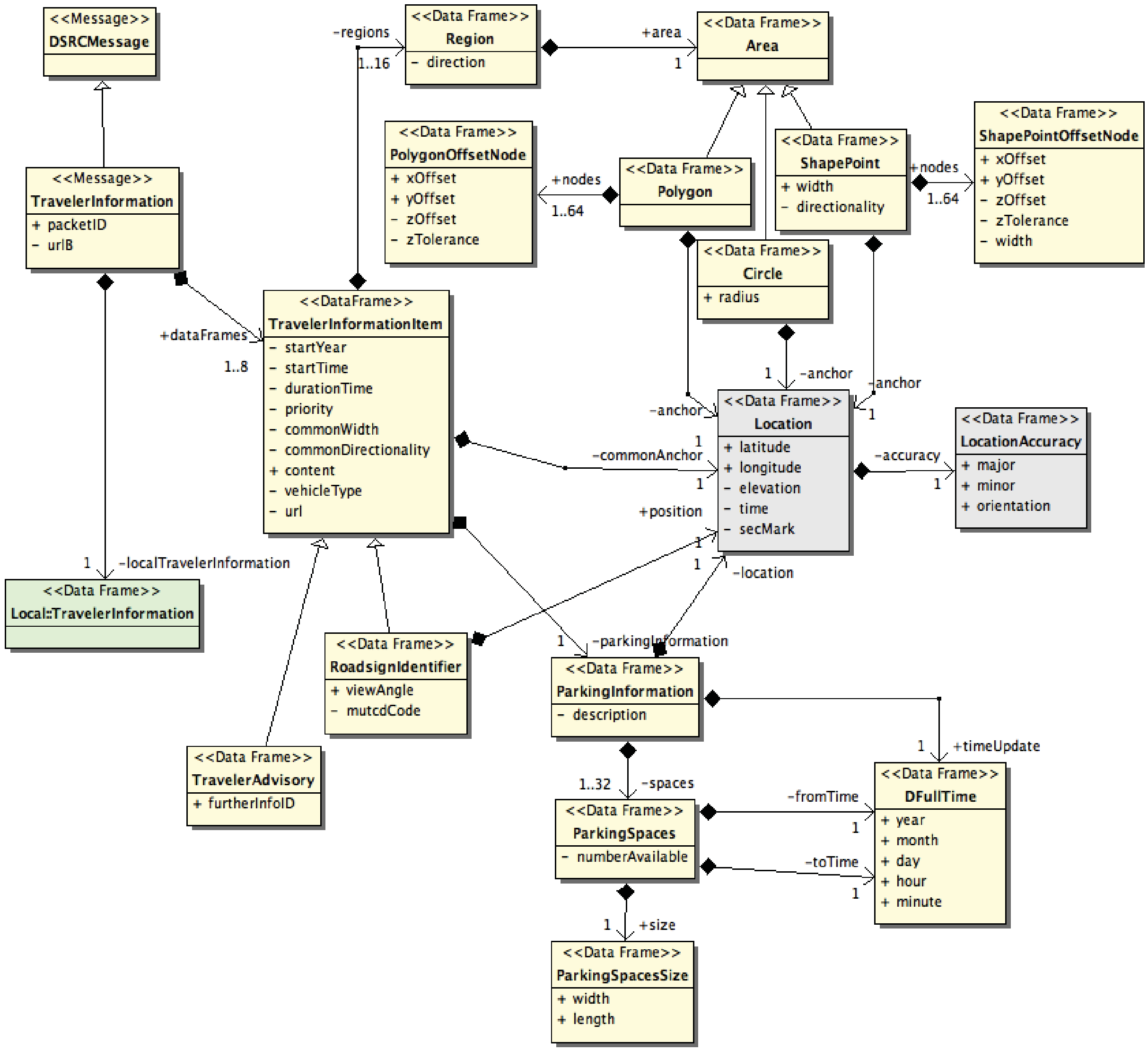


FIGURE 42 - DATA MODEL - travelerInformation

5.3.1.154 travelerInformationItem

```
travelerInformationItem ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TravelerInformationItem:frame"
ASN-NAME "TravelerInformationItem"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 155 }
DEFINITION     "A data frame used to provide the information for a traveler information
message, such as a traveler advisory or a road sign."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS   ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 158 },   -- TravelerInformationItemIdentifier
     { j2735DataFrames 156 },   -- TravelerInformationItemAnchor
     { j2735DataFrames 159 },   -- TravelerInformationItemRegions
     { j2735DataFrames 157 },   -- TravelerInformationItemContent
     { j2735DataFrames 88 }  -- ParkingInformation  }
```

```
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 191 },  -- TravelerInformationItem-start-year
     { j2735DataElements 190 },  -- TravelerInformationItem-start-minute
     { j2735DataElements 188 },  -- TravelerInformationItem-duration
     { j2735DataElements 189 },  -- TravelerInformationItem-priority
     { j2735DataElements 187 },  -- TravelerInformationItem-default-width
     { j2735DataElements 186 },  -- TravelerInformationItem-default-direction
     { j2735DataElements 185 },  -- TravelerInformationItem-applicable-vehicles
     { j2735DataElements 193 }  -- TravelerInformationItem-url-short  }
DATA-TYPE "
        TravelerInformationItem ::= SEQUENCE {
    msgId      TravelerInformationItemIdentifier,
    startYear  TravelerInformationItem-start-year OPTIONAL,
    startTime  TravelerInformationItem-start-minute OPTIONAL,
    durationTime       TravelerInformationItem-duration OPTIONAL,
    priority   TravelerInformationItem-priority OPTIONAL,
    commonAnchor       TravelerInformationItemAnchor OPTIONAL,
    commonWidth TravelerInformationItem-default-width OPTIONAL,
    commonDirectionality      TravelerInformationItem-default-direction OPTIONAL,
    regions    TravelerInformationItemRegions OPTIONAL,
    content    TravelerInformationItemContent,
    vehicleType TravelerInformationItem-applicable-vehicles OPTIONAL,
    parking    ParkingInformation OPTIONAL,
    url TravelerInformationItem-url-short OPTIONAL,    ... }  "}
```

5.3.1.155 travelerInformationItemAnchor

```
travelerInformationItemAnchor ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TravelerInformationItemAnchor:frame"
ASN-NAME "TravelerInformationItemAnchor"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 156 }
DEFINITION     "This data frame is the OER-encoding of the location data frame in the
WGS-84 coordinate system that is used to define a default reference point for geometric
areas within which a message or traveler information item is valid.  Unless otherwise
specified, this default reference point is used for all defined geometric areas for the
traveler information message.  The elevation field of the location data frame shall be
present, while the date, time, accuracy, and secMark field of the location data frame
shall not be present."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 87 }  -- Location-oer  }
DATA-TYPE "
        TravelerInformationItemAnchor ::= Location-oer  "}
```

5.3.1.156 travelerInformationItemContent

```
travelerInformationItemContent ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TravelerInformationItemContent:frame"
ASN-NAME "TravelerInformationItemContent"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 157 }
DEFINITION     "A data frame containing the contents of a traveler information item to be
broadcasted.  The contents of the traveler information item may include advisories, work
zone signs and directions, speed limits and cautions, roadside available services, or may
reflect physical MUTCD signs and directions."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { itisDataFrames iTIScodesAndText(1) }  }
```

```
DATA-TYPE "
        TravelerInformationItemContent ::= SEQUENCE (SIZE(1..100)) OF
ITIS.ITIScodesAndText"}
```

5.3.1.157 travelerInformationItemIdentifier

```
travelerInformationItemIdentifier ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TravelerInformationItemIdentifier:frame"
ASN-NAME "TravelerInformationItemIdentifier"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 158 }
DEFINITION     "A data frame identifying a traveler information message.  If the traveler
information message type is a traveler advisory, its message identifier consists of a 2-
byte advisory number.  If the traveler information message type is a roadsign, its message
identifier is a combination of the physical roadsign's geographic position, orientation,
and optionally, an MUTCD code."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 113 }  -- RoadsignIdentifier  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 5 }  -- Advisory-identifier  }
DATA-TYPE "
        TravelerInformationItemIdentifier ::= CHOICE
{
    furtherInfoID      Advisory-identifier,
    roadSignID RoadsignIdentifier}  "}
```

5.3.1.158 travelerInformationItemRegions

```
travelerInformationItemRegions ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TravelerInformationItemRegions:frame"
ASN-NAME "TravelerInformationItemRegions"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 159 }
DEFINITION     "A data frame that provides a series of valid geographic locations to
which a traveler information message is considered valid."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 111 }  -- Region   }
DATA-TYPE "
        TravelerInformationItemRegions ::= SEQUENCE (SIZE(1..16)) OF Region"}
```

5.3.1.159 travelerInformationItems

```
travelerInformationItems ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "TravelerInformationItems:frame"
ASN-NAME "TravelerInformationItems"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 160 }
DEFINITION     "A data frame containing one or more traveler information messages for
broadcast."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 155 }  -- TravelerInformationItem  }
DATA-TYPE "
        TravelerInformationItems ::= SEQUENCE (SIZE(1..8)) OF TravelerInformationItem"}
```

5.3.1.160 vehicleAxle

```
vehicleAxle ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleAxle:frame"
ASN-NAME "VehicleAxle"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 161 }
DEFINITION     "A data frame that provides a variety of information about an axle on a
connected vehicle.  The axle may be on the vehicle itself, or a trailer being towed by the
vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 163 }  -- VehicleBrakes  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 249 },  -- VehicleAxle-location
     { j2735DataElements 250 },  -- VehicleAxle-weight
     { j2735DataElements 248 }  -- VehicleAxle-distance  }
DATA-TYPE "
        VehicleAxle ::= SEQUENCE {
    axleLocation       VehicleAxle-location,
    axleWeight VehicleAxle-weight,
    brakes     VehicleBrakes OPTIONAL,
    distance   VehicleAxle-distance OPTIONAL,    ... }  "}
```

5.3.1.161 vehicleAxles

```
vehicleAxles ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleAxles:frame"
ASN-NAME "VehicleAxles"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 162 }
DEFINITION     "A data frame that consists of a series of data frames containing
information about each axle on the vehicle.  Typically used for commercial motor vehicles,
it provides information about each axle on the power unit and any trailers that are being
towed."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 161 }  -- VehicleAxle  }
DATA-TYPE "
        VehicleAxles ::= SEQUENCE (SIZE(1..20)) OF VehicleAxle"}
```

5.3.1.162 vehicleBrakes

```
vehicleBrakes ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleBrakes:frame"
ASN-NAME "VehicleBrakes"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 163 }
DEFINITION     "A data frame that provides a variety of information about the brake
system on an axle of a connected commercial motor vehicle.  Used primarily for safety
inspections, the axle may be on the power unit itself, or a trailer being towed by the
power unit."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 252 },  -- VehicleAxleBrake-left
     { j2735DataElements 254 },  -- VehicleAxleBrake-right
     { j2735DataElements 251 },  -- VehicleAxleBrake-actuator
     { j2735DataElements 253 },  -- VehicleAxleBrake-lining
     { j2735DataElements 255 }  -- VehicleAxleBrake-temperature  }
DATA-TYPE "
        VehicleBrakes ::= SEQUENCE {
    leftBrake  VehicleAxleBrake-left,
    rightBrake VehicleAxleBrake-right,
    brakeActuator      VehicleAxleBrake-actuator,
    brakeLining VehicleAxleBrake-lining,
    brakeTemperature   VehicleAxleBrake-temperature OPTIONAL,    ... }  "}
```

5.3.1.163 vehicleBrakeSystemStatus

```
vehicleBrakeSystemStatus ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleBrakeSystemStatus:frame"
ASN-NAME "VehicleBrakeSystemStatus"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 164 }
DEFINITION     "The data frame conveys a variety of information about the current brake
and system control activity of the vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 198 },  -- Vehicle-brake-applied-status
     { j2735DataElements 237 },  -- Vehicle-traction-control-state
     { j2735DataElements 195 },  -- Vehicle-antilock-brake-state
     { j2735DataElements 232 },  -- Vehicle-stability-control-state
     { j2735DataElements 199 },  -- Vehicle-brake-boost-status
     { j2735DataElements 196 }  -- Vehicle-auxiliary-brake-status  }
DATA-TYPE "
        VehicleBrakeSystemStatus ::= SEQUENCE {
    wheelbrakes Vehicle-brake-applied-status,
    traction   Vehicle-traction-control-state,
    abs Vehicle-antilock-brake-state,
    scs Vehicle-stability-control-state,
    brakeBoost Vehicle-brake-boost-status,
    auxBrakes  Vehicle-auxiliary-brake-status }"}
```

5.3.1.164 vehicleDriver

```
vehicleDriver ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleDriver:frame"
ASN-NAME "VehicleDriver"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 165 }
DEFINITION     "A data frame containing identifying information for a driver.  Typically
used only for commercial vehicle drivers who opt-in, this information is used for driver
safety inspections and for security purposes."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 36 }  -- DriverLicense  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 113 },  -- Person-name-last
     { j2735DataElements 112 },  -- Person-name-first
     { j2735DataElements 31 },  -- Driver-pin
     { j2735DataElements 111 }  -- Person-date-of-birth-oer  }
```

```
DATA-TYPE "
        VehicleDriver ::= SEQUENCE {
    nameLast    Person-name-last,
    nameFirst   Person-name-first,
    license     DriverLicense,
    pin Driver-pin OPTIONAL,
    dateOfBirth Person-date-of-birth-oer OPTIONAL,    ... }  "}
```

5.3.1.165 vehicleIdentification

```
vehicleIdentification ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleIdentification:frame"
ASN-NAME "VehicleIdentification"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 166 }
DEFINITION     "A data frame used to provide identity information about a selected
vehicle. This data frame is typically used with fleet type vehicles who can (or who must)
safely release such information for use with probe measurements or with other interactions
(such as a signal request).  At least one of the optional data elements shall be present
in the data frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { localDataFrames vehicleIdent(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 216 },  -- Vehicle-identifier
     { j2735DataElements 217 },  -- Vehicle-identifier-source
     { j2735DataElements 236 },  -- Vehicle-temporary-identifier
     { j2735DataElements 240 }  -- Vehicle-type  }
DATA-TYPE "
        VehicleIdentification ::= SEQUENCE {
    id  Vehicle-identifier OPTIONAL,
    owner      Vehicle-identifier-source OPTIONAL,
    tempID     Vehicle-temporary-identifier OPTIONAL,
    type       Vehicle-type OPTIONAL,
    localVehicleIdent  LOCAL.VehicleIdent OPTIONAL,    ... }  "}
```

5.3.1.166 vehicleLicenseInformation

```
vehicleLicenseInformation ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleLicenseInformation:frame"
ASN-NAME "VehicleLicenseInformation"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 167 }
DEFINITION     "A data frame that provides identification information about the motorized
vehicle.  This includes identification information about the vehicle itself, such as its
vehicle identification number (VIN) and license plate number; and the owner of the
vehicle, and the lessee, if applicable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "This data frame is typically used for commercial vehicle purposes only, such as
for roadside checks. The driver must opt-in to allow this data frame to be transmitted."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 168 }  -- VehicleLicensePlate  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 227 },  -- Vehicle-owner-oer
     { j2735DataElements 218 }  -- Vehicle-lessee-oer  }
DATA-TYPE "
        VehicleLicenseInformation ::= SEQUENCE {
    owner      Vehicle-owner-oer,
    licensePlate       VehicleLicensePlate,
    lessee     Vehicle-lessee-oer,    ... }  "}
```

5.3.1.167 vehicleLicensePlate

```
vehicleLicensePlate ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleLicensePlate:frame"
ASN-NAME "VehicleLicensePlate"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 168 }
DEFINITION     "A data frame providing information about a vehicle's license plate,
including country and jurisdiction of issue, and the license plate number.  Intended for
commercial vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 129 }  -- Registration-oer  }
DATA-TYPE "
        VehicleLicensePlate ::= Registration-oer  "}
```

5.3.1.168 vehicleLocationCorrection

```
vehicleLocationCorrection ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleLocationCorrection:frame"
ASN-NAME "VehicleLocationCorrection"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 169 }
DEFINITION     "A data frame used to convey a select sub-set of the RTCM messages
(message types 1001 TO 1032) which deal with differential corrections between users.
Encapsulates messages are those defined in RTCM Standard 10403.1 for Differential GNSS
(Global Navigation Satellite Systems) Services - Version 3 adopted on October 27, 2006
and its successors.  At the date this standard was published this included Amendment #2
published August 31, 2007."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "The octets defined here shall be set in accordance with the presentation layer
data values defined by RTCM 10403.1 and its successors.
    msg1001 -- pRange data GPS L1
    msg1002 -- pRange data GPS L1
    msg1003 -- pRange data GPS L1, L2
    msg1004 -- pRange data GPS L1, L2
    msg1005 -- observer station data
    msg1006 -- observer station data
    msg1007 -- antenna of observer station data
    msg1008 -- antenna of observer station data
    msg1009 -- pRange data GLONASS L1
    msg1010 -- pRange data GLONASS L1
    msg1011 -- pRange data GLONASS L1, L2
    msg1012 -- pRange data GLONASS L1, L2
    msg1013 -- system parameters data
    localrTCMPackage LOCAL.RTCMPackage OPTIONAL,
-- The below items shall never be sent over WSM stack encoding (other encodings may be
used) and may be removed from the ASN,
    msg1014 -- Network Aux Station (NAS) data
    msg1015 -- Ionospheric Correction data
    msg1016 -- Geometry Correction data
    msg1017 -- Combined Ionospheric and Geometry data
    -- msg1018 is reserved at this time.
    msg1019 -- Satellite Ephermeris data
    msg1020 -- Satellite Ephermeris data
    msg1021 -- Helmert-Abridged Molodenski Transform data
    msg1022 -- Molodenski-Badekas Transform data
    msg1023 -- Ellipse Residuals data
    msg1024 -- Plane-Grid Residuals data
    msg1025 -- Non-Lab Conic Project data
    msg1026 -- Lab Conic Conform Project data
```

```
    msg1027 -- Ob Mercator Project data
    -- msg1028 is reserved at this time.
    msg1029 -- Unicode test type data
    msg1030 -- GPS Residuals data
    msg1031 -- GLONASS Residuals data
    msg1032 -- Ref Station Position data"
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 170 },  -- VehicleLocationCorrectionPosition
     { localDataFrames rTCMPackage(1) },
     { localDataFrames rTCMPackage2(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 60 },  -- GPSUnit-status
     { j2735DataElements 6 }  -- AntennaOffset-per  }
-- REFERENCED-EXTERNALS
--     RTCM.Msg1001
--     RTCM.Msg1002
--     RTCM.Msg1003
--     RTCM.Msg1004
--     RTCM.Msg1005
--     RTCM.Msg1006
--     RTCM.Msg1007
--     RTCM.Msg1008
--     RTCM.Msg1009
--     RTCM.Msg1010
--     RTCM.Msg1011
--     RTCM.Msg1012
--     RTCM.Msg1013
--     RTCM.Msg1014
--     RTCM.Msg1015
--     RTCM.Msg1016
--     RTCM.Msg1017
--     RTCM.Msg1019
--     RTCM.Msg1020
--     RTCM.Msg1021
--     RTCM.Msg1022
--     RTCM.Msg1023
--     RTCM.Msg1024
--     RTCM.Msg1025
--     RTCM.Msg1026
--     RTCM.Msg1027
--     RTCM.Msg1029
--     RTCM.Msg1030
--     RTCM.Msg1031
--     RTCM.Msg1032
DATA-TYPE "
        VehicleLocationCorrection ::= SEQUENCE {
    anchorPoint VehicleLocationCorrectionPosition OPTIONAL,
    status      GPSUnit-status,
    offset      AntennaOffset-per,
    msg1001     RTCM.Msg1001 OPTIONAL,
    msg1002     RTCM.Msg1002 OPTIONAL,
    msg1003     RTCM.Msg1003 OPTIONAL,
    msg1004     RTCM.Msg1004 OPTIONAL,
    msg1005     RTCM.Msg1005 OPTIONAL,
    msg1006     RTCM.Msg1006 OPTIONAL,
    msg1007     RTCM.Msg1007 OPTIONAL,
    msg1008     RTCM.Msg1008 OPTIONAL,
    msg1009     RTCM.Msg1009 OPTIONAL,
    msg1010     RTCM.Msg1010 OPTIONAL,
    msg1011     RTCM.Msg1011 OPTIONAL,
    msg1012     RTCM.Msg1012 OPTIONAL,
    msg1013     RTCM.Msg1013 OPTIONAL,
    localrTCMPackage   LOCAL.RTCMPackage OPTIONAL,
    msg1014     RTCM.Msg1014 OPTIONAL,
```

```
    msg1015    RTCM.Msg1015 OPTIONAL,
    msg1016    RTCM.Msg1016 OPTIONAL,
    msg1017    RTCM.Msg1017 OPTIONAL,
    msg1019    RTCM.Msg1019 OPTIONAL,
    msg1020    RTCM.Msg1020 OPTIONAL,
    msg1021    RTCM.Msg1021 OPTIONAL,
    msg1022    RTCM.Msg1022 OPTIONAL,
    msg1023    RTCM.Msg1023 OPTIONAL,
    msg1024    RTCM.Msg1024 OPTIONAL,
    msg1025    RTCM.Msg1025 OPTIONAL,
    msg1026    RTCM.Msg1026 OPTIONAL,
    msg1027    RTCM.Msg1027 OPTIONAL,
    msg1029    RTCM.Msg1029 OPTIONAL,
    msg1030    RTCM.Msg1030 OPTIONAL,
    msg1031    RTCM.Msg1031 OPTIONAL,
    msg1032    RTCM.Msg1032 OPTIONAL,
    localrTCMPackage2  LOCAL.RTCMPackage2 OPTIONAL,    ... }  "}
```

5.3.1.169 vehicleLocationCorrectionPosition

```
vehicleLocationCorrectionPosition ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleLocationCorrectionPosition:frame"
ASN-NAME "VehicleLocationCorrectionPosition"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 170 }
DEFINITION     "This data frame represents the full position vector of the reference
connected device providing the differential corrections to the host connected device.
This data frame is only broadcasted by the remote connected device if the source of the
differential corrections is not at a fixed location, e.g., a connected vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 34 },  -- DDateTime
     { j2735DataFrames 172 },  -- VehicleMovement
     { j2735DataFrames 73 }  -- LocationAccuracy  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 86 },  -- Location-longitude
     { j2735DataElements 85 },  -- Location-latitude
     { j2735DataElements 84 },  -- Location-elevation
     { j2735DataElements 213 }  -- Vehicle-heading  }
DATA-TYPE "
        VehicleLocationCorrectionPosition ::= SEQUENCE {
    utcTime    DDateTime,
    long       Location-longitude,
    lat Location-latitude,
    elevation  Location-elevation,
    heading    Vehicle-heading OPTIONAL,
    speed      VehicleMovement OPTIONAL,
    posAccuracy LocationAccuracy OPTIONAL,    ... }  "}
```

5.3.1.170 vehicleModel

```
vehicleModel ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleModel:frame"
ASN-NAME "VehicleModel"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 171 }
DEFINITION     "A data frame used to provide the vehicle class, make, model, and model
year."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
```

```
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 205 },  -- Vehicle-class
     { j2735DataElements 222 },  -- Vehicle-make
     { j2735DataElements 224 },  -- Vehicle-model
     { j2735DataElements 247 },  -- Vehicle-year
     { j2735DataElements 212 }  -- Vehicle-fuel-type  }
DATA-TYPE "
        VehicleModel ::= SEQUENCE {
    class      Vehicle-class,
    make       Vehicle-make OPTIONAL,
    model      Vehicle-model OPTIONAL,
    year       Vehicle-year OPTIONAL,
    fuelType   Vehicle-fuel-type OPTIONAL,    ... }  "}
```

5.3.1.171 vehicleMovement

```
vehicleMovement ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleMovement:frame"
ASN-NAME "VehicleMovement"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 172 }
DEFINITION     "A data frame that defines the transmission and speed of the vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 239 },  -- Vehicle-transmission
     { j2735DataElements 231 }  -- Vehicle-speed  }
DATA-TYPE "
        VehicleMovement ::= SEQUENCE {
    transmission       Vehicle-transmission,
    speed      Vehicle-speed }"}
```

5.3.1.172 vehiclePathHistory

```
vehiclePathHistory ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehiclePathHistory:frame"
ASN-NAME "VehiclePathHistory"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 173 }
DEFINITION     "A data frame that defines an adaptable set of points reflecting recent
vehicle movement over some period of time and/or distance.  The points present in this
data frame represent a concise representation(s) of the actual path history of the vehicle
based on allowable position error tolerance between the actual vehicle path and its
concise representation.  This data frame allows creating a sequence of positions
(typically a vehicle motion track) over a limited period of time or distance (each called
pathHistoryPointType).  If the initial anchor point, which would be the current position
of the vehicle, is provided in the message in which this data frame is sent (such as the
basicSafetyMessage, then the initialPosition (vehiclePositionMark data frame) shall not be
sent.  The initial anchor point is used to create the offset values of the set.  Each path
history point is subtracted from the initial anchor point to create the offset values.
The first point set in the message is the closest in time to the anchor point, older
points follow in the order in which they were determined.  Each pathHistoryPointType is
supported in an octet blob style, and the sets of data in pathHistoryPointType are sent in
a single final octet blob (in other words each octet is made up of one or more sets of
inner data, using the same encoding).  The number of points sent in the
pathHistoryPointType01List data frame can be determined by inspecting the length of the T-
L-V of the ASN when sent.  The lat-long offset units used in the pathHistoryPointType
octet stream support units of 1/10th micro degrees of latitude and longitude.  The
elevation offset units are in 10 centimeter units.  The time is expressed in units of 10
ms. The GPSUnit-status uses 4 bytes to relate the pseudorange noise measured in the
system. The heading and speed are not offset values, and follow the units defined.  All of
these items are defined further in the relevant data entry."
DESCRIPTIVE-NAME-CONTEXT {""}
```

```
DATA-CONCEPT-TYPE data-frame
REMARKS  "Sets of octets in paths will be packed bit shifted and aligned such that no
unused bits are created.  This will require shifting every odd history point by 4 bits for
those data sets that do not end on an even byte boundary (those with no elevation entry).
 The very last four bits of the very last byte of the last point shall be filled with
zeros if it does not end on a byte boundary."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 175 },  -- VehiclePositionMark
     { j2735DataFrames 98 }  -- PathHistoryPointType01List  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 60 }  -- GPSUnit-status  }
DATA-TYPE "
        VehiclePathHistory ::= SEQUENCE {
    initialPosition    VehiclePositionMark OPTIONAL,
    currGPSstatus      GPSUnit-status OPTIONAL,
    crumbData  PathHistoryPointType01List,    ... }  "}
```

5.3.1.173 vehiclePathPrediction

```
vehiclePathPrediction ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehiclePathPrediction:frame"
ASN-NAME "VehiclePathPrediction"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 174 }
DEFINITION     "A data frame that allows vehicles to share their predicted path
trajectory by estimating future vehicle path of travel.  This future trajectory estimation
provides an indication of future positions of the transmitting vehicle and can
significantly enhance in-lane and out-of-lane threat classification.  Trajectories are
presented at a first order of curvature approximation, as a circle with a radius R, at an
origin located at (0, R), where the x-axis is bore sight from the transmitting device's
direction of motion and normal to the vehicle's vertical axis."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { localDataFrames pathPrediction(1) }  }
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 206 },  -- Vehicle-curve
     { j2735DataElements 207 }  -- Vehicle-curve-confidence  }
DATA-TYPE "
        VehiclePathPrediction ::= SEQUENCE {
    curve      Vehicle-curve,
    curveConfidence    Vehicle-curve-confidence,
    localPathPrediction       LOCAL.PathPrediction OPTIONAL,    ... }  "}
```

5.3.1.174 vehiclePositionMark

```
vehiclePositionMark ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehiclePositionMark:frame"
ASN-NAME "VehiclePositionMark"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 175 }
DEFINITION     "An association that references the definitive and precise location of the
vehicle's position."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 75 }  -- LocationMark  }
DATA-TYPE "
        VehiclePositionMark ::= LocationMark  "}
```

5.3.1.175 vehicleRequestItems

```
vehicleRequestItems ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleRequestItems:frame"
ASN-NAME "VehicleRequestItems"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 176 }
DEFINITION     "A data frame that contains a sequence of items requested from one device
to another device.  Each item consists of a piece of information that may be collected or
stored on the other device."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 266 }  -- VehicleRequest-item  }
DATA-TYPE "
        VehicleRequestItems ::= SEQUENCE (SIZE(1..32)) OF VehicleRequest-item"}
```

5.3.1.176 vehicleSize

```
vehicleSize ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleSize:frame"
ASN-NAME "VehicleSize"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 177 }
DEFINITION     "A data frame representing the vehicle length and vehicle width."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 243 },  -- Vehicle-width
     { j2735DataElements 219 }  -- Vehicle-length  }
DATA-TYPE "
        VehicleSize ::= SEQUENCE {
    width      Vehicle-width,
    length     Vehicle-length }"}
```

5.3.1.177 vehicleTire

```
vehicleTire ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleTire:frame"
ASN-NAME "VehicleTire"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 178 }
DEFINITION     "A data frame to provide information about a connected vehicle's tire."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 267 },  -- VehicleTire-location
     { j2735DataElements 268 },  -- VehicleTire-pressure
     { j2735DataElements 269 },  -- VehicleTire-temperature
     { j2735DataElements 270 }  -- VehicleTire-threshold  }
DATA-TYPE "
        VehicleTire ::= SEQUENCE {
    location   VehicleTire-location,
    pressure   VehicleTire-pressure,
    temperatureVehicleTire-temperature OPTIONAL,
    threshold  VehicleTire-threshold,    ... }  "}
```

5.3.1.178 vehicleTires

```
vehicleTires ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "VehicleTires:frame"
ASN-NAME "VehicleTires"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 179 }
DEFINITION     "A data frame that contains information about each tire on the connected
vehicle.  Typically used for commercial motor vehicles, it provides information about
tires on the power unit and any trailers that are being towed."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 178 }  -- VehicleTire  }
DATA-TYPE "
        VehicleTires ::= SEQUENCE (SIZE(1..64)) OF VehicleTire"}
```

5.3.1.179 wiperStatus

```
wiperStatus ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "WiperStatus:frame"
ASN-NAME "WiperStatus"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 180 }
DEFINITION     "A data frame that provides the current status of the wiper systems on the
subject vehicle, including front and rear wiper systems (where equipped)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  "Note that when the state changes an event flag may be raised in the
basicSafetyMessage and this data frame may be transmitted in Part II of that message to
relate the new state."
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 244 },  -- Vehicle-wipers-front
     { j2735DataElements 245 },  -- Vehicle-wipers-front-rate
     { j2735DataElements 246 }  -- Vehicle-wipers-rear  }
DATA-TYPE "
        WiperStatus ::= SEQUENCE {
    statusFront Vehicle-wipers-front,
    rateFront  Vehicle-wipers-front-rate,
    statusRear Vehicle-wipers-rear OPTIONAL,    ... }  "}
```

5.3.1.180 zoneNode

```
zoneNode ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ZoneNode:frame"
ASN-NAME "ZoneNode"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 181 }
DEFINITION     "This data frame defines a point along the centerline of a zone used for
which a signal priority or signal preemption scheme applies. Each point is a set of signed
offset values for determining the latitude, longitude, and optionally elevation, using the
then current reference point object to build a single point along the centerline of the
zone.  Each subsequent set of offset values (node) is additive and is the offset from the
last point."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 273 },  -- ZoneNode-x-offset
     { j2735DataElements 274 },  -- ZoneNode-y-offset
     { j2735DataElements 275 }  -- ZoneNode-z-offset  }
```

```
DATA-TYPE "
        ZoneNode ::= SEQUENCE {
    xOffset    ZoneNode-x-offset,
    yOffset    ZoneNode-y-offset,
    zOffset    ZoneNode-z-offset OPTIONAL,    ... }  "}
```

5.3.1.181 zoneNodes

```
zoneNodes ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "ZoneNodes:frame"
ASN-NAME "ZoneNodes"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 182 }
DEFINITION     "This data frame consists of a sequence of offset values used to describe
the centerline of a zone for which a signal priority or signal preemption scheme applies."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
REMARKS  ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 181 }  -- ZoneNode  }
DATA-TYPE "
        ZoneNodes ::= SEQUENCE (SIZE(1..32)) OF ZoneNode"}
```

5.4 Data Elements

This section defines the ISO 14817 ASN.1 representation of the data elements.

5.4.1 Acceleration4way Class Data Elements

5.4.1.1 acceleration4way-latitudinal

```
acceleration4way-latitudinal ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Acceleration4way.latitudinal:qty"
ASN-NAME "Acceleration4way-latitudinal"
ASN-OBJECT-IDENTIFIER { j2735DataElements 1 }
DEFINITION     "A data element representing the signed acceleration of the vehicle along
the Y axis or perpendicular to the vehicle's direction of travel in parallel with a left-
to right centerline, in units of 0.01 meters per second squared.  A range of over 2Gs is
supported.  Negative values indicate left turning action and positive values indicate
right-turning action.
The accuracy of the value shall be within 0.1 meters per second squared.  If the
acceleration is not within this accuracy, the value shall be set to unavailable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
        Acceleration4way-latitudinal ::= INTEGER (-2000..2001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "0.01 meters per second squared"
VALID-VALUE-RULE "The value 2000 shall be used for values greater than or equal to 2000.
The value -2000 shall be used for values less than or equal to -2000.  The value of 2001
shall be used when the value is unavailable."}
```

5.4.1.2 acceleration4way-longitudinal

```
acceleration4way-longitudinal ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Acceleration4way.longitudinal:qty"
ASN-NAME "Acceleration4way-longitudinal"
ASN-OBJECT-IDENTIFIER { j2735DataElements 2 }
DEFINITION     "A data element representing the signed acceleration of the vehicle along
its longitudinal axis, also known as its X axis or the vehicle's direction of travel in
parallel with a front to rear centerline, in units of 0.01 meters per second squared.  A
range of over 2Gs is supported.  Accelerations in the forward direction are taken as
positive, while negative values indicate braking action.
The accuracy of the value shall be within 0.1 meters per second squared.  If the
acceleration is not within this accuracy, the value shall be set to unavailable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Acceleration4way-longitudinal ::= INTEGER (-2000..2001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "0.01 meters per second squared"
VALID-VALUE-RULE "The value 2000 shall be used for values greater than or equal to 2000.
The value -2000 shall be used for values less than or equal to -2000.  The value of 2001
shall be used when the value is unavailable."}
```

5.4.1.3 acceleration4way-vertical

```
acceleration4way-vertical ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Acceleration4way.vertical:qty"
ASN-NAME "Acceleration4way-vertical"
ASN-OBJECT-IDENTIFIER { j2735DataElements 3 }
DEFINITION     "This one octet data element conveys the signed acceleration of the
vehicle along the vertical axis.  The sign follows the 'z-down orientation' convention of
SAE J670 (January 2008), so that acceleration downward is positive and acceleration upward
is negative.  The reader is encouraged to note the definitions provided in SAE J670 Figure
1B (Vehicle Axis Systems, Z-Down) and Figure 2B (Tire and Wheel Axis Systems, Z-Down).
The numeric representation of acceleration in this element is symmetric around zero
acceleration, and the precision is non-uniform.  Between -24 and +24 m/s^2 the precision
is 0.2 m/s^2.  The precision changes to 10 m/s^2 below -24 m/s^2 or above 24 m/s^2.
Integer -127 represents values equal or less than -94 m/s^2, -121 represents -34 m/s^2, -
120 represents -24 m/s^2, and each successive integer represents an increment of 0.2 m/s^2
up to integer +120, which represents 24 m/s^2.  Integer 121 represents value 34 m/s^2, 125
represents value 74 m/s^2, Integer 126 represents values equal or greater than 84 m/s^2.
Integer 127 represents 'unavailable' value.
By convention a device that is not accelerating or decelerating relative to the earth
surface shall report 0 m/s^2, and all other vertical accelerations are relative to this
convention, e.g. a device falling due to only gravity shall report 9.8 m/s^2, represented
by integer 49."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "   -- LSB precision of 0.2 m/s^2 steps over a range >= -24 and <= +24 m/s^2.
   -- LSB precision of 10 m/s^2 steps over a range < -24 or > 24 m/s^2 .
   -- value -127 = -94 m/s^2 or less,
   -- value -126 = -84 m/s^2
   -- value -125 = -74 m/s^2
   -- value -124 = -64 m/s^2
   -- value -123 = -54 m/s^2
   -- value -122 = -44 m/s^2
   -- value -121 = -34 m/s^2
   -- value -120 = -24 m/s^2
   -- value -119 = -23.8 m/s^2
   -- value    0 = 0 m/s^2
   -- value +119 = 23.8 m/s^2
```

```
   -- value +120 = 24.0 m/s^2
   -- value +121 = 34 m/s^2
   -- value +122 = 44 m/s^2
   -- value +123 = 54 m/s^2
   -- value +124 = 64 m/s^2
   -- value +125 = 74 m/s^2
   -- value +126 = 84 m/s^2 or greater
   -- value +127 for unavailable data."
STANDARD "SAE J2735"
DATA-TYPE "
    Acceleration4way-vertical ::= INTEGER (-127..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters per second squared"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.1.4 acceleration4way-yaw

```
acceleration4way-yaw ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Acceleration4way.yaw:rt"
ASN-NAME "Acceleration4way-yaw"
ASN-OBJECT-IDENTIFIER { j2735DataElements 4 }
DEFINITION     "The yaw rate of the vehicle is a signed value (to the right being
positive) and expressed in 0.01 degrees per second.  The yaw rate describes the amount of
a vehicle's rotation about its longitudinal axis in degrees per second.  For probe data,
the yaw rate describes the amount of a vehicle's rotation within a certain time period,
often at the time a Probe Data snapshot was taken.
The accuracy of the yaw rate is to be within 0.3 degrees per second.  If the yaw rate is
not within this accuracy, the value shall be set to unavailable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Acceleration4way-yaw ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "0.01 degrees per second"
VALID-VALUE-RULE "The value of 32766 shall be used when the value is equal to or greater
than 32766.  The value of 32767 shall be used when the value is unavailable."}
```

5.4.2 advisory Class Data Elements

5.4.2.1 advisory-identifier

```
advisory-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "advisory.Advisory-identifier:id"
ASN-NAME "Advisory-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 5 }
DEFINITION     "This data element is used as a message identifier for travel advisory
messages.  If supported, this data element can provide a link number to an event
identifier or other messages (described here and in other message set standards) which
relate to the same event."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Some message sets allow a request of other relevant messages by use of this
identifier, some others do not.  Some messages do not yet support this identifier and
force the message receiver to sort the recovered message to align event geographically.
This is expected to be an area of harmonization.  Developers should also note that data
from different source agencies can vary with the numbering used as well."
STANDARD "SAE J2735"
DATA-TYPE "
    Advisory-identifier ::= OCTET STRING (SIZE(2))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.3 AntennaOffset Class Data Elements

5.4.3.1 antennaOffset-per

```
antennaOffset-per ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "AntennaOffset.per:lctn"
ASN-NAME "AntennaOffset-per"
ASN-OBJECT-IDENTIFIER { j2735DataElements 6 }
DEFINITION     "This data element represents the UNALIGNED PER encoding of the
antennaOffset data frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 3 }  -- antennaOffset  }
DATA-TYPE "
    AntennaOffset-per ::= OCTET STRING (SIZE(4))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.3.2 antennaOffset-x

```
antennaOffset-x ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "AntennaOffset.x:lctn"
ASN-NAME "AntennaOffset-x"
ASN-OBJECT-IDENTIFIER { j2735DataElements 7 }
DEFINITION     "This data element represents the orthogonal offset from a known anchor
point to the electrical center of the GPS antenna along the longitudinal axis.  For a
vehicle, the anchor point is the center of the vehicle, and the offset is along the
longitudinal axis of the vehicle's SAE coordinate system; with the front of the vehicle
being a positive value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    AntennaOffset-x ::= INTEGER (-8191..8191)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.3.3 antennaOffset-y

```
antennaOffset-y ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "AntennaOffset.y:lctn"
ASN-NAME "AntennaOffset-y"
ASN-OBJECT-IDENTIFIER { j2735DataElements 8 }
DEFINITION     "This data element represents the orthogonal offset from a known anchor
point to the electrical center of the GPS antenna along the lateral axis.  For a vehicle,
the anchor point is the center of the vehicle, and the offset is along the lateral axis of
the vehicle's SAE coordinate system; with the right side of the vehicle, while facing
along the front of the vehicle, being a positive value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    AntennaOffset-y ::= INTEGER (-255..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.3.4 antennaOffset-z

```
antennaOffset-z ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "AntennaOffset.z:lctn"
ASN-NAME "AntennaOffset-z"
ASN-OBJECT-IDENTIFIER { j2735DataElements 9 }
DEFINITION     "This data element represents the orthogonal offset from a known anchor
point to the electrical center of the GPS antenna along the vertical axis.  For a vehicle,
the offset is taken from the bottom of the tires and the surface on which the vehicle is
resting, and normal to the Z-axis of the vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    AntennaOffset-z ::= INTEGER (-32767..511)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.4 Circle Class Data Elements

5.4.4.1 circle-radius

```
circle-radius ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Circle.radius:qty"
ASN-NAME "Circle-radius"
ASN-OBJECT-IDENTIFIER { j2735DataElements 11 }
DEFINITION     "This data element represents the radius from an anchor point and is used
to define a circular geometric area centered from this anchor point and extended to this
radius.  This geometric area defines a valid region within which a message or a traveler
information item is applicable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Circle-radius ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.5 Cmv Class Data Elements

5.4.5.1 cmv-current-trip-oer

```
cmv-current-trip-oer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Cmv.current-trip-oer:bin"
ASN-NAME "Cmv-current-trip-oer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 12 }
DEFINITION     "This data element is the OER encoding of the cmvTrip data frame.  This
data element is used by commercial motor vehicle to provide its bill of lading and
hazardous materials information."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 24 }  -- cmvTrip  }
DATA-TYPE "
    Cmv-current-trip-oer ::= OCTET STRING (SIZE(3..23))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.5.2 cmv-hazmat-identifier

```
cmv-hazmat-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Cmv.hazmat-identifier:nbr"
ASN-NAME "Cmv-hazmat-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 13 }
DEFINITION     "The CFR Title 49 hazardous material code for any observed or detected
hazardous materials.  (Reference 49CFR-172.336 and 172.101 Hazardous Materials Table)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Cmv-hazmat-identifier ::= INTEGER (0..9999)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.5.3 cmv-instructions

```
cmv-instructions ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Cmv.instructions:cd"
ASN-NAME "Cmv-instructions"
ASN-OBJECT-IDENTIFIER { j2735DataElements 14 }
DEFINITION     "This data element indicates if a commercial vehicle is cleared to bypass
or if the commercial vehicle is required to pull-into a roadside check station.  Typically
used with commercial vehicle operations."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Cmv-instructions ::= ENUMERATED {
    nodata (0),
    bypass (1),
    pullin (2),
    stationclosed (3),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "noData (0)
bypass (1)
pull-in (2)
station closed (3)"}
```

5.4.5.4 cmv-placard-identifier

```
cmv-placard-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Cmv.placard-identifier:nbr"
ASN-NAME "Cmv-placard-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 15 }
DEFINITION     "This data element is the numerical code representing the USDOT placard
code that is observed on the commercial motor vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "In the United States, the placard codes are defined in in CFR Title 49, Part
173."
STANDARD "SAE J2735"
DATA-TYPE "
    Cmv-placard-identifier ::= INTEGER (0..9999)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.6 CmvEncounter Class Data Elements

5.4.6.1 cmvEncounter-identifier

```
cmvEncounter-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "CmvEncounter.identifier:id"
ASN-NAME "CmvEncounter-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 16 }
DEFINITION     "This data element is an identifier assigned to each commercial vehicle
encounter.  An encounter may include screening events or safety inspections.  It is
discretion of the individual commercial vehicle agencies on how this identifier is
assigned."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    CmvEncounter-identifier ::= IA5String (SIZE(12))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "The value 0 shall be used when the value is unavailable."}
```

5.4.6.2 cmvEncounter-location-description

```
cmvEncounter-location-description ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "CmvEncounter.location-description:txt"
ASN-NAME "CmvEncounter-location-description"
ASN-OBJECT-IDENTIFIER { j2735DataElements 17 }
DEFINITION     "This data element is a text string providing a description of the
roadside check station.  This description may include directions to the roadside check
station.  Typically, this data element is associated with commercial vehicle operations."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    CmvEncounter-location-description ::= IA5String (SIZE(50))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.6.3 cmvEncounter-station

```
cmvEncounter-station ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "CmvEncounter.station:txt"
ASN-NAME "CmvEncounter-station"
ASN-OBJECT-IDENTIFIER { j2735DataElements 18 }
DEFINITION     "This data element is a text string name of the roadside check station."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "It is suggested that the name begin with the name of the agency performing the
roadside check."
STANDARD "SAE J2735"
DATA-TYPE "
    CmvEncounter-station ::= IA5String (SIZE(50))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.6.4 cmvEncounter-type

```
cmvEncounter-type ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "CmvEncounter.type:cd"
ASN-NAME "CmvEncounter-type"
ASN-OBJECT-IDENTIFIER { j2735DataElements 19 }
DEFINITION     "This data element identifies the types of roadside checks that were
performed during the encounter.  The type(s) is determined by what data was electronically
requested from the commercial vehicle.  The types of roadside checks include: vehicle
identification, driver identification, trailer data, cargo data, and driver duty logs."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    CmvEncounter-type ::=  BIT STRING {
    reserved0 (0),
    reserved1 (1),
    reserved2 (2),
    driverdutylogs (3),
    cargodata (4),
    trailerdata (5),
    driveridentification (6),
    vehicleidentificationinformation (7) } (SIZE(8))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.7 CmvRequest Class Data Elements

5.4.7.1 cmvRequest-default-direction

```
cmvRequest-default-direction ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "CmvRequest.default-direction:cd"
ASN-NAME "CmvRequest-default-direction"
ASN-OBJECT-IDENTIFIER { j2735DataElements 20 }
DEFINITION     "This data element represents the default allowed direction of travel on a
street lane or path described by shape points.  This data element is used to indicate the
direction of travel along the series of offset points defined for all shape point sets,
unless specified otherwise.  Valid values are forward (direction of travel follows node
ordering), reverse (direction of travel is the reverse of node ordering), or both
(direction of travel allowed in both directions)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    CmvRequest-default-direction ::= ENUMERATED {
    forward (0),
    reverse (1),
    both (2) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.7.2 cmvRequest-default-width

```
cmvRequest-default-width ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "CmvRequest.default-width:qty"
ASN-NAME "CmvRequest-default-width"
ASN-OBJECT-IDENTIFIER { j2735DataElements 21 }
DEFINITION     "A data element representing the default width of a geographic area in
units of 1 centimeter.  This width is used as part of the definition of geographic regions
where the commercial vehicle request is valid for, unless specified otherwise."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    CmvRequest-default-width ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.7.3 cmvRequest-encounter-identifier

```
cmvRequest-encounter-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "CmvRequest.encounter-identifier:id"
ASN-NAME "CmvRequest-encounter-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 22 }
DEFINITION     "This data element is the identifier assigned to the commercial vehicle
encounter for which an RSU is requesting information for, from a commercial motor vehicle.
 An encounter includes screening events, safety inspections or other roadside checks."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    CmvRequest-encounter-identifier ::= IA5String (SIZE(12))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.7.4 cmvRequest-item

```
cmvRequest-item ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "CmvRequest.item:cd"
ASN-NAME "CmvRequest-item"
ASN-OBJECT-IDENTIFIER { j2735DataElements 23 }
DEFINITION     "This data element is used to specify what item (or items) are being
requested from a connected commercial motor vehicle.  The requested item is typically
transmitted from a connected device to a commercial motor vehicle as part of commercial
vehicle roadside checks."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    CmvRequest-item ::=  BIT STRING {
    reserved0 (0),
    reserved1 (1),
    screeningevent (2),
    cargodata (3),
    trailerdata (4),
    driverdutylog (5),
    driveridentification (6),
    vehicleidentification (7) } (SIZE(8))  "
```

```
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.8 CmvScreening Class Data Elements

5.4.8.1 cmvScreeningAck-encounter-crc

```
cmvScreeningAck-encounter-crc ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "CmvScreeningAck-encounter-crc:bin"
ASN-NAME "CmvScreeningAck-encounter-crc"
ASN-OBJECT-IDENTIFIER { j2735DataElements 24 }
DEFINITION     "A two byte data element equal to the dSRCMessage-crc data element
previously transmitted in the commercialScreeningData message.  This data element is used
as a check to confirm the receiving connected device has properly received the message,
that is, the integrity of the message is intact."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    CmvScreeningAck-encounter-crc ::= OCTET STRING (SIZE(2))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.9 CmvTrip Class Data Elements

5.4.9.1 cmvTrip-shipping-identifier

```
cmvTrip-shipping-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "CmvTrip.shipping-identifier:txt"
ASN-NAME "CmvTrip-shipping-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 25 }
DEFINITION     "A data element containing the shipping document number or bill of lading
number assigned by the carrier.  This data element is typically used for commercial
vehicle credentialing."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    CmvTrip-shipping-identifier ::= IA5String (SIZE(1..16))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.10 ConnectedDevice Class Data Elements

5.4.10.1 connectedDevice-type

```
connectedDevice-type ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ConnectedDevice.type:cd"
ASN-NAME "ConnectedDevice-type"
ASN-OBJECT-IDENTIFIER { j2735DataElements 26 }
DEFINITION     "This data element indicates the type of connected device being
referenced.  This data element can be used to identify the type of center that a forwarded
message should be sent to.  To accept a forwarded message, the local network will be able
to identify the correct local center to send the message to based on the type identified."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
```

```
DATA-TYPE "
    ConnectedDevice-type ::=  BIT STRING {
    trafficmanagementcenter (0),
    publicsafetyagency (1),
    transitagency (2) } (SIZE(8))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.11 Global Class Data Elements

5.4.11.1 dDay

```
dDay ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Global.DDay:gps"
ASN-NAME "DDay"
ASN-OBJECT-IDENTIFIER { j2735DataElements 27 }
DEFINITION     "The DSRC style day is a simple value consisting of integer values from
zero to 31."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    DDay ::= INTEGER (0..31)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "day of month"
VALID-VALUE-RULE "The value 0 shall be used when the value is unavailable."}
```

5.4.11.2 dHour

```
dHour ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Global.DHour:gps"
ASN-NAME "DHour"
ASN-OBJECT-IDENTIFIER { j2735DataElements 28 }
DEFINITION     "The DSRC style hour is a simple value consisting of integer values from
zero to 23 representing the hours within a day.  The value of 31 SHALL represent an
unknown value, the range 24 to 30 is reserved."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    DHour ::= INTEGER (0..31)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "hour of day"
VALID-VALUE-RULE "The value 31 shall be used when the value is unavailable.  The values 24
to 30 are all reserved."}
```

5.4.11.3 dMinute

```
dMinute ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Global.DMinute:gps"
ASN-NAME "DMinute"
ASN-OBJECT-IDENTIFIER { j2735DataElements 29 }
DEFINITION     "The DSRC style minute is a simple value consisting of integer values from
zero to 59 representing the minutes within an hour."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    DMinute ::= INTEGER (0..63)  "
```

```
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "minute of hour"
VALID-VALUE-RULE "The value 63 shall be used when the value is unavailable.  The values 60
to 62 are all reserved."}
```

5.4.11.4 dMonth

```
dMonth ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Global.DMonth:gps"
ASN-NAME "DMonth"
ASN-OBJECT-IDENTIFIER { j2735DataElements 30 }
DEFINITION     "The DSRC style month is a simple value consisting of integer values from
one to 12 representing the month within a year.  The range 13 to 14 and the value zero are
all reserved."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    DMonth ::= INTEGER (0..15)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "month of year"
VALID-VALUE-RULE "The value 0 shall be used when the value is unavailable.  The values 0,
13 and 14 are all reserved."}
```

5.4.12 Driver Class Data Elements

5.4.12.1 driver-pin

```
driver-pin ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Driver.pin:txt"
ASN-NAME "Driver-pin"
ASN-OBJECT-IDENTIFIER { j2735DataElements 31 }
DEFINITION     "A data element identifying a driver's personal identification number
(PIN).  This PIN, which is a text field, is used to verify the identity of the driver."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "This data element is typically used for commercial vehicle purposes only, such as
for safety inspections, or for security purposes; and is typically assigned to a driver by
the motor carrier.  In the United States, this PIN is normally the last 4 digits of the
driver's social security number.  The driver must opt-in to allow this data element to be
transmitted."
STANDARD "SAE J2735"
DATA-TYPE "
    Driver-pin ::= IA5String (SIZE(1..40))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.13 DriverLogEvent Class Data Elements

5.4.13.1 driverLogEvent-diagnostic

```
driverLogEvent-diagnostic ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DriverLogEvent.diagnostic:cd"
ASN-NAME "DriverLogEvent-diagnostic"
ASN-OBJECT-IDENTIFIER { j2735DataElements 32 }
DEFINITION     "This data element records the type of diagnostic performed (e.g., power-
on, self-test, power-off, etc.) for diagnostic events (events where the driverLogEvent-
status is noted as 'DG' - See driverLogEvent-status)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
```

```
REMARKS "Values supported:
   PWRON - Power on - EOBR initial power-on.
   PWROFF - Power off - EOBR power-off.
   TESTOK - test okay - EOBR self-test successful.
   SERVIC - Service - EOBR Malfunction (return unit to factory for servicing).
   MEMERR - memory error - System memory error.
   LOWVLT - Low voltage - Low system supply voltage.
   BATLOW - battery low - Internal system battery backup low.
   CLKERR - clock error - EOBR system clock error (clock not set or defective).
   BYPASS - Bypass - EOBR system bypassed (RODS data not collected).
   INTFUL - internal memory full - Internal storage memory full (requires download or
transfer to external storage).
   DATACC - Data accepted - System accepted driver data entry.
   EXTFUL - external memory full- External memory full (smartcard or other external data
storage device full).
   EXTERR - external data access error - Access external storage device failed.
   DLOADY - download yes - EOBR data download successful.
   DLOADN - download no - Data download rejected (unauthorized request/wrong Password)."
STANDARD "SAE J2735"
DATA-TYPE "
    DriverLogEvent-diagnostic ::= ENUMERATED {
    pwron (1),
    pwroff (2),
    testok (3),
    servic (4),
    memerr (5),
    lowvlt (6),
    batlow (7),
    clkerr (8),
    bypass (9),
    intful (10),
    datacc (11),
    extful (12),
    exterr (13),
    dloady (14),
    dloadn (15) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.13.2 driverLogEvent-distance

```
driverLogEvent-distance ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DriverLogEvent.distance:qty"
ASN-NAME "DriverLogEvent-distance"
ASN-OBJECT-IDENTIFIER { j2735DataElements 33 }
DEFINITION     "This data element represents the distance in kilometers to nearest
populated place from the location where an event occurred.  The nearest populated place
location is defined by the driverLogEvent-place data element."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    DriverLogEvent-distance ::= INTEGER (-32767..99999)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "kilometers"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.13.3 driverLogEvent-error

```
driverLogEvent-error ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DriverLogEvent.error:cd"
ASN-NAME "DriverLogEvent-error"
ASN-OBJECT-IDENTIFIER { j2735DataElements 34 }
DEFINITION     "This data element represents the error code associated with an event.
Typically, this data element is associated with on board recording devices for commercial
vehicle drivers."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Values supported:
 NODRID - no driver ID - No driver information in system and vehicle is in motion.
 PINERR - PIN error - Driver PIN/identification number invalid.
 DRIDRD - Driver ID read - Driver information successfully read from external storage
device (transferred to EOBR).
 DPYERR - display error - EOBR display malfunction.
 KEYERR - keyboard error - EOBR keyboard/input device malfunction.
 NOLTLN - no latitude longitude - No latitude and longitude from positioning sensor.
 NOTSYC - no time synchronization - Unable to synchronize with external time reference
input.
 COMERR - communications error - Unable to communicate with external data link (to home
office or wireless service provider).
 NOECM - no ECM data - No sensory information received from vehicle's Engine Control
Module (ECM).
 ECMID - ECM ID number mismatch - ECM identification / serial number mismatch (with
preprogrammed information)."
STANDARD "SAE J2735"
DATA-TYPE "
    DriverLogEvent-error ::= ENUMERATED {
    nodrid (1),
    pinerr (2),
    dridrd (3),
    dpyerr (4),
    keyerr (5),
    noltln (6),
    notsyc (7),
    comerr (8),
    noecm (9),
    ecmid (10) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.13.4 driverLogEvent-odometer

```
driverLogEvent-odometer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DriverLogEvent.odometer:qty"
ASN-NAME "DriverLogEvent-odometer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 35 }
DEFINITION     "This data element represents the total vehicle kilometers traveled as
noted on vehicle odometer or as measured by any other compliant means such as vehicle
location system, etc.  With total vehicle distance recorded at the time of each event,
vehicle distance traveled while driving, etc., can be computed."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    DriverLogEvent-odometer ::= INTEGER (0..9999999)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "kilometers"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.13.5 driverLogEvent-place

```
driverLogEvent-place ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DriverLogEvent.place:cd"
ASN-NAME "DriverLogEvent-place"
ASN-OBJECT-IDENTIFIER { j2735DataElements 36 }
DEFINITION     "This data element represents the location where an event occurred.  The
location codes must correspond, at a minimum, to ANSI INCITS 446-2008, American National
Standard for Information Technology - Identifying Attributes for Named Physical and
Cultural Geographic Features (Except Roads and Highways) of the United States, Its
Territories, Outlying Areas, and freely Associated Areas and the Waters of the Same to the
Limit of the Twelve-Mile Statutory Zone (10/28/2008), where GNIS Feature Class = Populated
Place (incorporated by reference, see Federal Motor Carrier Safety Administration, 49 CFR
Parts 395.18).  For further information, see also the Geographic Names Information System
(GNIS) at http://geonames.usgs.gov/domestic/index.html."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Each location code is unique within a FIPS state code.  Lookup list derived from
GNIS."
STANDARD "SAE J2735"
DATA-TYPE "
    DriverLogEvent-place ::= INTEGER (-32767..99999)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.13.6 driverLogEvent-sequence-number

```
driverLogEvent-sequence-number ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DriverLogEvent.sequence-number:id"
ASN-NAME "DriverLogEvent-sequence-number"
ASN-OBJECT-IDENTIFIER { j2735DataElements 37 }
DEFINITION     "A data element that provides a serial identifier for an event that is
unique to a particular vehicle and a particular day.  Typically, this data element is
associated with on board recording devices for commercial vehicle drivers."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    DriverLogEvent-sequence-number ::= INTEGER (1..9999)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.13.7 driverLogEvent-status

```
driverLogEvent-status ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DriverLogEvent.status:cd"
ASN-NAME "DriverLogEvent-status"
ASN-OBJECT-IDENTIFIER { j2735DataElements 38 }
DEFINITION     "Character codes for the four driver duty status change events, state
border crossing event, and diagnostic events.  This data element is associated with on
board recording devices for commercial vehicle drivers."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "OFF = Off Duty
  SB = Sleeper Berth
  D = On Duty Driving
  ON = On Duty Not Driving
  DG = Diagnostic."
STANDARD "SAE J2735"
```

```
DATA-TYPE "
    DriverLogEvent-status ::= ENUMERATED {
    off-duty (1),
    sleeper-berth (2),
    on-duty-driving (3),
    on-duty-not-driving (4),
    diagnostic (5) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.13.8 driverLogEvent-status-update

```
driverLogEvent-status-update ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DriverLogEvent.status-update:cd"
ASN-NAME "DriverLogEvent-status-update"
ASN-OBJECT-IDENTIFIER { j2735DataElements 39 }
DEFINITION     "This data element represents the status of an event, either Current (the
most up-to date, update or edit) or Historical (the original record if the record has
subsequently been updated or edited)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    DriverLogEvent-status-update ::= ENUMERATED {
    current (1),
    historical (2) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.13.9 driverLogEvent-update-person

```
driverLogEvent-update-person ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DriverLogEvent.update-person:id"
ASN-NAME "DriverLogEvent-update-person"
ASN-OBJECT-IDENTIFIER { j2735DataElements 40 }
DEFINITION     "This data element is an identifier of the person who last updated or
edited a record.  Typically, this data element is associated with on board recording
devices for commercial vehicle drivers."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    DriverLogEvent-update-person ::= IA5String (SIZE(40))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.13.10 driverLogEvent-update-reason

```
driverLogEvent-update-reason ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DriverLogEvent.update-reason:txt"
ASN-NAME "DriverLogEvent-update-reason"
ASN-OBJECT-IDENTIFIER { j2735DataElements 41 }
DEFINITION     "This data element contains a textual note related to the more recent
record updated or edited.  This is a brief narrative regarding the reason for the record
update or edit.  Typically, this data element is associated with on board recording
devices for commercial vehicle drivers."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
```

```
STANDARD "SAE J2735"
DATA-TYPE "
    DriverLogEvent-update-reason ::= IA5String (SIZE(60))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.14 Global Class Data Elements

5.4.14.1 dSecond

```
dSecond ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Global.DSecond:gps"
ASN-NAME "DSecond"
ASN-OBJECT-IDENTIFIER { j2735DataElements 42 }
DEFINITION     "The DSRC style second expressed in this data element is a simple value
consisting of integer values from zero to 60999 representing the ms within a minute.  A
leap second is represented by the value range 60000 to 60999.
The accuracy shall be within one millisecond of the actual atomic time (or some other
benchmark time) when the positioning data is determined.  If the accuracy cannot be met,
the value shall be set to unavailable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The value contained in the dSecond data element must refer to a known point in
time within the DSRC system that is shared or understood by the user community.  This
point in time is typically the moment when the position determination was made for most
messages (such as the basicSafetyMessage).  Other measurements present in the same message
(speed, heading etc.) should be aligned to that moment insofar as possible in the
implementation.
The need for a leap second arises from the difference between solar time and UTC time.  A
useful reference on this topic is: http://tycho.usno.navy.mil/leapsec.html  "
STANDARD "SAE J2735"
DATA-TYPE "
    DSecond ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "ms"
VALID-VALUE-RULE "The value of 65535 shall be used when the value is unavailable.  Values
from 61000 to 65534 are reserved."}
```

5.4.15 DSRCMessage Class Data Elements

5.4.15.1 dSRCMessage-crc

```
dSRCMessage-crc ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DSRCMessage.crc:bin"
ASN-NAME "DSRCMessage-crc"
ASN-OBJECT-IDENTIFIER { j2735DataElements 43 }
DEFINITION     "A two byte data element calculated over the payload bytes of the message
(starting with the initial sequence and ending with the last data element before the CRC
itself and including all tag, length, and values bytes found in between).  Always placed
as the very last data element in the message.  The generating polynomial used is the 'CRC-
CCITT' commonly expressed as x^16 + x^12 + x^5 + 1. An initial seed value of zero shall be
used.  Note that because the first byte of every DSRC message is never zero (it is 0x30),
framing errors due to incorrectly clocking initial zero values cannot occur.  Note that
the MSB byte is always transmitted first, following the typical ASN bytes order.  When a
well formed DSRC message (including its last two bytes holding the CRC value) is decoded
and input to the CRC process, the resulting CRC should always be the value zero."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Created with the CRC-CCITT polynomial."
STANDARD "SAE J2735"
DATA-TYPE "
    DSRCMessage-crc ::= OCTET STRING (SIZE(2))  "
```

```
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.15.2 dSRCMessage-sequence-number

```
dSRCMessage-sequence-number ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "DSRCMessage.sequence-number:id"
ASN-NAME "DSRCMessage-sequence-number"
ASN-OBJECT-IDENTIFIER { j2735DataElements 44 }
DEFINITION     "This data element is used to provide a sequence number within a stream of
messages of the same message type and from the same sender.  A sender may initialize this
element to any value in the range 0-127 when sending the first message with a given
message type, or if the sender has changed identity (e.g., by changing its vehicle-
temporary-identifier) since sending the most recent message with that message type.
Otherwise, this data element shall be set equal to one greater than the value used in the
most recent message of the same message type.  For this element the value after 127 is
zero.
The receipt of a non-sequential value (from the same sending device and message type)
implies that one or more messages from that sending device may have been lost, unless the
data element has been reinitialized due to an identity change."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "In usage, some devices change their vehicle-temporary-identifier frequently, to
prevent identity tracking, while others do not.  A change in vehicle-temporary-identifier
data element value (which also changes the message contents in which it appears) implies
that the dSRCMessage-sequence-number may also change value.
If a sender is composing a message with new content for a given message type, and the
vehicle-temporary-identifier has not changed since it sent the previous message, the
sender shall increment the previous value.
If a sender is composing a message with new content for a given message type, and the
vehicle-temporary-identifier has changed since it sent the previous message, the sender
may set the dSRCMessage-sequence-number to any valid value in the range (including
incrementing the previous value).
If a sender is composing a message with the same content as the most recent message of the
same message type, and less than 10 seconds have elapsed since it sent the previous
message of that message type, the sender will use the same dSRCMessage-sequence-number as
sent in the previous message.
If a sender is composing a message with the same content as the most recent message of the
same message type, and at least 10 seconds have elapsed since it sent the previous message
of that message type, the sender may set the dSRCMessage-sequence-number element to any
valid value in the range; this includes the reuse of the previous value.
If a sending device sends more than one stream of messages from message types that utilize
the dSRCMessage-sequence-number, it shall maintain a separate dSRCMessage-sequence-number
state for each message type so that the dSRCMessage-sequence-number value in a given
message identifies its place in the stream of that message type.  The dSRCMessage-
sequence-number element is a function only of the message type in a given sending device,
not of the one or more applications in that device which may be sending the same type of
message."
STANDARD "SAE J2735"
DATA-TYPE "
    DSRCMessage-sequence-number ::= INTEGER (0..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.16 Global Class Data Elements

5.4.16.1 dYear

```
dYear ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Global.DYear:gps"
ASN-NAME "DYear"
ASN-OBJECT-IDENTIFIER { j2735DataElements 45 }
DEFINITION     "The DSRC style year is a simple value consisting of integer values from
zero to 9999 representing the year according to the Gregorian calendar date system."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    DYear ::= INTEGER (0..9999)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "year"
VALID-VALUE-RULE "The value of 0 shall be used when the value is unknown."}
```

5.4.17 Emissions Class Data Elements

5.4.17.1 emissions-carbonmonoxide-idling

```
emissions-carbonmonoxide-idling ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.carbonmonoxide-idling:qty"
ASN-NAME "Emissions-carbonmonoxide-idling"
ASN-OBJECT-IDENTIFIER { j2735DataElements 46 }
DEFINITION     "This data element represents the amount of the carbon monoxide being
emitted by the vehicle as the vehicle is idling (not moving with the engine on)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 89.0
grams/hour."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-carbonmonoxide-idling ::= INTEGER (0..10001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".1 grams per hour"
VALID-VALUE-RULE "The value of 10001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.2 emissions-carbonmonoxide-running

```
emissions-carbonmonoxide-running ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.carbonmonoxide-running:qty"
ASN-NAME "Emissions-carbonmonoxide-running"
ASN-OBJECT-IDENTIFIER { j2735DataElements 47 }
DEFINITION     "This data element represents the amount of the carbon monoxide being
emitted by the vehicle as the vehicle is moving."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 0.83
grams/mile."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-carbonmonoxide-running ::= INTEGER (0..10001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".001 grams per kilometer"
VALID-VALUE-RULE "The value of 10001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.3 emissions-co2-idling

```
emissions-co2-idling ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.co2-idling:qty"
ASN-NAME "Emissions-co2-idling"
ASN-OBJECT-IDENTIFIER { j2735DataElements 48 }
DEFINITION     "This data element represents the amount of carbon dioxide (CO2) being
emitted by the vehicle as the vehicle is idling (not moving with the engine on)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 8977.0
grams/hour."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-co2-idling ::= INTEGER (0..300001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".1 grams per hour"
VALID-VALUE-RULE "The value of 300001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.4 emissions-co2-running

```
emissions-co2-running ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.co2-running:qty"
ASN-NAME "Emissions-co2-running"
ASN-OBJECT-IDENTIFIER { j2735DataElements 49 }
DEFINITION     "This data element represents the amount of carbon dioxide (CO2) being
emitted by the vehicle as the vehicle is moving."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 752.0
grams/mile."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-co2-running ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".1 grams per kilometer"
VALID-VALUE-RULE "The value of 65534 shall be used when the value is 65534 or greater.
The value of 65535 shall be used when the value is unknown or unavailable."}
```

5.4.17.5 emissions-nox-idling

```
emissions-nox-idling ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.nox-idling:qty"
ASN-NAME "Emissions-nox-idling"
ASN-OBJECT-IDENTIFIER { j2735DataElements 50 }
DEFINITION     "This data element represents the amount of nitrogen oxide being emitted
by the vehicle as the vehicle is idling (not moving with the engine on). Although nitrogen
oxide can refer to a binary compound of oxygen and nitrogen, or a mixture of such
compounds.  In atmospheric chemistry, air pollution, and related fields, nitrogen oxides
refers specifically to NOx (NO and NO2)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 236.00
grams/hour."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-nox-idling ::= INTEGER (0..1000001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".01 grams per hour"
VALID-VALUE-RULE "The value of 1000001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.6 emissions-nox-running

```
emissions-nox-running ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.nox-running:qty"
ASN-NAME "Emissions-nox-running"
ASN-OBJECT-IDENTIFIER { j2735DataElements 51 }
DEFINITION     "This data element represents the amount of nitrogen oxide being emitted
by the vehicle as the vehicle is moving. Although nitrogen oxide can refer to a binary
compound of oxygen and nitrogen, or a mixture of such compounds.  In atmospheric
chemistry, air pollution, and related fields, nitrogen oxides refers specifically to NOx
(NO and NO2)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 3.50
grams/mile."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-nox-running ::= INTEGER (0..10001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".01 grams per kilometer"
VALID-VALUE-RULE "The value of 10001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.7 emissions-pm10-idling

```
emissions-pm10-idling ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.pm10-idling:qty"
ASN-NAME "Emissions-pm10-idling"
ASN-OBJECT-IDENTIFIER { j2735DataElements 52 }
DEFINITION     "This data element represent the amount of particulate matter (PM) smaller
than 10 microns in diameter being emitted by the vehicle as the vehicle is idling (not
moving with the engine on).  Particulate matter is the term for solid or liquid particles
found in the air. Some particles are large or dark enough to be seen as soot or smoke, but
fine particulate matter is tiny and is generally not visible to the naked eye. Mobile
source particulate emissions consist mainly of these very tiny particles; PM10 includes
particles smaller than 10 microns in diameter."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 1.76
grams/hour."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-pm10-idling ::= INTEGER (0..10001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".001 grams per hour"
VALID-VALUE-RULE "The value of 10001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.8 emissions-pm10-running

```
emissions-pm10-running ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.pm10-running:qty"
ASN-NAME "Emissions-pm10-running"
ASN-OBJECT-IDENTIFIER { j2735DataElements 53 }
DEFINITION     "This data element represent the amount of particulate matter (PM) smaller
than 10 microns in diameter being emitted by the vehicle as the vehicle is moving.
Particulate matter is the term for solid or liquid particles found in the air. Some
particles are large or dark enough to be seen as soot or smoke, but fine particulate
matter is tiny and is generally not visible to the naked eye. Mobile source particulate
emissions consist mainly of these very tiny particles; PM10 includes particles smaller
than 10 microns in diameter."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
```

```
REMARKS "The FMCSA average for an average long-haul truck emissions level is 0.16
grams/mile."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-pm10-running ::= INTEGER (0..1001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".001 grams per kilometer"
VALID-VALUE-RULE "The value of 1001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.9 emissions-pm25-idling

```
emissions-pm25-idling ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.pm25-idling:qty"
ASN-NAME "Emissions-pm25-idling"
ASN-OBJECT-IDENTIFIER { j2735DataElements 54 }
DEFINITION     "This data element represent the amount of particulate matter (PM) smaller
than 2.5 microns in diameter being emitted by the vehicle as the vehicle is idling (not
moving with the engine on).  Particulate matter is the term for solid or liquid particles
found in the air. Some particles are large or dark enough to be seen as soot or smoke, but
fine particulate matter is tiny and is generally not visible to the naked eye. Mobile
source particulate emissions consist mainly of these very tiny particles; PM2.5 includes
particles smaller than 2.5 microns in diameter."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 1.71
grams/hour."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-pm25-idling ::= INTEGER (0..10001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".001 grams per hour"
VALID-VALUE-RULE "The value of 10001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.10 emissions-pm25-running

```
emissions-pm25-running ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.pm25-running:qty"
ASN-NAME "Emissions-pm25-running"
ASN-OBJECT-IDENTIFIER { j2735DataElements 55 }
DEFINITION     "This data element represent the amount of particulate matter (PM) smaller
than 2.5 microns in diameter being emitted by the vehicle as the vehicle is moving.
Particulate matter is the term for solid or liquid particles found in the air. Some
particles are large or dark enough to be seen as soot or smoke, but fine particulate
matter is tiny and is generally not visible to the naked eye. Mobile source particulate
emissions consist mainly of these very tiny particles; PM2.5 includes particles smaller
than 2.5 microns in diameter."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 0.16
grams/mile."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-pm25-running ::= INTEGER (0..1001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".001 grams per kilometer"
VALID-VALUE-RULE "The value of 1001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.11 emissions-so2-idling

```
emissions-so2-idling ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.so2-idling:qty"
ASN-NAME "Emissions-so2-idling"
ASN-OBJECT-IDENTIFIER { j2735DataElements 56 }
DEFINITION     "This data element represents the amount of sulfur dioxide (SO2) being
emitted by the vehicle as the vehicle is idling (not moving with the engine on)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 0.06
grams/hour."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-so2-idling ::= INTEGER (0..10001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".0001 grams per hour"
VALID-VALUE-RULE "The value of 10001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.12 emissions-so2-running

```
emissions-so2-running ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.so2-running:qty"
ASN-NAME "Emissions-so2-running"
ASN-OBJECT-IDENTIFIER { j2735DataElements 57 }
DEFINITION     "This data element represents the amount of sulfur dioxide (SO2) being
emitted by the vehicle as the vehicle is moving."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 0.006
grams/mile."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-so2-running ::= INTEGER (0..10001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".0001 grams per kilometer"
VALID-VALUE-RULE "The value of 10001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.13 emissions-voc-idling

```
emissions-voc-idling ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.voc-idling:qty"
ASN-NAME "Emissions-voc-idling"
ASN-OBJECT-IDENTIFIER { j2735DataElements 58 }
DEFINITION     "This data element represent the amount of volatile organic compounds
(VOCs) being emitted by the vehicle as the vehicle is idling (not moving with the engine
on).  Volatile organic compounds (VOCs) are organic chemicals that have a high vapor
pressure at ordinary, room-temperature conditions.  Some VOCs are dangerous to human
health or cause harm to the environment."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 55.0
grams/hour."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-voc-idling ::= INTEGER (0..10001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".1 grams per hour"
VALID-VALUE-RULE "The value of 10001 shall be used when the value is unknown or
unavailable."}
```

5.4.17.14 emissions-voc-running

```
emissions-voc-running ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Emissions.voc-running:qty"
ASN-NAME "Emissions-voc-running"
ASN-OBJECT-IDENTIFIER { j2735DataElements 59 }
DEFINITION     "This data element represent the amount of volatile organic compounds
(VOCs) being emitted by the vehicle as the vehicle is moving.  Volatile organic compounds
(VOCs) are organic chemicals that have a high vapor pressure at ordinary, room-temperature
conditions.  Some VOCs are dangerous to human health or cause harm to the environment."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The FMCSA average for an average long-haul truck emissions level is 0.15
grams/mile."
STANDARD "SAE J2735"
DATA-TYPE "
    Emissions-voc-running ::= INTEGER (0..10001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ".001 grams per kilometer"
VALID-VALUE-RULE "The value of 10001 shall be used when the value is unknown or
unavailable."}
```

5.4.18 GPS Class Data Elements

5.4.18.1 gPSUnit-status

```
gPSUnit-status ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "GPSUnit-status:cd"
ASN-NAME "GPSUnit-status"
ASN-OBJECT-IDENTIFIER { j2735DataElements 60 }
DEFINITION     "This data element is used to relate the status of a GPS system in terms
of its general health, lock on satellites in view, and use of any correction information.
 Various bits can be asserted (made to a value of one) to reflect these values."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "A GPS set with unknown health and not tracking or corrections would be
represented by all zeros.  A value of zero shall be used when the data is unavailable.
  unavailable (0),              -- Not equipped or unavailable
  ishealthy (1),
  ismonitored (2),
  basestationtype (3),          -- Set to zero if a moving base station, set to one if it
is a fixed based station
  apdopofunder5 (4),             -- A dilution of precision greater than 5
  inviewofunder5 (5),           -- Less than 5 satellites in view
  localcorrectionspresent (6),
  networkcorrectionspresent (7)"
STANDARD "SAE J2735"
DATA-TYPE "
    GPSUnit-status ::= ENUMERATED {
    unavailable (0),
    ishealthy (1),
    ismonitored (2),
    basestationtype (3),
    apdopofunder5 (4),
    inviewofunder5 (5),
    localcorrectionspresent (6),
    networkcorrectionspresent (7) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.19 Intersection Class Data Elements

5.4.19.1 intersection-default-lane-width

```
intersection-default-lane-width ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Intersection.default-lane-width:qty"
ASN-NAME "Intersection-default-lane-width"
ASN-OBJECT-IDENTIFIER { j2735DataElements 61 }
DEFINITION     "This data element is used to define the default width to use for all
lanes related to the intersection; the value may be overridden within the definition of
each lane."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Intersection-default-lane-width ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.19.2 intersection-identifier

```
intersection-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Intersection.identifier:id"
ASN-NAME "Intersection-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 62 }
DEFINITION     "This data element is used to globally and uniquely define an intersection
within a country or region in a 32 bit field."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Assignment rules for this value are established elsewhere and may use regional
assignment schemas that vary.  Note that often only the lower 16 bits of this value will
be sent as the operational region (e.g., state or province) will be known and not sent
each time.  Values with the first three bytes set as zero are reserved for use as
reference intersection identifiers (intersection which may be reused in other places by
providing an identifier and an anchor point to locate them)."
STANDARD "SAE J2735"
DATA-TYPE "
    Intersection-identifier ::= OCTET STRING (SIZE(2..4))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.19.3 intersection-identifier-referenced

```
intersection-identifier-referenced ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Intersection.identifier-referenced:id"
ASN-NAME "Intersection-identifier-referenced"
ASN-OBJECT-IDENTIFIER { j2735DataElements 63 }
DEFINITION     "This data element is used to identify the intersection within a country
or region that a computed intersection is based on.  The computed intersection should have
the same exact geometric information as this 'referenced' intersection, except possibly
the orientation."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Intersection-identifier-referenced ::= OCTET STRING (SIZE(2..4))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.19.4 intersection-orientation

```
intersection-orientation ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Intersection.orientation:qty"
ASN-NAME "Intersection-orientation"
ASN-OBJECT-IDENTIFIER { j2735DataElements 64 }
DEFINITION     "This data element is used to identify the orientation (rotation) of a
computed intersection relative to the referenced intersection.  An orientation 'to the
east' is defined as the positive direction."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Intersection-orientation ::= INTEGER (0..28800)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "0.0125 degrees"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.19.5 intersection-version

```
intersection-version ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Intersection.version:id"
ASN-NAME "Intersection-version"
ASN-OBJECT-IDENTIFIER { j2735DataElements 65 }
DEFINITION     "This data element is used to identify the version of the intersection's
roadway geometric information being broadcast."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Intersection-version ::= INTEGER (0..32768)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.20 IntersectionSignalized Class Data Elements

5.4.20.1 intersectionSignalized-preempt

```
intersectionSignalized-preempt ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "IntersectionSignalized.preempt:cd"
ASN-NAME "IntersectionSignalized-preempt"
ASN-OBJECT-IDENTIFIER { j2735DataElements 66 }
DEFINITION     "This data element is used to indicate the preempt state if a signal
preemption request is currently being serviced.  This data element also is used to
acknowledge a signal preempt request - a signalized intersection may have multiple preempt
states to relate.  Bits 3-0 are used to relate the current preemption state of the signal
system.  These bits follow the values and definitions of the PreemptState object of NTCIP
1202 v2.19f  as its starting point and adds values of 0 and 10."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "With bits set as follows:
-- Bit 7 (MSB) - Set if the state is currently active.  Only one active state can exist at
a time, and this state should be sent first in any sequence.
-- Bits 6~4 The preempt value that is being described.
-- Bits 3~0 the state bits, as follows:
  -- none (0), -- No preemption (same as value = 2)
  -- other (1), -- Other
  -- notActive (2), -- Not Active (same as value = 0)
  -- notActiveWithCall (3), -- Not Active With Call
  -- entryStarted (4), -- Entry Started
  -- trackService (5), -- Track Service
```

```
  -- dwell (6), -- Dwell
  -- linkActive (7), -- Link Active
  -- existStarted (8), -- Exit Started
  -- maximumPresence (9), -- Max Presence
  -- acknowledgedButOverridden (10), -- Acknowledged but Over-ridden
  -- reserved :  11 to 15"
STANDARD "SAE J2735"
DATA-TYPE "
    IntersectionSignalized-preempt ::= OCTET STRING (SIZE(1))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.20.2 intersectionSignalized-priority

```
intersectionSignalized-priority ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "IntersectionSignalized.priority:cd"
ASN-NAME "IntersectionSignalized-priority"
ASN-OBJECT-IDENTIFIER { j2735DataElements 67 }
DEFINITION     "This data element is used to indicate the priority state if a signal
priority (SP) request is currently being serviced.  This data element also is used to
acknowledge a signal priority request - a signalized intersection may have multiple
priority states to relate.  Bits 3-0 are used to relate the current priority state of the
signal system."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "With bits set as follows:
-- Bit 7 (MSB) - Set if the state is currently active.  Only one active state can exist at
a time, and this state should be sent first in any sequence.
-- Bits 6~4    - The priority value that is being described.
-- Bits 3~0    - The state bits, as follows:
  -- noneActive (0), -- No signal priority (same as value = 1)
  -- none (1), -- SP None
  -- requested (2), -- SP Requested
  -- active (3), -- SP Active
  -- activeButInhibitd (4), -- SP Reservice (active but inhibited)
  -- success (5), -- SP Success
  -- removed  (6), -- SP Removed
  -- clearFail (7), -- SP Clear Fail
  -- detectFail (8), -- SP Detect Fail
  -- detectClear (9), -- SP Detect Clear
  -- abort (10), -- SP Abort (needed to remain on-line)
  -- delayTiming (11), -- SP Delay Timing
  -- extendTiming (12), -- SP Extend Timing
  -- preemptOverride (13), -- SP Preempt Over-ride
  -- adaptiveOverride (14), -- SP Adaptive Over-ride
  -- reserved (15), ..."
STANDARD "SAE J2735"
DATA-TYPE "
    IntersectionSignalized-priority ::= OCTET STRING (SIZE(1))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.20.3 intersectionSignalized-state

```
intersectionSignalized-state ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "IntersectionSignalized.state:cd"
ASN-NAME "IntersectionSignalized-state"
ASN-OBJECT-IDENTIFIER { j2735DataElements 68 }
DEFINITION     "This data element provides information about the operational status of
the traffic signal controller.  This status object is similar to the one defined in the
Advanced Traffic Controller (ATC) specification's status information."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The bits of this object are as follows.  A bit set to a logic one indicates that
the described condition is present at the intersection while a bit set to zero indicates
that it is not present.  All bits are set to zero in normal operation.
manualcontrol (0)   - (LSB) Manual Control is enabled.
stoptime (1)        - Stop Time is activated and all counting/timing has stopped.
conflictmode (2)    - Intersection is in the conflict flash state.
preemptactive (3)   - Preempt is active
priorityactive (4)  - Priority is active
Reserved0 (5)
Reserved1 (6)
Reserved2 (7)"
STANDARD "SAE J2735"
DATA-TYPE "
    IntersectionSignalized-state ::=  BIT STRING {
    manualcontrol (0),
    stoptime (1),
    conflictmode (2),
    preemptactive (3),
    priorityactive (4),
    reserved0 (5),
    reserved1 (6),
    reserved2 (7) } (SIZE(8))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.20.4 intersectionSignalized-time

```
intersectionSignalized-time ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "IntersectionSignalized.time:gps"
ASN-NAME "IntersectionSignalized-time"
ASN-OBJECT-IDENTIFIER { j2735DataElements 69 }
DEFINITION     "This data element is used to relate the time as detected by a traffic
signal controller, with a precision of 1/10 of a second.  A range of 2 full minutes is
supported and it can be presumed that the receiver shares a common sense of time with the
sender which is kept aligned to within a few seconds.  A data element in the using message
allows detection and correction of different rates and offsets between the clocks and the
latency of message transmission."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    IntersectionSignalized-time ::= INTEGER (0..1202)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one-tenth of a second"
VALID-VALUE-RULE "The value of 1201 shall be used to indicate indefinite time.  The value
of 1202 shall be used when the value is undefined or unavailable. "}
```

5.4.21 IntersectionSignalizedRequest Class Data Elements

5.4.21.1 intersectionSignalizedRequest-approach

```
intersectionSignalizedRequest-approach ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedRequest.approach:id"
ASN-NAME "IntersectionSignalizedRequest-approach"
ASN-OBJECT-IDENTIFIER { j2735DataElements 70 }
DEFINITION     "This data element represents the lane number that the connected device
expects to be in when approaching an intersection that the connected device is requesting
preferential treatment."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    IntersectionSignalizedRequest-approach ::= OCTET STRING (SIZE(1))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.21.2 intersectionSignalizedRequest-cancel

```
intersectionSignalizedRequest-cancel ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedRequest.cancel:cd"
ASN-NAME "IntersectionSignalizedRequest-cancel"
ASN-OBJECT-IDENTIFIER { j2735DataElements 71 }
DEFINITION     "A data element containing the signal priority or preempt scheme that was
previously requested by the connected device, but is now requested to be cancelled.  This
data element has either a priority value or a preemption value, depending on the setting
of the MSB and what data frame it is used in.  A value of B'1111' indicates a request for
cabinet flash when the data element is used in a preempt.  The value B'0111' is reserved
when used for a priority request.  The value B'000' is reserved.  "
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "In use, the connected device must determine which preempt number or priority
number to request by analyzing its location relative to the roadway geometry information
broadcasted.
Encoded as follows:
  upper nibble:  Preempt #:
  -- Bit 7  (MSB)  1 =  Preempt and 0 =  Priority
  -- Remaining 3 bits: Range of 0..7. The values of 1..6 represent the respective
controller preempt or priority to be cancelled. The value of 7 represents a request for a
cabinet flash preempt, while the value of 0 is reserved.
  lower nibble:  Strategy #:
  -- Range is 0..15 and is used to specify a desired strategy to be cancelled."
STANDARD "SAE J2735"
DATA-TYPE "
    IntersectionSignalizedRequest-cancel ::= OCTET STRING (SIZE(1))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.21.3 intersectionSignalizedRequest-codeword

```
intersectionSignalizedRequest-codeword ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedRequest.codeword:txt"
ASN-NAME "IntersectionSignalizedRequest-codeword"
ASN-OBJECT-IDENTIFIER { j2735DataElements 72 }
DEFINITION     "This data element is used to convey a prior known string of bytes between
systems, typically to establish trust or validity of the message request in which it is
found.  The use and setting of these words, as well as any policy regarding changing the
value over time, is up to the participants."
```

```
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    IntersectionSignalizedRequest-codeword ::= OCTET STRING (SIZE(1..16))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.21.4 intersectionSignalizedRequest-egress

```
intersectionSignalizedRequest-egress ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedRequest.egress:id"
ASN-NAME "IntersectionSignalizedRequest-egress"
ASN-OBJECT-IDENTIFIER { j2735DataElements 73 }
DEFINITION     "This data element represents the lane number that a connected device
would like to exit the intersection on as part of the connected device's request for
preferential treatment at a signalized intersection.."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    IntersectionSignalizedRequest-egress ::= OCTET STRING (SIZE(1))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.21.5 intersectionSignalizedRequest-number

```
intersectionSignalizedRequest-number ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedRequest.number:cd"
ASN-NAME "IntersectionSignalizedRequest-number"
ASN-OBJECT-IDENTIFIER { j2735DataElements 74 }
DEFINITION     "A data element is used to indicate signal priority or preempt schemes.
This data element is used to select which preempt or priority controller operational
strategy (sequence) is to be requested.  This data element has either a priority value or
a preemption value, depending on the setting of the MSB and what data frame it is used in.
 A value of B'1111' indicates a request for cabinet flash when the data element is used in
a preempt.  The value B'0111' is reserved when used for a priority request.  The value
B'000' is reserved."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "In use, the connected device must determine which preempt number or priority
number to request by analyzing its location relative to the roadway geometry information
broadcasted.
Encoded as follows:
  upper nibble:  Preempt #:
  -- Bit 7  (MSB)  1 =  Preempt and 0 =  Priority
  -- Remaining 3 bits: Range of 0..7. The values of 1..6 represent the respective
controller preempt or Priority to be activated. The value of 7 represents a request for a
cabinet flash preempt, while the value of 0 is reserved.
  lower nibble:  Strategy #:
  -- Range is 0..15 and is used to specify a desired strategy  (if available)."
STANDARD "SAE J2735"
DATA-TYPE "
    IntersectionSignalizedRequest-number ::= OCTET STRING (SIZE(1))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.22 Lane Class Data Elements

5.4.22.1 lane-crosswalk-attributes

```
lane-crosswalk-attributes ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Lane.crosswalk-attributes:cd"
ASN-NAME "Lane-crosswalk-attributes"
ASN-OBJECT-IDENTIFIER { j2735DataElements 75 }
DEFINITION     "This data element relates the type of cross walk that is being described.
 The term crosswalk lane in this standard is generic and may include such items as a
bicycle crossings and other non-motorized uses."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "A value of '00000000 indicates no data available.
1    (LSB) Lane provides a two-way travel for all non-motorized travelers
2    Pedestrian crosswalk only
3    Bicycle crossing only
4    Railroad track is present
5-15 Reserved  "
STANDARD "SAE J2735"
DATA-TYPE "
    Lane-crosswalk-attributes ::= ENUMERATED {
    nodata (0),
    twowaypath (1),
    pedestriancrosswalk (2),
    bikelane (3),
    railroadtrackpresent (4),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.22.2 lane-number

```
lane-number ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Lane.number:id"
ASN-NAME "Lane-number"
ASN-OBJECT-IDENTIFIER { j2735DataElements 76 }
DEFINITION     "This data element defines a number used to uniquely identify the lane
within the context of the intersection or roadway segment description.  This data element,
in conjunction with the intersection or segment identifier, forms a globally unique way to
identify a specific lane."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Lane-number ::= INTEGER (0..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.22.3 lane-oer

```
lane-oer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Lane.oer:bin"
ASN-NAME "Lane-oer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 77 }
DEFINITION     "This data element is the OER encoding of the lane data frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 68 }  -- lane  }
```

```
DATA-TYPE "
    Lane-oer ::= OCTET STRING (SIZE(8..1419))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.22.4 lane-segment-attributes

```
lane-segment-attributes ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Lane.segment-attributes:cd"
ASN-NAME "Lane-segment-attributes"
ASN-OBJECT-IDENTIFIER { j2735DataElements 78 }
DEFINITION     "This data element relates a description of the lane segment."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Lane-segment-attributes ::= ITIS.LaneRoadway  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.22.5 lane-special-attributes

```
lane-special-attributes ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Lane.special-attributes:cd"
ASN-NAME "Lane-special-attributes"
ASN-OBJECT-IDENTIFIER { j2735DataElements 79 }
DEFINITION     "This data element relates the types and allowed (possible) movements from
a special vehicle lane.  Typically this deals with lanes describing trains (all forms of
tracked vehicles) and transit vehicles (buses and other public transport) that are part of
an intersection shared with motorized vehicle lanes."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "0 (LSB) No data
1    Lane is an egress path
2    Lane is a railroad track
3    Transit vehicle only lane
4    HOV lane
5    Bus only lane
6    Vehicles entering
7    Vehicles leaving
8    Eco-lane
9-15 Reserved  "
STANDARD "SAE J2735"
DATA-TYPE "
    Lane-special-attributes ::= ENUMERATED {
    nodata (0),
    egresspath (1),
    railroadtrack (2),
    transitonlylane (3),
    hovlane (4),
    busonly (5),
    vehiclesentering (6),
    vehiclesleaving (7),
    ecolane (8),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.22.6 lane-vehicle-attributes

```
lane-vehicle-attributes ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Lane.vehicle-attributes:cd"
ASN-NAME "Lane-vehicle-attributes"
ASN-OBJECT-IDENTIFIER { j2735DataElements 80 }
DEFINITION     "This data element relates the allowed (possible) movements from a
motorized vehicle lane. Note that in practice these values may be further restricted by
vehicle class, local regulatory environment and other changing conditions.  If the bit for
egressPath is set, then the described path represents the out-bound flow of traffic from
the approach.  In rare cases and for very small intersections, this bit may also indicate
bi-directional flow of traffic along the lane, although this is more often seen in other
types of lanes (such as when describing a pedestrian lane)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "With bits as defined:
noLaneData              VehicleLaneAttributes ::= 0
     - ('0000000000000000'B)
egressPath              VehicleLaneAttributes ::= 1
     - ('0000000000000001'B)
     - a two-way path or an outbound path is described
maneuverStraightAllowed VehicleLaneAttributes ::= 2
     - ('0000000000000010'B)
maneuverLeftAllowed     VehicleLaneAttributes ::= 4
     - ('0000000000000100'B)
maneuverRightAllowed    VehicleLaneAttributes ::= 8
     - ('0000000000001000'B)
yield                   VehicleLaneAttributes ::= 16
     - ('0000000000010000'B)
maneuverNoUTurn         VehicleLaneAttributes ::= 32
     - ('0000000000100000'B)
maneuverNoTurnOnRed     VehicleLaneAttributes ::= 64
     - ('0000000001000000'B)
maneuverNoStop          VehicleLaneAttributes ::= 128
     - ('0000000010000000'B)
noStop                  VehicleLaneAttributes ::= 256
     - ('0000000100000000'B)
noTurnOnRed             VehicleLaneAttributes ::= 512
     - ('0000001000000000'B)
hovLane                 VehicleLaneAttributes ::= 1024
     - ('0000010000000000'B)
busOnly                 VehicleLaneAttributes ::= 2048
     - ('0000100000000000'B)
busAndTaxiOnly          VehicleLaneAttributes ::= 4096
     - ('0001000000000000'B)
maneuverHOVLane         VehicleLaneAttributes ::= 8192
     - ('0010000000000000'B)
maneuverSharedLane      VehicleLaneAttributes ::= 16384
     - ('0100000000000000'B)  a two way left turn lane
maneuverBikeLane        VehicleLaneAttributes ::= 32768
     - ('1000000000000000'B)"
STANDARD "SAE J2735"
DATA-TYPE "
    Lane-vehicle-attributes ::= OCTET STRING (SIZE(2))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "Values to 127 reserved for standard use.  Values 128 to 255 reserved for
local use."}
```

5.4.22.7 lane-width

```
lane-width ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Lane.width:qty"
ASN-NAME "Lane-width"
ASN-OBJECT-IDENTIFIER { j2735DataElements 81 }
DEFINITION     "This data element conveys the width of a lane in LSB units of 1 cm.
Maximum value would be a lane of over 327 meters."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Note that one half the lane width is used to find the 'edge' of the lane, as
measured from its center, as described by a set of offset values."
STANDARD "SAE J2735"
DATA-TYPE "
    Lane-width ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.23 LaneConnection Class Data Elements

5.4.23.1 laneConnection-destination-lane

```
laneConnection-destination-lane ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "LaneConnection.destination-lane:id"
ASN-NAME "LaneConnection-destination-lane"
ASN-OBJECT-IDENTIFIER { j2735DataElements 82 }
DEFINITION     "This data element defines the lane identifier (number) of the destination
lane for a specific maneuver from the lane being described."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    LaneConnection-destination-lane ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.23.2 laneConnection-maneuver

```
laneConnection-maneuver ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "LaneConnection.maneuver:cd"
ASN-NAME "LaneConnection-maneuver"
ASN-OBJECT-IDENTIFIER { j2735DataElements 83 }
DEFINITION     "This data element is used to describe the specific use of the lane from
the point of view of the lane description that contains it.   It describes the maneuver to
be performed by the connected device in the subject lane to 'enter' the lane that the
subject lane is 'connected to'.  For example, a given lane may represent the lane that a
vehicle would enter when making a 'left turn' from the subject lane.  More than one lane
may be the 'left turn lane' that the subject lane is 'connected to' so the use of these
values among the set of lanes is not exclusive.  However, every lane that the subject lane
connects to can be only of one type at a time (from the perspective of the lane
description that contains it).  A softleftturn and a softrightturn is used only where
there is more than one left turn and right turn, respectively.  A soft turn movement is
located between a straight (through) movement and a hard turn movement, i.e., a soft left
turn is between a left turn and a straight ahead movement. "
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Treated as an octet byte when used in the packed octets of the laneConnection
data frame (no BER tagging is present in this small blob)."
STANDARD "SAE J2735"
```

```
DATA-TYPE "
    LaneConnection-maneuver ::= ENUMERATED {
    unknown (0),
    uturn (1),
    leftturn (2),
    rightturn (3),
    straightahead (4),
    softleftturn (5),
    softrightturn (6),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "Values to 127 reserved for standard use.  Values 128 to 255 reserved for
local use.  The upper bits are reserved for any other indications to be defined in the
future, such as enter a freeway or entering a private drive."}
```

5.4.24 Location Class Data Elements

5.4.24.1 location-elevation

```
location-elevation ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Location.elevation:lctn"
ASN-NAME "Location-elevation"
ASN-OBJECT-IDENTIFIER { j2735DataElements 84 }
DEFINITION     "This data element represents the position of road surface, above or below
the WGS-84 reference ellipsoid at the geometric center of the connected device.  The
accuracy of the elevation shall be at least within 3 meters of the actual elevation (as
defined in SAE J2735) at an HDOP smaller than 5 under open sky conditions within the 1
sigma absolute error.  If the accuracy cannot be met, the value shall be set to
unavailable.  "
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Elevations from 0 to 61439 decimeters are encoded as normal integers. Elevations
from -4095 to -1 decimeters are offset by 65536 such that they are encoded as 61441 to
65535. The value 61440 shall be used to represent 'unavailable'. Examples of this encoding
are:
-1.0 m = 65526
-0.1 m = 65535 (0xFFFF)
0.0 m = 0 (0x0000)
100.0 m = 1000 (0x03E8)
unavailable = 61440 (0xF000)"
STANDARD "SAE J2735"
DATA-TYPE "
    Location-elevation ::= OCTET STRING (SIZE(2))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "decimeter"
VALID-VALUE-RULE "The value represents an asymmetric range of positive and negative values
from -409.5 meters to 6143.9 meters. Values below zero shall be offset by 6553.6 meters.
An elevation higher than +6143.9 meters is represented the same as 6143.9 meters. An
elevation lower than -409.5 meters is represented the same as -409.5 meters. If the
elevation is unavailable, it shall encode the data element with the integer value 61440."}
```

5.4.24.2 location-latitude

```
location-latitude ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Location.latitude:lctn"
ASN-NAME "Location-latitude"
ASN-OBJECT-IDENTIFIER { j2735DataElements 85 }
DEFINITION     "This data element is the geographic latitude of an object, expressed in
1/10th integer microdegrees, with reference to the horizontal datum then in use.
The accuracy of the value shall be at least within 1.5 meters of the actual latitude at an
HDOP smaller than 5 under open sky conditions within the 1 sigma absolute error.  If the
accuracy cannot be met, the value shall be set to unavailable."
DESCRIPTIVE-NAME-CONTEXT {""}
```

```
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Location-latitude ::= INTEGER (-900000000..900000001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenth of a micro degree"
VALID-VALUE-RULE "The value 900000001 shall be used when the value is unavailable."}
```

5.4.24.3 location-longitude

```
location-longitude ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Location.longitude:lctn"
ASN-NAME "Location-longitude"
ASN-OBJECT-IDENTIFIER { j2735DataElements 86 }
DEFINITION     "This data element is the geographic longitude of an object, expressed in
1/10th integer microdegrees, with reference to the horizontal datum then in use.
The accuracy of the value shall be at least within 1.5 meters of the actual longitude at
an HDOP smaller than 5 under open sky conditions within the 1 sigma absolute error.  If
the accuracy cannot be met, the value shall be set to unavailable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Location-longitude ::= INTEGER (-1800000000..1800000001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenth of a micro degree"
VALID-VALUE-RULE "The value 1800000001 shall be used when the value is unavailable."}
```

5.4.24.4 location-oer

```
location-oer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Location.oer:bin"
ASN-NAME "Location-oer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 87 }
DEFINITION     "This data element is the OER encoding of the location data frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 72 }  -- location  }
DATA-TYPE "
    Location-oer ::= OCTET STRING (SIZE(9..29))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.24.5 location-secMark

```
location-secMark ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Location.secMark:qty"
ASN-NAME "Location-secMark"
ASN-OBJECT-IDENTIFIER { j2735DataElements 88 }
DEFINITION     "The DSRC style second expressed in this data element is a simple value
consisting of integer values from zero to 60999 representing the ms within a minute.  A
leap second is represented by the value range 60000 to 60999.
The accuracy shall be within one ms of the actual atomic time (or some other benchmark
time) when the positioning data is determined.  If the accuracy cannot be met, the value
shall be set to unavailable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
```

```
REMARKS "The value contained in this data element must refer to a known point in time
within the DSRC system that is shared or understood by the user community.  This point in
time is typically the moment when the position determination was made for most messages,
such as the basicSafetyMessage.  Other measurements present in the same message (speed,
heading, etc.) should be aligned to that moment insofar as possible in the implementation.
The need for a leap second arises from the difference between solar time and UTC time.  A
useful reference on this topic is: http://tycho.usno.navy.mil/leapsec.html"
STANDARD "SAE J2735"
DATA-TYPE "
    Location-secMark ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "ms"
VALID-VALUE-RULE "The value of 65535 shall be used when the value is unavailable in the
range of the minute.  Values from 61000 to 65534 are reserved for standard use."}
```

5.4.25 LocationAccuracy Class Data Elements

5.4.25.1 locationAccuracy-major

```
locationAccuracy-major ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "LocationAccuracy.major:qty"
ASN-NAME "LocationAccuracy-major"
ASN-OBJECT-IDENTIFIER { j2735DataElements 89 }
DEFINITION     "The accuracy of the positional determination along the semi-major axis at
one standard deviation."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    LocationAccuracy-major ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "5 centimeters"
VALID-VALUE-RULE "The value of 254 shall be used when the accuracy is 12.70 meters or
greater.  The value of 255 shall be used when the value is unknown or unavailable."}
```

5.4.25.2 locationAccuracy-minor

```
locationAccuracy-minor ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "LocationAccuracy.minor:qty"
ASN-NAME "LocationAccuracy-minor"
ASN-OBJECT-IDENTIFIER { j2735DataElements 90 }
DEFINITION     "The accuracy of the positional determination along the semi-minor axis at
one standard deviation."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    LocationAccuracy-minor ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "5 centimeters"
VALID-VALUE-RULE "The value of 254 shall be used when the accuracy is 12.70 meters or
greater.  The value of 255 shall be used when the value is unknown or unavailable."}
```

5.4.25.3 locationAccuracy-orientation

```
locationAccuracy-orientation ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "LocationAccuracy.orientation:qty"
ASN-NAME "LocationAccuracy-orientation"
ASN-OBJECT-IDENTIFIER { j2735DataElements 91 }
DEFINITION     "The accuracy of the orientation of the semi-major axis relative to true
north (0-359.9945078786 degrees).  In steps of 360/65535 degrees = 0.0054932479 degrees,
with an orientation to the east as the positive direction ."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    LocationAccuracy-orientation ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "360/65535 degrees = 0.0054932479 degrees"
VALID-VALUE-RULE "The value of 65535 shall be used when the value is unknown or
unavailable."}
```

5.4.26 Mayday Class Data Elements

5.4.26.1 mayday-identifier

```
mayday-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Mayday.identifier:id"
ASN-NAME "Mayday-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 92 }
DEFINITION     "This data element is a 4-byte random device identifier used to indicate
the identity of a device when broadcasting a mayday message.  This value is used to
associate the mayday message with the device and to distinguish it when multiple devices
are involved in an incident."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Mayday-identifier ::= OCTET STRING (SIZE(4))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.26.2 mayday-type

```
mayday-type ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Mayday.type:cd"
ASN-NAME "Mayday-type"
ASN-OBJECT-IDENTIFIER { j2735DataElements 93 }
DEFINITION     "This data element represents the type of event that the connected
device's sensors has detected that resulted in a mayday transmission.  Airbags being
deployed or an overturned vehicle represent situations where one or more passengers may be
injured and require medical attention.  A user may also manually activate the mayday
transmission.  For all other situations when a vehicle may need assistance, such as a
mechanical failure or out of fuel, the vehicle will indicate that the vehicle is
disabled."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
```

```
DATA-TYPE "
    Mayday-type ::= ENUMERATED {
    unavailable (0),
    vehicledisabled (1),
    airbagsdeployed (2),
    vehicleoverturned (3),
    manuallyactivated (4),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "Values to 127 reserved for standard use.
Values 128 to 255 reserved for local use."}
```

5.4.27 Registration Class Data Elements

5.4.27.1 namedRegistration-oer

```
namedRegistration-oer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Registration.NamedRegistration-oer:bin"
ASN-NAME "NamedRegistration-oer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 94 }
DEFINITION     "The OER-encoded representation of the namedRegistration data frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 85 }  -- NamedRegistration  }
DATA-TYPE "
    NamedRegistration-oer ::= OCTET STRING (SIZE(1..282))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.28 NMEA Class Data Elements

5.4.28.1 nMEA-MsgType

```
nMEA-MsgType ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "NMEA.MsgType:nbr"
ASN-NAME "NMEA-MsgType"
ASN-OBJECT-IDENTIFIER { j2735DataElements 95 }
DEFINITION     "This data element provides the message and submessage type as defined in
the 0183 NMEA revision being use."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The message type is also in nMEA-Payload."
STANDARD "SAE J2735"
DATA-TYPE "
    NMEA-MsgType ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.28.2 nMEA-Payload

```
nMEA-Payload ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "NMEA.Payload:bin"
ASN-NAME "NMEA-Payload"
ASN-OBJECT-IDENTIFIER { j2735DataElements 96 }
DEFINITION     "This data element contains the stream of bytes in the actual NMEA 0183
message that is being transmitted."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    NMEA-Payload ::= OCTET STRING (SIZE(1..1023))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.28.3 nMEA-Revision

```
nMEA-Revision ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "NMEA.Revision:cd"
ASN-NAME "NMEA-Revision"
ASN-OBJECT-IDENTIFIER { j2735DataElements 97 }
DEFINITION     "The specific edition of the NMEA standard which is being used (if
present). This is needed to know precisely the mapping of the messages types to their
definitions, as well as some minor transport layer ordering details when received in the
mobile unit."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Will normally be Version 2.0."
STANDARD "SAE J2735"
DATA-TYPE "
    NMEA-Revision ::= ENUMERATED {
    unknown (0),
    reserved (1),
    rev1 (10),
    rev2 (20),
    rev3 (30),
    rev4 (40),
    rev5 (50),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "Values to 127 reserved for standard use.
Values 128 to 255 for local use."}
```

5.4.29 Obstacle Class Data Elements

5.4.29.1 obstacle-direction

```
obstacle-direction ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Obstacle.direction:nbr"
ASN-NAME "Obstacle-direction"
ASN-OBJECT-IDENTIFIER { j2735DataElements 98 }
DEFINITION     "This data element draws from the output of a device's sensing system to
report the obstacle direction from the device detecting and reporting the obstacle.  The
data is expressed in unsigned units of 0.0125 degrees as azimuth relative to forward
direction of device (A value of 28799 represents 359.9875 degrees).  Headings 'to the
right, when facing the forward direction of the device are defined as the positive
direction."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
```

```
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Obstacle-direction ::= INTEGER (0..28800)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "0.0125 degrees"
VALID-VALUE-RULE "The value of 28880 shall be used when the value is unavailable."}
```

5.4.29.2 obstacle-distance

```
obstacle-distance ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Obstacle.distance:qty"
ASN-NAME "Obstacle-distance"
ASN-OBJECT-IDENTIFIER { j2735DataElements 99 }
DEFINITION     "This data element draws from the output of a device's sensing system to
report the presence of an obstacle and its measured distance from the device detecting and
reporting the obstacle.  This information can be used by road authorities to investigate
and remove the obstacle, as well as by other vehicles in advising drivers or on-board
systems of the obstacle location.  Distance is expressed in meters."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Obstacle-distance ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.30 Parking Class Data Elements

5.4.30.1 parkingInformation-description

```
parkingInformation-description ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ParkingInformation-description:txt"
ASN-NAME "ParkingInformation-description"
ASN-OBJECT-IDENTIFIER { j2735DataElements 100 }
DEFINITION     "A data element providing a description of the parking facility.  This
description may include additional information about the parking facility, such as what
exit to use to get the parking facility, or what parking amenities is available at the
facility.  This data element is typically used in providing traveler information to
commercial vehicle drivers about upcoming rest areas."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ParkingInformation-description ::= IA5String (SIZE(1..255))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.30.2 parkingSpaces-available

```
parkingSpaces-available ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ParkingSpaces-available:qty"
ASN-NAME "ParkingSpaces-available"
ASN-OBJECT-IDENTIFIER { j2735DataElements 101 }
DEFINITION     "This data element represents the number of parking spaces, by parking
space size, available at a parking facility."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
```

```
DATA-TYPE "
    ParkingSpaces-available ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.30.3 parkingSpace-length

```
parkingSpace-length ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ParkingSpace-length:qty"
ASN-NAME "ParkingSpace-length"
ASN-OBJECT-IDENTIFIER { j2735DataElements 102 }
DEFINITION     "This data element represents the maximum length of the vehicle the
parking space can accommodate expressed in centimeters."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ParkingSpace-length ::= INTEGER (0..1023)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "The value 0 shall be used for when the value is unavailable."}
```

5.4.30.4 parkingSpace-width

```
parkingSpace-width ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ParkingSpace-width:qty"
ASN-NAME "ParkingSpace-width"
ASN-OBJECT-IDENTIFIER { j2735DataElements 103 }
DEFINITION     "This data element represents the maximum width of the vehicle the parking
space can accommodate expressed in centimeters."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ParkingSpace-width ::= INTEGER (0..1023)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "The value 0 shall be used for when the value is unavailable."}
```

5.4.31 PathNode Class Data Elements

5.4.31.1 pathNode-superelevation

```
pathNode-superelevation ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PathNode.superelevation:pct"
ASN-NAME "PathNode-superelevation"
ASN-OBJECT-IDENTIFIER { j2735DataElements 104 }
DEFINITION     "This data element represents the superelevation at the current node.  The
superelevation is the incline, or bank across the width of the lane.  This data element is
used only to represent the bank of a curved roadway segment - it is not intended to
represent the slope of a straight roadway segment.  A positive superelevation represents a
bank where the edge of the lane closest to the center point of the curved roadway segment
has a lower elevation than the edge of the lane furthest from the center point."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    PathNode-superelevation ::= INTEGER (-127..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "units of tenth of a percent"
```

```
VALID-VALUE-RULE "The value -127 shall be used for values equal to -127 (-12.7%) or
lesser.
The value 127 shall be used for values equal to 127 (12.7%) or greater.  "}
```

5.4.31.2 pathNode-width

```
pathNode-width ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PathNode.width:qty"
ASN-NAME "PathNode-width"
ASN-OBJECT-IDENTIFIER { j2735DataElements 105 }
DEFINITION     "This data element conveys the width of a lane at the path node location."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Note that one half the lane width is used to find the 'edge' of the lane, as
measured from its center, as described by a set of offset values."
STANDARD "SAE J2735"
DATA-TYPE "
    PathNode-width ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.31.3 pathNode-x-offset

```
pathNode-x-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PathNode.x-offset:lctn"
ASN-NAME "PathNode-x-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 106 }
DEFINITION     "This data element represents the (signed) offset along the x-axis
(latitude) from a reference point.   Along with the pathNode-y-offset and pathNode-z-
offset, these data elements define the location of one point (node) along the center line
of a lane.  A series of nodes defines the path of the centerline of the lane.  The initial
offset value (node) is from an intersection's reference point, or a geometric area's
anchor point.  The distance is measured in units of centimeter.  A positive offset value
represents a location to the east of the previous node."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    PathNode-x-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.31.4 pathNode-y-offset

```
pathNode-y-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PathNode.y-offset:lctn"
ASN-NAME "PathNode-y-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 107 }
DEFINITION     "This data element represents the (signed) offset along the y-axis
(longitude) from a reference point.  Along with the pathNode-x-offset and pathNode-y-
offset, these data elements define the location of one point (node) along the center line
of a lane.  A series of nodes defines the path of the centerline of the lane.  The initial
offset value (node) is from an intersection's reference point, or a geometric area's
anchor point.  All subsequent offsets are additive from the last set of offset values
(node).  The distance is measured in units of centimeter.  A positive offset value
represents a location to the north of the previous node."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
```

```
    PathNode-y-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.31.5 pathNode-z-offset

```
pathNode-z-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PathNode.z-offset:lctn"
ASN-NAME "PathNode-z-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 108 }
DEFINITION     "This data element represents the (signed) offset along the z-axis
(vertical) from a reference point.  Along with the pathNode-x-offset and pathNode-y-
offset, these data elements define the location of one point (node) along the center line
of a lane.  A series of nodes defines the path of the centerline of the lane.  The initial
offset value (node) is from an intersection's reference point, or a geometric area's
anchor point.  All subsequent offsets are additive from the last set of offset values
(node).  The distance is measured in units of centimeter.  A positive value represents an
elevation higher along the vertical axis from the previous node."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    PathNode-z-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.32 PathOffset Class Data Elements

5.4.32.1 pathOffset-lateral-offset

```
pathOffset-lateral-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PathOffset.lateral-offset:qty"
ASN-NAME "PathOffset-lateral-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 109 }
DEFINITION     "This data element is an integer value expressing the perpendicular offset
from a reference lane number that a computed lane is offset from.  The measurement is
taken from the reference lane center line to the new center line.  The units are a signed
value of 1 centimeter."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    PathOffset-lateral-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.32.2 pathOffset-reference-lane

```
pathOffset-reference-lane ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PathOffset.reference-lane:id"
ASN-NAME "PathOffset-reference-lane"
ASN-OBJECT-IDENTIFIER { j2735DataElements 110 }
DEFINITION     "This data element defines the identifier (number) of the lane that a
computed lane references.  A computed lane references this (reference) lane-number, which
is found in the same intersection or segment, and uses a lateral offset value to map the
path of this lane."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
```

```
STANDARD "SAE J2735"
DATA-TYPE "
    PathOffset-reference-lane ::= INTEGER (0..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.33 Driver Class Data Elements

5.4.33.1 person-date-of-birth-oer

```
person-date-of-birth-oer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Driver.Person-date-of-birth-oer:bin"
ASN-NAME "Person-date-of-birth-oer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 111 }
DEFINITION     "This data element is the OER-encoded value of the dDate data frame
representing the date of birth of the driver."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "This data element is typically used for commercial vehicle purposes only, such as
for safety inspections, or for security purposes.  The driver must opt-in to allow this
data element to be transmitted."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 33 }  -- dDate  }
DATA-TYPE "
    Person-date-of-birth-oer ::= OCTET STRING (SIZE(4))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.33.2 person-name-first

```
person-name-first ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Driver.Person-name-first:txt"
ASN-NAME "Person-name-first"
ASN-OBJECT-IDENTIFIER { j2735DataElements 112 }
DEFINITION     "A data element identifying a person's first name."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "This data element is typically used for commercial vehicle purposes only, such as
for safety inspections, or for security purposes.  The driver must opt-in to allow this
data element to be transmitted."
STANDARD "SAE J2735"
DATA-TYPE "
    Person-name-first ::= IA5String (SIZE(1..35))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.33.3 person-name-last

```
person-name-last ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Driver.Person-name-last:txt"
ASN-NAME "Person-name-last"
ASN-OBJECT-IDENTIFIER { j2735DataElements 113 }
DEFINITION     "A data element identifying a person's last name, family name, or
surname."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "This data element is typically used for commercial vehicle purposes only, such as
for safety inspections, or for security purposes.  The driver must opt-in to allow this
data element to be transmitted."
STANDARD "SAE J2735"
```

```
DATA-TYPE "
    Person-name-last ::= IA5String (SIZE(1..35))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.34 Polygon Class Data Elements

5.4.34.1 polygonOffsetNode-x-offset

```
polygonOffsetNode-x-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PolygonOffsetNode-x-offset:lctn"
ASN-NAME "PolygonOffsetNode-x-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 114 }
DEFINITION     "This data element represents the (signed) offset along the x-axis
(latitude) from the geometric area's anchor point.  The distance is measured in units of
one meter.  A positive offset value represents a location to the east of the anchor
point."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    PolygonOffsetNode-x-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.34.2 polygonOffsetNode-y-offset

```
polygonOffsetNode-y-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PolygonOffsetNode-y-offset:lctn"
ASN-NAME "PolygonOffsetNode-y-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 115 }
DEFINITION     "This data element represents the (signed) offset along the y-axis
(longitude) from the geometric area's anchor point.  The distance is measured in units of
one meter.  A positive offset value represents a location to the north of the anchor
point."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    PolygonOffsetNode-y-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.34.3 polygonOffsetNode-z-offset

```
polygonOffsetNode-z-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PolygonOffsetNode-z-offset:lctn"
ASN-NAME "PolygonOffsetNode-z-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 116 }
DEFINITION     "This data element represents the (signed) offset along the z-axis
(vertical) from the geometric area's anchor point.  The distance is measured in units of
one meter.  A positive offset value represents an elevation upward from the anchor point."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    PolygonOffsetNode-z-offset ::= INTEGER (-32767..32767)  "
```

```
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.34.4 polygonOffsetNode-z-tolerance

```
polygonOffsetNode-z-tolerance ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PolygonOffsetNode-z-tolerance:lctn"
ASN-NAME "PolygonOffsetNode-z-tolerance"
ASN-OBJECT-IDENTIFIER { j2735DataElements 117 }
DEFINITION     "This data element represents the tolerance along the z-axis (vertical)
from the geometric area's anchor point.  The valid geometric area would be between the
elevation (as determined by the location of the anchor point and polygonOffsetNode-z-
offset) plus and minus the tolerance value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    PolygonOffsetNode-z-tolerance ::= INTEGER (-127..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.35 Probe Class Data Elements

5.4.35.1 probe-orientation

```
probe-orientation ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.orientation:cd"
ASN-NAME "Probe-orientation"
ASN-OBJECT-IDENTIFIER { j2735DataElements 118 }
DEFINITION     "A data element used to define a set of sixteen 22.5 degree slices of a
unit circle (defined as 0~360 degrees of heading) which, when set to one, indicates that
the enclosing probe data management message applies to travel or motion in that slice
angle.  For example a value of 0x8181 would indicate that the probe data management
message applies to connected devices traveling in directions due North and due South.  A 2
byte value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Each bit 22.5 degree starting from North and moving Eastward (clockwise)
noHeading                HeadingSlice ::= '0000'H
allHeadings              HeadingSlice ::= 'FFFF'H
from000-0to022-5degrees  HeadingSlice ::= '0001'H
from022-5to045-0degrees  HeadingSlice ::= '0002'H
from045-0to067-5degrees  HeadingSlice ::= '0004'H
from067-5to090-0degrees  HeadingSlice ::= '0008'H
from090-0to112-5degrees  HeadingSlice ::= '0010'H
from112-5to135-0degrees  HeadingSlice ::= '0020'H
from135-0to157-5degrees  HeadingSlice ::= '0040'H
from157-5to180-0degrees  HeadingSlice ::= '0080'H
from180-0to202-5degrees  HeadingSlice ::= '0100'H
from202-5to225-0degrees  HeadingSlice ::= '0200'H
from225-0to247-5degrees  HeadingSlice ::= '0400'H
from247-5to270-0degrees  HeadingSlice ::= '0800'H
from270-0to292-5degrees  HeadingSlice ::= '1000'H
from292-5to315-0degrees  HeadingSlice ::= '2000'H
from315-0to337-5degrees  HeadingSlice ::= '4000'H
from337-5to360-0degrees  HeadingSlice ::= '8000'H"
STANDARD "SAE J2735"
DATA-TYPE "
    Probe-orientation ::= OCTET STRING (SIZE(2))  "
```

```
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "units of 22.5 degrees"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.35.2 probe-segment-number

```
probe-segment-number ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.segment-number:id"
ASN-NAME "Probe-segment-number"
ASN-OBJECT-IDENTIFIER { j2735DataElements 119 }
DEFINITION     "This data element enables users to identify a connected vehicle's
trajectory for a limited amount of time or over a limited distance.  It is randomly
generated by a vehicle every 120 seconds or 1 km, whichever comes last.  The interval
between changes in the probe segment number (PSN) is a random time between 3 and 13
seconds and a random distance between 50 and 250 meters, whichever comes last.  When
sending probe data messages containing with a PSN, each message must contain a single PSN.
For example when using the PSN in a Probe Data snapshot, all snapshots contained within a
single message must contain the same PSN.  All remaining snapshots with a PSN that has
already been sent to an RSU will be purged when the RSU communication link is broken.
Event-based snapshots do not contain a PSN."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Value determined by local device as per standard"
STANDARD "SAE J2735"
DATA-TYPE "
    Probe-segment-number ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.35.3 probe-transmission-interval

```
probe-transmission-interval ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.transmission-interval:qty"
ASN-NAME "Probe-transmission-interval"
ASN-OBJECT-IDENTIFIER { j2735DataElements 120 }
DEFINITION     "A data element that defines the time interval between transmissions of
probe messages by a connected vehicle when under the probe management process."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Probe-transmission-interval ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "seconds"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.35.4 probeSample-end

```
probeSample-end ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ProbeSample-end:nbr"
ASN-NAME "ProbeSample-end"
ASN-OBJECT-IDENTIFIER { j2735DataElements 121 }
DEFINITION     "This data element represents the end of the range of the last two digits
of the connected vehicle's MAC address for which a Probe Data Management will apply.  This
data element is sent by a Probe Data Management message, along with the probeSample-start
data element, representing a range of values.  If the MAC address of the vehicle falls
within this range, then the Probe Data Management policy should be applied.  The numbers
are inclusive, e.g., using 0x10 and 0x20 would provide a 1/16th sample and the values 0x00
and 0x80 would provide a 50% sample."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
```

```
STANDARD "SAE J2735"
DATA-TYPE "
    ProbeSample-end ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.35.5 probeSample-start

```
probeSample-start ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ProbeSample-start:nbr"
ASN-NAME "ProbeSample-start"
ASN-OBJECT-IDENTIFIER { j2735DataElements 122 }
DEFINITION     "This data element represents the start of the range of the last two
digits of the connected vehicle's MAC address for which a Probe Data Management will
apply.  This data element is sent by a Probe Data Management message, along with the
probeSample-end data element, representing a range of values.  If the MAC address of the
vehicle falls within this range, then the Probe Data Management policy should be applied.
 The numbers are inclusive, e.g., using 0x10 and 0x20 would provide a 1/16th sample and
the values 0x00 and 0x80 would provide a 50% sample."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ProbeSample-start ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.35.6 probeTermination-distance

```
probeTermination-distance ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ProbeTermination-distance:qty"
ASN-NAME "ProbeTermination-distance"
ASN-OBJECT-IDENTIFIER { j2735DataElements 123 }
DEFINITION     "This data element provides a Distance-to-Live type of time-out.  This
data element allows a probe data management process to temporarily change the data
collection policies of the connected vehicle for a fixed distance.  Once the connected
vehicle travels the provided distance, in meters, the temporary data collection policies
ceases and the default condition is applied."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ProbeTermination-distance ::= INTEGER (1..30000)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.35.7 probeTermination-time

```
probeTermination-time ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ProbeTermination-time:qty"
ASN-NAME "ProbeTermination-time"
ASN-OBJECT-IDENTIFIER { j2735DataElements 124 }
DEFINITION     "This data element provides a Time-to-Live type of time-out.  This data
element allows a probe data management process to temporarily change the data collection
policies of the connected vehicle for a fixed period of time.  Once the provided time
period has elapsed, in seconds, the temporary data collection policies ceases and the
default condition is applied."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
```

```
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ProbeTermination-time ::= INTEGER (1..1800)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "seconds"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.36 Area Class Data Elements

5.4.36.1 region-orientation

```
region-orientation ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Area.Region-orientation:cd"
ASN-NAME "Region-orientation"
ASN-OBJECT-IDENTIFIER { j2735DataElements 125 }
DEFINITION     "A data element used to define a set of sixteen 22.5 degree slices of a
unit circle (defined as 0~360 degrees of heading) which, when set to one, indicate that
travel or motion along that angle is allowed.  Typically used to indicate a gross
direction of travel to which the enclosing message or data frame applies.  For example a
value of 0x8181 would indicate travel both directions due North and due South.  A 2 byte
value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Each bit 22.5 degree starting from North and moving Eastward (clockwise)
noHeading                HeadingSlice ::= '0000'H
allHeadings              HeadingSlice ::= 'FFFF'H
from000-0to022-5degrees  HeadingSlice ::= '0001'H
from022-5to045-0degrees  HeadingSlice ::= '0002'H
from045-0to067-5degrees  HeadingSlice ::= '0004'H
from067-5to090-0degrees  HeadingSlice ::= '0008'H
from090-0to112-5degrees  HeadingSlice ::= '0010'H
from112-5to135-0degrees  HeadingSlice ::= '0020'H
from135-0to157-5degrees  HeadingSlice ::= '0040'H
from157-5to180-0degrees  HeadingSlice ::= '0080'H
from180-0to202-5degrees  HeadingSlice ::= '0100'H
from202-5to225-0degrees  HeadingSlice ::= '0200'H
from225-0to247-5degrees  HeadingSlice ::= '0400'H
from247-5to270-0degrees  HeadingSlice ::= '0800'H
from270-0to292-5degrees  HeadingSlice ::= '1000'H
from292-5to315-0degrees  HeadingSlice ::= '2000'H
from315-0to337-5degrees  HeadingSlice ::= '4000'H
from337-5to360-0degrees  HeadingSlice ::= '8000'H"
STANDARD "SAE J2735"
DATA-TYPE "
    Region-orientation ::= OCTET STRING (SIZE(2))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "units of 22.5 degrees"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.37 Registration Class Data Elements

5.4.37.1 registration-country

```
registration-country ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Registration.country:cd"
ASN-NAME "Registration-country"
ASN-OBJECT-IDENTIFIER { j2735DataElements 126 }
DEFINITION     "This data element is the two-character country codes as defined in ISO
3166-1 alpha-2.  This data element is used to define the country that issued the
registration. "
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "This data element is typically used for commercial vehicle purposes only, such as
for safety inspections, or for security purposes.  The driver must opt-in to allow this
data element to be transmitted."
```

```
STANDARD "SAE J2735"
DATA-TYPE "
    Registration-country ::= IA5String (SIZE(2))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.37.2 registration-identifier

```
registration-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Registration.identifier:id"
ASN-NAME "Registration-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 127 }
DEFINITION     "This data element represents the registration or identification number."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "This data element is typically used for commercial vehicle purposes only, such as
for safety inspections, or for security purposes.  The driver must opt-in to allow this
data element to be transmitted."
STANDARD "SAE J2735"
DATA-TYPE "
    Registration-identifier ::= IA5String (SIZE(17))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.37.3 registration-jurisdiction

```
registration-jurisdiction ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Registration.jurisdiction:cd"
ASN-NAME "Registration-jurisdiction"
ASN-OBJECT-IDENTIFIER { j2735DataElements 128 }
DEFINITION     "This data element is the two or three character code assigned to a
principal subdivision (e.g., provinces or states) of all countries, as coded in ISO 3166-
2."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "In the United States, this data element is the two-character assigned state codes
defined by the US DOT Federal Motor Carrier Safety Administration.  This data element is
used to define the state or province that issued the registration.  See
http://mcmiscatalog.fmcsa.dot.gov/states.asp.
This data element is typically used for commercial vehicle purposes only, such as for
safety inspections, or for security purposes.  The driver must opt-in to allow this data
element to be transmitted."
STANDARD "SAE J2735"
DATA-TYPE "
    Registration-jurisdiction ::= IA5String (SIZE(3))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.37.4 registration-oer

```
registration-oer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Registration.oer:bin"
ASN-NAME "Registration-oer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 129 }
DEFINITION     "The OER-encoded representation of the registration data frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 112 }  -- registration  }
```

```
DATA-TYPE "
    Registration-oer ::= OCTET STRING (SIZE(6..24))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.38 Roadsign Class Data Elements

5.4.38.1 roadsign-orientation

```
roadsign-orientation ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Roadsign.orientation:cd"
ASN-NAME "Roadsign-orientation"
ASN-OBJECT-IDENTIFIER { j2735DataElements 130 }
DEFINITION     "This data element represents the connected device's direction of motion
while facing the active side of the roadway sign.  The device's direction of motion is
defined by a set of sixteen 22.5 degree slices of a unit circle (defined as 0~360 degrees
of heading) which, when set to one, indicates that travel or motion along that angle is
allowed.  For example a value of 0x8001 would indicate the physical roadsign is visible to
vehicles traveling due North.  A 2 byte value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Each bit 22.5 degree starting from North and moving Eastward (clockwise)
noHeading                HeadingSlice ::= '0000'H
allHeadings              HeadingSlice ::= 'FFFF'H
from000-0to022-5degrees  HeadingSlice ::= '0001'H
from022-5to045-0degrees  HeadingSlice ::= '0002'H
from045-0to067-5degrees  HeadingSlice ::= '0004'H
from067-5to090-0degrees  HeadingSlice ::= '0008'H
from090-0to112-5degrees  HeadingSlice ::= '0010'H
from112-5to135-0degrees  HeadingSlice ::= '0020'H
from135-0to157-5degrees  HeadingSlice ::= '0040'H
from157-5to180-0degrees  HeadingSlice ::= '0080'H
from180-0to202-5degrees  HeadingSlice ::= '0100'H
from202-5to225-0degrees  HeadingSlice ::= '0200'H
from225-0to247-5degrees  HeadingSlice ::= '0400'H
from247-5to270-0degrees  HeadingSlice ::= '0800'H
from270-0to292-5degrees  HeadingSlice ::= '1000'H
from292-5to315-0degrees  HeadingSlice ::= '2000'H
from315-0to337-5degrees  HeadingSlice ::= '4000'H
from337-5to360-0degrees  HeadingSlice ::= '8000'H"
STANDARD "SAE J2735"
DATA-TYPE "
    Roadsign-orientation ::= OCTET STRING (SIZE(2))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "units of 22.5 degrees"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.38.2 roadsign-type

```
roadsign-type ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Roadsign.type:cd"
ASN-NAME "Roadsign-type"
ASN-OBJECT-IDENTIFIER { j2735DataElements 131 }
DEFINITION     "This data element is used to describe the what basic MUTCD type a road
sign expression falls into."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
```

```
REMARKS "The bytes defined as follows:
  none (0)              - non-MUTCD information;
  regulatory (1)        - Regulatory signs;
  warning (2)           - Warning signs;
  maintenance (3)       - Maintenance and construction;
  motoristService (4)   - Motorist Services;
  guide (5)             - Guide signs;
  rec (6)               - Recreation and Cultural Interest"
STANDARD "SAE J2735"
DATA-TYPE "
    Roadsign-type ::= ENUMERATED {
    none (0),
    regulatory (1),
    warning (2),
    maintenance (3),
    motoristservice (4),
    guide (5),
    rec (6),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "Values to 127 reserved for standard use.  Values 128 to 255 reserved for
local use."}
```

5.4.39 RTCM Class Data Elements

5.4.39.1 rTCM-header-oer

```
rTCM-header-oer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "RTCM.header-oer:bin"
ASN-NAME "RTCM-header-oer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 132 }
DEFINITION     "This data element is the OER encoding of the rTCMHeader data frame.  This
data element is used to convey RTCM differential correction information between users."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The gPSUnit-status is to occupy 1 byte, and the antennaOffset is to occupy 4
bytes."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 116 }  -- rTCMHeader  }
DATA-TYPE "
    RTCM-header-oer ::= OCTET STRING (SIZE(5))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.39.2 rTCM-ID

```
rTCM-ID ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "RTCM.ID:id"
ASN-NAME "RTCM-ID"
ASN-OBJECT-IDENTIFIER { j2735DataElements 133 }
DEFINITION     "This data element provides the 12 bit value defined in the RTCM standards
for each message.  In this standard this is rounded to 16 bits (2 bytes) and the upper
four bits are defined as zero when one of the RTCM messages are used.  Any bit being set
to one in this range would indicate a locally defined (non national standard) meaning.
Note that the RTCM message standard itself defines some private proprietary message types
(in the range 4001 to 4095 in the 12 bit system) and these are also supported.  Refer to
the RTCM standard for the latest list of these assignments and uses."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
```

```
DATA-TYPE "
    RTCM-ID ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.39.3 rTCM-Payload

```
rTCM-Payload ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "RTCM.Payload:bin"
ASN-NAME "RTCM-Payload"
ASN-OBJECT-IDENTIFIER { j2735DataElements 134 }
DEFINITION     "This data element contains the stream of bytes in the actual RTCM message
that is being sent."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    RTCM-Payload ::= OCTET STRING (SIZE(1..1023))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.39.4 rTCM-Revision

```
rTCM-Revision ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "RTCM.Revision:cd"
ASN-NAME "RTCM-Revision"
ASN-OBJECT-IDENTIFIER { j2735DataElements 135 }
DEFINITION     "The specific revision of the RTCM standard which is being used.  This is
needed to know precisely the mapping of the messages types to their definitions, as well
as some minor transport layer ordering details when received in the mobile unit."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "In order to fully support the use of networked transport of RTCM corrections (so-
called Ntrip systems), the enumerated list of protocol types provides for all the common
types outlined in RTCM Standard 10410.0, Appendix B.  It is anticipated that revisions 3.x
and 2.3 will predominate in practice."
STANDARD "SAE J2735"
DATA-TYPE "
    RTCM-Revision ::= ENUMERATED {
    unknown (0),
    reserved (1),
    rtcmcmr (2),
    rtcmcmrplus (3),
    rtcmsapos (4),
    rtcmsaposadv (5),
    rtcmrtca (6),
    rtcmraw (7),
    rtcmrinex (8),
    rtcmsp3 (9),
    rtcmbinex (10),
    rtcmrev2x (19),
    rtcmrev20 (20),
    rtcmrev21 (21),
    rtcmrev23 (23),
    rtcmrev30 (30),
    rtcmrev31 (31),
    ...  }  "
```

```
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "The value rTcmRev2x (19) shall be used when specific revision is not known.
The value rtcmRev23 (23) is Standard 10402.3.
The value rtcmRev31 (23) is Standard 10403.1.
Values to 127 reserved for standard use.
Values 128 to 255 reserved for local use."}
```

5.4.40 Segment Class Data Elements

5.4.40.1 segment-default-lane-width

```
segment-default-lane-width ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Segment.default-lane-width:qty"
ASN-NAME "Segment-default-lane-width"
ASN-OBJECT-IDENTIFIER { j2735DataElements 136 }
DEFINITION     "This data element is used to define the default width to use for all lanes related to the roadway segment; the value may be overridden within the definition of each lane."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Segment-default-lane-width ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.40.2 segment-identifier

```
segment-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Segment.identifier:id"
ASN-NAME "Segment-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 137 }
DEFINITION     "This data element is used to globally and uniquely define a roadway segment within a country or region in a 32 bit field."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Assignment rules for this value are established elsewhere and may use regional assignment schemas that vary.  Note that often only the lower 16 bits of this value will be sent as the operational region (e.g., a state or province) will be known and not sent each time."
STANDARD "SAE J2735"
DATA-TYPE "
    Segment-identifier ::= OCTET STRING (SIZE(2..4))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.40.3 segment-version

```
segment-version ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Segment.version:id"
ASN-NAME "Segment-version"
ASN-OBJECT-IDENTIFIER { j2735DataElements 138 }
DEFINITION     "This data element is used to identify the version of the roadway segment's geometric information being broadcast."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
```

```
DATA-TYPE "
    Segment-version ::= INTEGER (-2147483647..2147483647)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.41 ShapePoint Class Data Elements

5.4.41.1 shapePoint-direction

```
shapePoint-direction ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ShapePoint.direction:cd"
ASN-NAME "ShapePoint-direction"
ASN-OBJECT-IDENTIFIER { j2735DataElements 139 }
DEFINITION     "This data element defines the allowed direction of travel on a street
lane or path described by shape points.  It indicates the direction of travel along the
series of offset points defined in a shape point set.  Valid values are forward (direction
of travel follows node ordering), reverse (direction of travel is the reverse of node
ordering), or both (direction of travel allowed in both directions)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ShapePoint-direction ::= ENUMERATED {
    forward (0),
    reverse (1),
    both (2) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.41.2 shapePoint-width

```
shapePoint-width ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ShapePoint.width:qty"
ASN-NAME "ShapePoint-width"
ASN-OBJECT-IDENTIFIER { j2735DataElements 140 }
DEFINITION     "This data element conveys the width of a shape point set.  Each shape
point set node defines the center line path of a geometric area within which a message or
traveler information item is valid.  This data element defines the width of the geometric
area at each shape point set node, unless otherwise specified."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ShapePoint-width ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.41.3 shapePointOffsetNode-width

```
shapePointOffsetNode-width ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ShapePointOffsetNode-width:qty"
ASN-NAME "ShapePointOffsetNode-width"
ASN-OBJECT-IDENTIFIER { j2735DataElements 141 }
DEFINITION     "This data element conveys the width of the geographic area at the node.
Each shape point set node defines the center line path of a geometric area within which a
message or traveler information item is valid.  This data element defines the width of the
geometric area at that shape point set node."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
```

```
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ShapePointOffsetNode-width ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.41.4 shapePointOffsetNode-x-offset

```
shapePointOffsetNode-x-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ShapePointOffsetNode-x-offset:lctn"
ASN-NAME "ShapePointOffsetNode-x-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 142 }
DEFINITION     "This data element represents the (signed) offset along the x-axis
(latitude) from a reference point.  The initial offset value (starting point) is from the
shape point's anchor point.  All subsequent offsets are additive from the last set of
offset values (node).  The distance is measured in units of centimeter.  A positive offset
value represents a location to the east of the previous node."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ShapePointOffsetNode-x-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.41.5 shapePointOffsetNode-y-offset

```
shapePointOffsetNode-y-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ShapePointOffsetNode-y-offset:lctn"
ASN-NAME "ShapePointOffsetNode-y-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 143 }
DEFINITION     "This data element represents the (signed) offset along the y-axis
(longitude) from a reference point.  The initial offset value (starting point) is from the
shape point's anchor point.  All subsequent offsets are additive from the last set of
offset values (node).  The distance is measured in units of centimeter.  A positive offset
value represents a location to the north of the previous node."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ShapePointOffsetNode-y-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.41.6 shapePointOffsetNode-z-offset

```
shapePointOffsetNode-z-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ShapePointOffsetNode-z-offset:lctn"
ASN-NAME "ShapePointOffsetNode-z-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 144 }
DEFINITION     "This data element represents the (signed) offset along the z-axis
(vertical) from a reference point.  The initial offset value (starting point) is from the
shape point's anchor point.  All subsequent offsets are additive from the last set of
offset values (node).  The distance is measured in units of centimeter.  A positive value
represents an elevation higher along the vertical axis from the previous node."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
```

```
STANDARD "SAE J2735"
DATA-TYPE "
    ShapePointOffsetNode-z-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.41.7 shapePointOffsetNode-z-tolerance

```
shapePointOffsetNode-z-tolerance ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ShapePointOffsetNode-z-tolerance:lctn"
ASN-NAME "ShapePointOffsetNode-z-tolerance"
ASN-OBJECT-IDENTIFIER { j2735DataElements 145 }
DEFINITION     "This data element represents the tolerance along the z-axis (vertical)
from the geometric area's anchor point.  The valid geometric area would be between the
elevation (shapePointOffsetNode-z-offset) plus and minus the tolerance value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ShapePointOffsetNode-z-tolerance ::= INTEGER (-127..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.42 Probe Class Data Elements

5.4.42.1 snapshotDistance-interval-higher

```
snapshotDistance-interval-higher ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.SnapshotDistance-interval-higher:qty"
ASN-NAME "SnapshotDistance-interval-higher"
ASN-OBJECT-IDENTIFIER { j2735DataElements 146 }
DEFINITION     "This data element defines the higher distance interval traveled by the
vehicle between the generation of periodic snapshots in a connected vehicle, as a function
of the vehicle speed.  This data element is used in conjunction with the snapshotSpeed-
threshold-higher data element - a connected vehicle, with a vehicle speed equal to or
higher than the speed defined in the snapshotSpeed-threshold-higher data element, will
generate a periodic snapshot every time after the connected vehicle has traveled the
distance provided by this data element.  For connected vehicle speeds between the
snapshotSpeed-threshold-higher and snapshotSpeed-threshold-lower, the distance interval
between the generation of periodic snapshots is determined by the same linear relationship
between the snapshotDistance-interval-higher and snapshotDistance-interval-lower."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotDistance-interval-higher ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.42.2 snapshotDistance-interval-lower

```
snapshotDistance-interval-lower ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.SnapshotDistance-interval-lower:qty"
ASN-NAME "SnapshotDistance-interval-lower"
ASN-OBJECT-IDENTIFIER { j2735DataElements 147 }
DEFINITION     "This data element defines the lower distance interval traveled by the
vehicle between the generation of periodic snapshots in a connected vehicle, as a function
of the vehicle speed.  This data element is used in conjunction with the snapshotSpeed-
threshold-lower data element - a connected vehicle, with a vehicle speed equal to or less
than the speed defined in the snapshotSpeed-threshold-lower data element, will generate a
periodic snapshot every time after the connected vehicle has traveled the distance
provided by this data element.  For connected vehicle speeds between the snapshotSpeed-
threshold-higher and snapshotSpeed-threshold-lower, the distance interval between the
generation of periodic snapshots is determined by the same linear relationship between the
snapshotDistance-interval-higher and snapshotDistance-interval-lower."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotDistance-interval-lower ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.43 SnapshotRequest Class Data Elements

5.4.43.1 snapshotRequest-all

```
snapshotRequest-all ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotRequest.all:nbr"
ASN-NAME "SnapshotRequest-all"
ASN-OBJECT-IDENTIFIER { j2735DataElements 148 }
DEFINITION     "A data element that, when set to 1, allows an agency to request that a
connected device include a sensor reading whenever that connected device generates a
(probe) snapshot.  Used with the vehicle-status-type-tag."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotRequest-all ::= BOOLEAN  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.43.2 snapshotRequest-threshold-greater

```
snapshotRequest-threshold-greater ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotRequest.threshold-greater:nbr"
ASN-NAME "SnapshotRequest-threshold-greater"
ASN-OBJECT-IDENTIFIER { j2735DataElements 149 }
DEFINITION     "A data element that allows an agency to request that a connected device
generate a snapshot when a sensor reading on the connected device rises above (is greater
than) this value.  Used with the vehicle-status-type-tag."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotRequest-threshold-greater ::= INTEGER (-32767..2147483647)  "
```

```
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.43.3 snapshotRequest-threshold-lower

```
snapshotRequest-threshold-lower ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotRequest.threshold-lower:nbr"
ASN-NAME "SnapshotRequest-threshold-lower"
ASN-OBJECT-IDENTIFIER { j2735DataElements 150 }
DEFINITION     "A data element that allows an agency to request that a connected device
generate a snapshot when a sensor reading on the connected device falls below (is less
than) this value.  Used with the vehicle-status-type-tag."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotRequest-threshold-lower ::= INTEGER (-32767..2147483647)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.44 Probe Class Data Elements

5.4.44.1 snapshotSpeed-threshold-higher

```
snapshotSpeed-threshold-higher ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.SnapshotSpeed-threshold-higher:qty"
ASN-NAME "SnapshotSpeed-threshold-higher"
ASN-OBJECT-IDENTIFIER { j2735DataElements 151 }
DEFINITION     "This data element defines the higher instantaneous speed value to
determine the intervals between the generation of periodic snapshots in a connected
vehicle.  The default method for generating periodic snapshots is to use time and the
vehicle's current speed to linearly space the intervals between snapshots - as the vehicle
speed increases, the interval between periodic snapshots increases (See Section
3.6.1.5.1.2.1).  However, an optional method to generate periodic snapshots is to use
distance traveled and the vehicle's current speed to linearly space the intervals between
snapshots."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The default value is 268 (26.8 meters per second)."
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotSpeed-threshold-higher ::= INTEGER (0..8191)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenths of a meter per second"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.44.2 snapshotSpeed-threshold-lower

```
snapshotSpeed-threshold-lower ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.SnapshotSpeed-threshold-lower:qty"
ASN-NAME "SnapshotSpeed-threshold-lower"
ASN-OBJECT-IDENTIFIER { j2735DataElements 152 }
DEFINITION     "This data element defines the lower instantaneous (point) speed value to
determine the interval between the generation of periodic snapshots in a connected
vehicle.  The default method for generating periodic snapshots is to use time and the
vehicle's current speed to linearly space the intervals between snapshots - as the vehicle
speed increases, the interval between periodic snapshots increases (See Section
3.6.1.5.1.2.1).  However, an optional method to generate periodic snapshots is to use
distance traveled and the vehicle's current speed to linearly space the intervals between
snapshots."
```

```
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The default value is 89 (8.9 meters per second)."
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotSpeed-threshold-lower ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenths of a meter per second"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.44.3 snapshotStop-last

```
snapshotStop-last ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.SnapshotStop-last:qty"
ASN-NAME "SnapshotStop-last"
ASN-OBJECT-IDENTIFIER { j2735DataElements 153 }
DEFINITION     "This data element is used in conjunction with other data elements to
define when a connected vehicle is considered to be stopped for the purposes of generating
start and stop snapshots.  A connected vehicle is considered stopped when there is no
movement for a threshold stop time (snapshotStop-time) and when no other stops have
occurred within another threshold time (last stop threshold).  This data element defines
the last stop threshold."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The default value is 150 (15.0 seconds)."
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotStop-last ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenths of a second"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.44.4 snapshotStop-start

```
snapshotStop-start ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.SnapshotStop-start:qty"
ASN-NAME "SnapshotStop-start"
ASN-OBJECT-IDENTIFIER { j2735DataElements 154 }
DEFINITION     "This data element defines the threshold that the connected vehicle's
point speed, in meters per second, must reach before the connected vehicle is no longer
considered stopped for the purpose of generating periodic, and start and stop snapshots.
For example, if this value is 90, the vehicle is no longer considered stopped when its
point speed reaches 1.8 meters per second."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The default value is 225 (4.5 meters per second)."
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotStop-start ::= INTEGER (0..8191)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "units of 0.02 meters per second"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.44.5 snapshotStop-time

```
snapshotStop-time ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.SnapshotStop-time:qty"
ASN-NAME "SnapshotStop-time"
ASN-OBJECT-IDENTIFIER { j2735DataElements 155 }
```

```
DEFINITION     "This data element is used in conjunction with other data elements to
define when a connected vehicle is considered to be stopped for the purposes of generating
snapshots.  This data element defines the time threshold, in tenths of a second, that a
connected vehicle's point speed, in meters per second, is zero, before the connected
vehicle is considered stopped for the purpose of generating periodic snapshots, and start
and stop snapshots.  For example, if this value is 50, a vehicle is considered stopped if
its point speed is 0 meters per seconds for 5 seconds."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The default value is 50 (5.0 seconds)."
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotStop-time ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenths of a second"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.44.6 snapshotTime-interval-higher

```
snapshotTime-interval-higher ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.SnapshotTime-interval-higher:qty"
ASN-NAME "SnapshotTime-interval-higher"
ASN-OBJECT-IDENTIFIER { j2735DataElements 156 }
DEFINITION     "This data element defines the higher time interval that must elapse
between the generation of periodic snapshots in a connected vehicle, as a function of the
vehicle speed.  This data element is used in conjunction with the snapshotTime-threshold-
higher data element.  A connected vehicle, with a vehicle speed equal to or higher than
the speed defined in the snapshotSpeed-threshold-higher data element, will generate a
periodic snapshot every time after the time interval has elapsed as defined by this data
element.  For connected vehicle speeds between the snapshotSpeed-threshold-higher and
snapshotSpeed-threshold-lower, the time interval between the generation of periodic
snapshots is determined by the same linear relationship between the snapshotTime-interval-
higher and snapshotTime-interval-lower."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The default value is 20 (20 seconds)."
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotTime-interval-higher ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "seconds"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.44.7 snapshotTime-interval-lower

```
snapshotTime-interval-lower ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Probe.SnapshotTime-interval-lower:qty"
ASN-NAME "SnapshotTime-interval-lower"
ASN-OBJECT-IDENTIFIER { j2735DataElements 157 }
DEFINITION     "This data element defines the lower time interval that must elapse
between the generation of periodic snapshots in a connected vehicle, as a function of the
vehicle speed.  This data element is used in conjunction with the snapshotTime-threshold-
lower data element.  A connected vehicle, with a vehicle speed equal to or lower than the
speed defined in the snapshotSpeed-threshold-lower data element, will generate a periodic
snapshot every time after the time interval has elapsed as defined by this data element.
For connected vehicle speeds between the snapshotSpeed-threshold-higher and snapshotSpeed-
threshold-lower, the time interval between the generation of periodic snapshots is
determined by the same linear relationship between the snapshotTime-interval-higher and
snapshotTime-interval-lower."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The default value is 4 (4 seconds)."
STANDARD "SAE J2735"
DATA-TYPE "
```

```
    SnapshotTime-interval-lower ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "seconds"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.45 SnapshotWeather Class Data Elements

5.4.45.1 snapshotWeather-dewpoint

```
snapshotWeather-dewpoint ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotWeather.dewpoint:qty"
ASN-NAME "SnapshotWeather-dewpoint"
ASN-OBJECT-IDENTIFIER { j2735DataElements 158 }
DEFINITION     "This data element represents the measured dewpoint temperature in tenths
of degrees Celsius."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotWeather-dewpoint ::= NTCIP.EssDewpointTemp  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenth of a degree Celsius"
VALID-VALUE-RULE "A value of 1001 shall be used when the value is unavailable or to
indicate an error condition.
Resolution is based on WMO Binary Code Form FM 94 BUFR Table B item 0 12 003; temperature
in Kelvin is determined by adding 273.15 to this value."}
```

5.4.45.2 snapshotWeather-precipitation-depth

```
snapshotWeather-precipitation-depth ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotWeather.precipitation-depth:qty"
ASN-NAME "SnapshotWeather-precipitation-depth"
ASN-OBJECT-IDENTIFIER { j2735DataElements 159 }
DEFINITION     "This data element represents the measured thickness of ice or depth of
water on the surface of the roadway measured in 1/10th of millimeters."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotWeather-precipitation-depth ::= NTCIP.EssSurfaceIceOrWaterDepth  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one-tenth of a millimeter"
VALID-VALUE-RULE "The value of 65535 shall be used when the value is unavailable or to
indicate an error condition."}
```

5.4.45.3 snapshotWeather-radiation

```
snapshotWeather-radiation ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotWeather.radiation:qty"
ASN-NAME "SnapshotWeather-radiation"
ASN-OBJECT-IDENTIFIER { j2735DataElements 160 }
DEFINITION     "This data element represents the average total radiation hitting the
earth's surface in watts per square meter."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotWeather-radiation ::= INTEGER (0..1001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "watts per square meter"
```

```
VALID-VALUE-RULE "The value of 1001 shall be used when the value is unavailable or to
indicate an error condition."}
```

5.4.45.4 snapshotWeather-snow-depth

```
snapshotWeather-snow-depth ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotWeather.snow-depth:qty"
ASN-NAME "SnapshotWeather-snow-depth"
ASN-OBJECT-IDENTIFIER { j2735DataElements 161 }
DEFINITION     "This data element represents the measured depth of unpacked snow in
centimeters on the driving surface."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotWeather-snow-depth ::= NTCIP.EssRoadwaySnowDepth  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "The value of 3001 shall be used when the value is unavailable or to
indicate an error condition."}
```

5.4.45.5 snapshotWeather-snow-depth-adjacent

```
snapshotWeather-snow-depth-adjacent ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotWeather.snow-depth-adjacent:qty"
ASN-NAME "SnapshotWeather-snow-depth-adjacent"
ASN-OBJECT-IDENTIFIER { j2735DataElements 162 }
DEFINITION     "This data element represents the measured depth of snow in centimeters on
representative areas other than the highway pavement, avoiding drifts and plowed areas."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotWeather-snow-depth-adjacent ::= NTCIP.EssAdjacentSnowDepth  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "The value 3001 shall be used when the value is unavailable or to
indicate an error condition."}
```

5.4.45.6 snapshotWeather-surface-temperature

```
snapshotWeather-surface-temperature ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotWeather.surface-temperature:qty"
ASN-NAME "SnapshotWeather-surface-temperature"
ASN-OBJECT-IDENTIFIER { j2735DataElements 163 }
DEFINITION     "This data element represents the measured pavement surface temperature in
tenths of degrees Celsius."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotWeather-surface-temperature ::= NTCIP.EssSurfaceTemperature  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one tenth of a degree Celsius"
VALID-VALUE-RULE "A value 1001 shall be used when the value is unavailable or to indicate
an error condition."}
```

5.4.45.7 snapshotWeather-visibility

```
snapshotWeather-visibility ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotWeather.visibility:qty"
ASN-NAME "SnapshotWeather-visibility"
ASN-OBJECT-IDENTIFIER { j2735DataElements 164 }
DEFINITION     "This data element represents the surface visibility measured in one tenth
of a meter."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotWeather-visibility ::= NTCIP.EssVisibility  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one tenth of a meter"
VALID-VALUE-RULE "The value 1000001 shall be used when the value is unavailable or to
indicate an error condition.
The value for WMO Code Form FM 94 BUFR Table B item 0 20 001 is given by this value
divided by 100."}
```

5.4.45.8 snapshotWeather-wind-direction

```
snapshotWeather-wind-direction ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotWeather.wind-direction:qty"
ASN-NAME "SnapshotWeather-wind-direction"
ASN-OBJECT-IDENTIFIER { j2735DataElements 165 }
DEFINITION     "This data element represents the direction from which the wind is blowing
as measured by the wind sensor in degrees clockwise.  For mobile platforms, the wind
direction shall be corrected for the movement of the device.  Normal observations, as
defined by the WMO, shall report a wind direction in the range of 1 to 360 with 90 meaning
from the east and 360 meaning from the north."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotWeather-wind-direction ::= NTCIP.WindSensorSpotDirection  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "degrees"
VALID-VALUE-RULE "A value of 0 shall be used to indicate 'calm', when the associated speed
is zero (0), or 'light and variable,' when the associated wind speed is greater than zero.
 The value of 361 shall be used to indicate an error condition and shall always be
reported if the associated speed also indicates an error condition."}
```

5.4.45.9 snapshotWeather-wind-speed

```
snapshotWeather-wind-speed ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "SnapshotWeather.wind-speed:qty"
ASN-NAME "SnapshotWeather-wind-speed"
ASN-OBJECT-IDENTIFIER { j2735DataElements 166 }
DEFINITION     "This data element represents the measured spot wind speed in meters per
second.  For mobile platforms, the wind speed shall be corrected for the movement of the
device."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    SnapshotWeather-wind-speed ::= INTEGER (0..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "meters per second"
```

```
VALID-VALUE-RULE "A value of 126 shall be used to indicate a wind speed of 126 meters per
second or greater.  A value of 127 shall be used when the value is unavailable or to
indicate an error condition."}
```

5.4.46 Vehicle Class Data Elements

5.4.46.1 time-offset

```
time-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.Time-offset:gps"
ASN-NAME "Time-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 167 }
DEFINITION     "This data element represents the difference in time from a reference
point."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Time-offset ::= INTEGER (1..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "10 ms"
VALID-VALUE-RULE "The value of 65534 shall be used for 65534 or greater.  The value of
65535 shall be used when the value is unavailable."}
```

5.4.47 TrafficSignalMovement Class Data Elements

5.4.47.1 trafficSignalMovement-clearance-duration

```
trafficSignalMovement-clearance-duration ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TrafficSignalMovement.clearance-duration:gps"
ASN-NAME "TrafficSignalMovement-clearance-duration"
ASN-OBJECT-IDENTIFIER { j2735DataElements 168 }
DEFINITION     "A data element that represents the time when the clearance state for the
subject movement state is predicted to end.  Clearance states, such as yellow states for
motorized vehicles or flashing-don't-walks for pedestrian movements, are typically fixed
durations in length. This data element is in units of deciseconds (1/10 of a second) since
midnight."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    TrafficSignalMovement-clearance-duration ::= INTEGER (0..864010)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one-tenth of a second"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.47.2 trafficSignalMovement-expiration-early

```
trafficSignalMovement-expiration-early ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TrafficSignalMovement.expiration-early:gps"
ASN-NAME "TrafficSignalMovement-expiration-early"
ASN-OBJECT-IDENTIFIER { j2735DataElements 169 }
DEFINITION     "A data element that represents the earliest time when the subject
movement state is predicted to change.  For actuated traffic signal controllers, this time
will be equal to the time that the minimum green and pedestrian times have been satisfied.
 For traffic signal controllers operating in fixed time, the earliest time of change will
be equal to the value in the trafficSignalMovement-expiration-late.  This data element is
in units of deciseconds (1/10 of a second) since midnight."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
```

```
DATA-TYPE "
    TrafficSignalMovement-expiration-early ::= INTEGER (0..864010)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one-tenth of a second"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.47.3 trafficSignalMovement-expiration-late

```
trafficSignalMovement-expiration-late ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TrafficSignalMovement.expiration-late:gps"
ASN-NAME "TrafficSignalMovement-expiration-late"
ASN-OBJECT-IDENTIFIER { j2735DataElements 170 }
DEFINITION     "A data element that represents the latest time when the subject movement
state is predicted to change.  For actuated traffic signal controllers, this time will be
equal to the time that the maximum allowable green is reached.  For traffic signal
controllers operating in fixed time, the earliest time of change will be equal to the
value in the trafficSignalMovement-expiration-early. This data element is in units of
deciseconds (1/10 of a second) since midnight."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    TrafficSignalMovement-expiration-late ::= INTEGER (0..864010)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one-tenth of a second"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.47.4 trafficSignalMovement-indication-crosswalk

```
trafficSignalMovement-indication-crosswalk ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TrafficSignalMovement.indication-crosswalk:cd"
ASN-NAME "TrafficSignalMovement-indication-crosswalk"
ASN-OBJECT-IDENTIFIER { j2735DataElements 171 }
DEFINITION     "A data element indicating the current or the next signal state of a
particular known pedestrian crosswalk and movement (depending on usage context).  Used in
the sPAT data frame, the data element is a 8-bit encoded string, allowing multiple values
to be indicated.
Note that when used in the trafficSignalMovement data frames, this data element appears
twice for pedestrian lanes, once for the current active movement state, and once for the
next 'clearance' movement state (when the current movement state is not simply all-red or
all don't-walks)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The byte is defined as follows:
  unavailable (0) - not equipped or unavailable
  stop (1)        - do not walk
  caution (2)     - flashing dont walk sign
  walk (3)        - walk active"
STANDARD "SAE J2735"
DATA-TYPE "
    TrafficSignalMovement-indication-crosswalk ::= ENUMERATED {
    unavailable (0),
    stop (1),
    caution (2),
    walk (3) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.47.5 trafficSignalMovement-indication-special

```
trafficSignalMovement-indication-special ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TrafficSignalMovement.indication-special:cd"
ASN-NAME "TrafficSignalMovement-indication-special"
ASN-OBJECT-IDENTIFIER { j2735DataElements 172 }
DEFINITION     "A data element indicating the current (or the next) state pertaining to
specialized motor vehicles (such as a light rail train). Used in the sPAT data frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The byte is defined as follows:
  unknown (0),  -- unknown or unavailable
  notInUse (1), -- default state, empty, or not in use
  arriving (2), -- special lane is about to be occupied
  present (3),  -- special lane is occupied with a vehicle
  departing (4), -- special lane is about to be empty"
STANDARD "SAE J2735"
DATA-TYPE "
    TrafficSignalMovement-indication-special ::= OCTET STRING (SIZE(8))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.47.6 trafficSignalMovement-indication-vehicle

```
trafficSignalMovement-indication-vehicle ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TrafficSignalMovement.indication-vehicle:cd"
ASN-NAME "TrafficSignalMovement-indication-vehicle"
ASN-OBJECT-IDENTIFIER { j2735DataElements 173 }
DEFINITION     "A data element indicating the current (or the next) signal state of all
signal indications pertaining to a particular known lane or movement (set of lanes).
Note that when used in the movement data frames the signal state appears twice for
motorized vehicle lanes, once for the current state, and once for the next 'clearance'
phase (usually a yellow indication and the current state is not simply red).  For stopped
signals (red states) no yellow phase data is needed, nor is it present for lane states
which deal with trains."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    TrafficSignalMovement-indication-vehicle ::=  BIT STRING {
    reserved0 (0),
    reserved1 (1),
    reserved2 (2),
    reserved3 (3),
    flashing-u-turn (4),
    red-u-turn (5),
    yellow-u-turn (6),
    green-u-turn (7),
    flashing-soft-right (8),
    red-soft-right (9),
    yellow-soft-right (10),
    green-soft-right (11),
    flashing-soft-left (12),
    red-soft-left (13),
    yellow-soft-left (14),
    green-soft-left (15),
    flashing-straight-arrow (16),
    red-straight-arrow (17),
    yellow-straight-arrow (18),
    green-straight-arrow (19),
    flashing-right (20),
```

```
    red-right (21),
    yellow-right (22),
    green-right (23),
    flashing-left (24),
    red-left (25),
    yellow-left (26),
    green-left (27),
    flashing-ball (28),
    red-ball (29),
    yellow-ball (30),
    green-ball (31) } (SIZE(32))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.47.7 trafficSignalMovement-pedestrian-call

```
trafficSignalMovement-pedestrian-call ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TrafficSignalMovement.pedestrian-call:cd"
ASN-NAME "TrafficSignalMovement-pedestrian-call"
ASN-OBJECT-IDENTIFIER { j2735DataElements 174 }
DEFINITION     "A data element indicating if a pedestrian call for the movement-state has
been detected."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The byte is defined as follows:
  unavailable (0) - not equipped or unavailable;
  no pedestrian call detected (1);
  pedestrian call detected (2)."
STANDARD "SAE J2735"
DATA-TYPE "
    TrafficSignalMovement-pedestrian-call ::= ENUMERATED {
    unavailable (0),
    no-pedestrian-call-detected (1),
    pedestrian-call-detected (2) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.47.8 trafficSignalMovement-pedestrian-detect

```
trafficSignalMovement-pedestrian-detect ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TrafficSignalMovement.pedestrian-detect:cd"
ASN-NAME "TrafficSignalMovement-pedestrian-detect"
ASN-OBJECT-IDENTIFIER { j2735DataElements 175 }
DEFINITION     "A data element indicating the (possible) presence of one or more
pedestrians or other objects in the crosswalk area, independent of the technology used to
determine this."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    TrafficSignalMovement-pedestrian-detect ::= ENUMERATED {
    unavailable (0),
    no-pedestrians-detected (1),
    one-or-more-possible-pedestrians-detected (2) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.47.9 trafficSignalMovementLanes

```
trafficSignalMovementLanes ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TrafficSignalMovementLanes:cd"
ASN-NAME "TrafficSignalMovementLanes"
ASN-OBJECT-IDENTIFIER { j2735DataElements 176 }
DEFINITION     "This data element is a sequence of one or more octets, where each octet
represents one of the lanes in an intersection.  Each byte is encoded as a lane number."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    TrafficSignalMovementLanes ::= OCTET STRING (SIZE(1..127))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.48 TrafficSignalPriority Class Data Elements

5.4.48.1 trafficSignalPriority-lane

```
trafficSignalPriority-lane ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TrafficSignalPriority.lane:id"
ASN-NAME "TrafficSignalPriority-lane"
ASN-OBJECT-IDENTIFIER { j2735DataElements 177 }
DEFINITION     "This data element defines the lane identifier for which the signal
priority or signal preemption scheme applies."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    TrafficSignalPriority-lane ::= INTEGER (0..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.48.2 trafficSignalPriority-number

```
trafficSignalPriority-number ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TrafficSignalPriority.number:cd"
ASN-NAME "TrafficSignalPriority-number"
ASN-OBJECT-IDENTIFIER { j2735DataElements 178 }
DEFINITION     "A data element is used to indicate what signal priority or preempt
schemes are available.  This data element has either a priority value or a preemption
value, depending on the setting of the MSB and what data frame it is used in.  A value of
B'1111' indicates a request for cabinet flash when the data element is used in a preempt.
 The value B'0111' is reserved when used for a priority request.  The value B'000' is
reserved.  "
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "In use, the vehicle must determine which preempt number or priority number to
request by analyzing its location relative to the map layer information.
Encoded as follows:
  upper nibble:  Preempt #:
  -- Bit 7  (MSB)  1 =  Preempt and 0 =  Priority
  -- Remaining 3 bits: Range of 0..7. The values of 1..6 represent the respective
controller preempt or Priority to be activated. The value of 7 represents a request for a
cabinet flash preempt, while the value of 0 is reserved.
  lower nibble:  Strategy #:
  -- Range is 0..15 and is used to specify a desired strategy  (if available)."
```

```
STANDARD "SAE J2735"
DATA-TYPE "
    TrafficSignalPriority-number ::= OCTET STRING (SIZE(1))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.49 Trailer Class Data Elements

5.4.49.1 trailer-count-axle

```
trailer-count-axle ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Trailer.count-axle:qty"
ASN-NAME "Trailer-count-axle"
ASN-OBJECT-IDENTIFIER { j2735DataElements 179 }
DEFINITION     "A data element representing the number of axles on the trailer."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Trailer-count-axle ::= INTEGER (0..7)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "The value of zero (0) shall be used for when the value is unavailable or
unknown."}
```

5.4.49.2 trailer-count-tire

```
trailer-count-tire ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Trailer.count-tire:qty"
ASN-NAME "Trailer-count-tire"
ASN-OBJECT-IDENTIFIER { j2735DataElements 180 }
DEFINITION     "A data element representing the number of tires on the trailer."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Trailer-count-tire ::= INTEGER (0..31)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "The value of zero (0) shall be used for when the value is unavailable or
unknown."}
```

5.4.49.3 trailer-oer

```
trailer-oer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Trailer.oer:bin"
ASN-NAME "Trailer-oer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 181 }
DEFINITION     "A data element representing the OER encoding of the trailer data frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 151 }  -- trailer  }
DATA-TYPE "
    Trailer-oer ::= OCTET STRING (SIZE(10..71))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.49.4 trailer-vin

```
trailer-vin ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Trailer.vin:id"
ASN-NAME "Trailer-vin"
ASN-OBJECT-IDENTIFIER { j2735DataElements 182 }
DEFINITION     "The data element is used to convey the trailer's vehicle identification
number (VIN)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "This is an opt-in component that may be used by commercial vehicle drivers for
electronic screenings."
STANDARD "SAE J2735"
DATA-TYPE "
    Trailer-vin ::= IA5String (SIZE(17))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.49.5 trailer-weight

```
trailer-weight ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Trailer.weight:qty"
ASN-NAME "Trailer-weight"
ASN-OBJECT-IDENTIFIER { j2735DataElements 183 }
DEFINITION     "A data element reused from the SAE J1939 standard and encoded as 2
kilograms per bit, with a range of 0 - 128,510 kilograms (kg)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The term 'weight' is used in J1939, while the term 'mass' is used in J2735"
STANDARD "SAE J2735"
DATA-TYPE "
    Trailer-weight ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "2 kg"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.50 TravelerInformation Class Data Elements

5.4.50.1 travelerInformation-identifier

```
travelerInformation-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TravelerInformation.identifier:id"
ASN-NAME "TravelerInformation-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 184 }
DEFINITION     "A data element providing an identifier for a traveler information packet.
 Each packet may contain multiple traveler information items, such as traveler advisories
or road signs."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The recommended structure is an octet string which is a combination of an agency
identifier in the most significant byte that is unique within a region (e.g., state), and
a timestamp in the subsequent bytes (minute of the year).  The timestamp is the minute of
the year when the contents of the traveler information packet was last changed.  A change
in any travel advisory or road sign in the traveler information packet results in a change
in the timestamp."
STANDARD "SAE J2735"
DATA-TYPE "
    TravelerInformation-identifier ::= OCTET STRING (SIZE(4))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.50.2 travelerInformationItem-applicable-vehicles

```
travelerInformationItem-applicable-vehicles ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TravelerInformationItem-applicable-vehicles:cd"
ASN-NAME "TravelerInformationItem-applicable-vehicles"
ASN-OBJECT-IDENTIFIER { j2735DataElements 185 }
DEFINITION     "This data element represents the types of the vehicle, as defined by the
FHWA 13-Category Classification System, that a traveler information message is valid for.
 The connected vehicle must be of that vehicle type for the traveler information message
to be presented to the traveler.  If the value of All Vehicles is sent, the message may be
presented to all types of connected devices."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "  All Vehicles    ::= 'FFFF'H
  unknown              ::= '0001'H
  special              ::= '0002'H
  motorcycle           ::= '0004'H
  car                  ::= '0008'H
  carOther             ::= '0010'H
  bus                  ::= '0020'H
  axleCnt2             ::= '0040'H
  axleCnt3             ::= '0080'H
  axleCnt4             ::= '0100'H
  axleCnt4Trailer      ::= '0200'H
  axleCnt5Trailer      ::= '0040'H
  axleCnt6Trailer      ::= '0080'H
  axleCnt5MultiTrailer ::= '1000'H
  axleCnt6MultiTrailer ::= '2000'H
  axleCnt7MultiTrailer ::= '4000'H"
STANDARD "SAE J2735"
DATA-TYPE "
    TravelerInformationItem-applicable-vehicles ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.50.3 travelerInformationItem-default-direction

```
travelerInformationItem-default-direction ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TravelerInformationItem-default-direction:cd"
ASN-NAME "TravelerInformationItem-default-direction"
ASN-OBJECT-IDENTIFIER { j2735DataElements 186 }
DEFINITION     "This data element represents the default allowed direction of travel on a
street lane or path described by shape points.  This data element is used to indicate the
direction of travel along the series of offset points defined for all shape point sets,
unless specified otherwise.  Valid values are forward (direction of travel follows node
ordering), reverse (direction of travel is the reverse of node ordering), or both
(direction of travel allowed in both directions)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    TravelerInformationItem-default-direction ::= ENUMERATED {
    forward (0),
    reverse (1),
    both (2) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.50.4 travelerInformationItem-default-width

```
travelerInformationItem-default-width ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TravelerInformationItem-default-width:qty"
ASN-NAME "TravelerInformationItem-default-width"
ASN-OBJECT-IDENTIFIER { j2735DataElements 187 }
DEFINITION     "A data element representing the default width of a geographic area in
units of 1 centimeter.  This width is used as part of the definition of geographic regions
where the traveler information item is valid for, unless specified otherwise."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    TravelerInformationItem-default-width ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.50.5 travelerInformationItem-duration

```
travelerInformationItem-duration ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TravelerInformationItem-duration:qty"
ASN-NAME "TravelerInformationItem-duration"
ASN-OBJECT-IDENTIFIER { j2735DataElements 188 }
DEFINITION     "A data element representing the duration, in units of whole minutes, that
the travelerInformationItem is expected to persist for.  The start time is defined by the
data element travelerInformationItem-start-minute and by, if defined,
travelerInformationItem-start-year."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    TravelerInformationItem-duration ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "minute"
VALID-VALUE-RULE "The value of 65535 shall be used when the duration is 65535 minutes or
greater."}
```

5.4.50.6 travelerInformationItem-priority

```
travelerInformationItem-priority ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TravelerInformationItem-priority:nbr"
ASN-NAME "TravelerInformationItem-priority"
ASN-OBJECT-IDENTIFIER { j2735DataElements 189 }
DEFINITION     "A data element representing the relative importance of the traveler
information item, on a scale from zero (least important) to seven (most important).  The
selection of importance will be made by the agency broadcasting the messages."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "How a connected device presents two messages with the same importance is outside
the scope of this standard."
STANDARD "SAE J2735"
DATA-TYPE "
    TravelerInformationItem-priority ::= INTEGER (0..7)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.50.7 travelerInformationItem-start-minute

```
travelerInformationItem-start-minute ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TravelerInformationItem-start-minute:gps"
ASN-NAME "TravelerInformationItem-start-minute"
ASN-OBJECT-IDENTIFIER { j2735DataElements 190 }
DEFINITION     "A data element used to establish when a traveler information message
being broadcasted is valid.  The data element is expressed as the current minute within
the current year, unless the TravelerInformationItem-start-year is also broadcasted, in
which event it is the current minute of the broadcasted year."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    TravelerInformationItem-start-minute ::= INTEGER (0..527040)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "minutes"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.50.8 travelerInformationItem-start-year

```
travelerInformationItem-start-year ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TravelerInformationItem-start-year:gps"
ASN-NAME "TravelerInformationItem-start-year"
ASN-OBJECT-IDENTIFIER { j2735DataElements 191 }
DEFINITION     "A data element used in combination with the TravelerInformationItem-
start-minute to establish the start time for sending messages to travelers.  The data
element is expressed as an integer value from 0 to 9999, representing the year according
to the Gregorian calendar date system.  If this data element is not broadcasted, then the
start time for broadcasting messages to travelers is the current year."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    TravelerInformationItem-start-year ::= INTEGER (0..9999)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "year"
VALID-VALUE-RULE "The value of 0 shall be used for when the value is unavailable."}
```

5.4.50.9 travelerInformation-url-base

```
travelerInformation-url-base ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TravelerInformation.url-base:txt"
ASN-NAME "TravelerInformation-url-base"
ASN-OBJECT-IDENTIFIER { j2735DataElements 192 }
DEFINITION     "This data element contains a valid internet style URI/URL (Uniform
Resource Locator) in the form of a text string which will form the base of a compound
string which, when combined with the travelerInformationItem-url-short data element, will
link to the designated resource.  The string is to be interpreted as case-insensitive.
Lower case is recommended. The protocol to be used (such as http) should be given in the
string."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "It is the responsibility of the local deployment to ensure that all parties can
reach the URL given over their own networks, and that the protocols used are acceptable to
all.  In other words, do not use URLs which depend on private network access to work."
STANDARD "SAE J2735"
DATA-TYPE "
    TravelerInformation-url-base ::= IA5String (SIZE(1..45))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
```

```
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.50.10 travelerInformationItem-url-short

```
travelerInformationItem-url-short ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TravelerInformationItem-url-short:txt"
ASN-NAME "TravelerInformationItem-url-short"
ASN-OBJECT-IDENTIFIER { j2735DataElements 193 }
DEFINITION     "A valid internet style URI / URL in the form of a text string which will
be used as the final portion of a compound string which, when combined with the
travelerInformation-url-base data element, will link to the designated resource.  The
string is to be interpreted as case-insensitive.  Lower case is recommended.  The very
first letter of the string shall be used to differentiate which one of multiple
travelerInformation-url-base values in a single system is to be used.  This allows for a
total of up to 26+10= 36 such base addresses to exist.  This initial letter is then
stripped off and used to differentiate which base a given short value is to be used with."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "It is the responsibility of the local deployment to ensure that all parties can
reach the URL given over their own networks, and that the protocols used are acceptable to
all."
STANDARD "SAE J2735"
DATA-TYPE "
    TravelerInformationItem-url-short ::= IA5String (SIZE(1..15))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51 Vehicle Class Data Elements

5.4.51.1 vehicle-airbags-deployed

```
vehicle-airbags-deployed ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.airbags-deployed:qty"
ASN-NAME "Vehicle-airbags-deployed"
ASN-OBJECT-IDENTIFIER { j2735DataElements 194 }
DEFINITION     "This data element represents the number of airbags in the vehicle that
has been deployed since the vehicle ignition has been turned on."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-airbags-deployed ::= INTEGER (0..31)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "The value of 31 shall be used when the value is unavailable."}
```

5.4.51.2 vehicle-antilock-brake-state

```
vehicle-antilock-brake-state ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.antilock-brake-state:cd"
ASN-NAME "Vehicle-antilock-brake-state"
ASN-OBJECT-IDENTIFIER { j2735DataElements 195 }
DEFINITION     "This data element conveys the state of the sender's anti-lock braking
system.  The four defined states are: the state is unavailable, an anti-lock braking
system is off, an anti-lock braking system is on but not engaged, and an anti-lock braking
system is on and engaged."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "   unavailable (0) -- B'00  Not Equipped with an anti-lock braking system or
status is unavailable
   off (1)      -- B'01 Anti-lock braking system is Off
   on (2)       -- B'10  Anti-lock braking system is On (but not Engaged)
```

```
   engaged (3) -- B'11  Anti-lock braking system is Engaged
 "
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-antilock-brake-state ::= ENUMERATED {
    unavailable (0),
    off (1),
    on (2),
    engaged (3) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.3 vehicle-auxiliary-brake-status

```
vehicle-auxiliary-brake-status ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.auxiliary-brake-status:cd"
ASN-NAME "Vehicle-auxiliary-brake-status"
ASN-OBJECT-IDENTIFIER { j2735DataElements 196 }
DEFINITION     "This data element conveys the state of the sender's auxiliary brake
system (often also called a parking brake).  The three defined states are: Vehicle not
equipped, auxiliary brake not engaged, and auxiliary brake system engaged."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "   unavailable (0) -- B'00  Not Equipped with an auxiliary brake or status is
unavailable
   off (1)      -- B'01 Auxiliary brake is not engaged
   on (2)       -- B'10  Auxiliary brake is engaged
   reserved (3) -- B'11"
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-auxiliary-brake-status ::= ENUMERATED {
    unavailable (0),
    off (1),
    on (2),
    reserved (3) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.4 vehicle-brake-applied-pressure

```
vehicle-brake-applied-pressure ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.brake-applied-pressure:cd"
ASN-NAME "Vehicle-brake-applied-pressure"
ASN-OBJECT-IDENTIFIER { j2735DataElements 197 }
DEFINITION     "This data element indicates the applied pressure on the vehicle brake
system.  The applied pressure is measured in 15 equal increments, with 1 indicating a
minimal amount of (braking) pressure being applied, and 15 indicating maximum amount of
(braking) pressure being applied to the vehicle brake system.  Unavailable indicates that
the brake pressure status is unavailable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "   unavailable (0) -- Not Equipped or status is unavailable
   minPressure (1) -- Minimum braking pressure (0 - 16.7%)
   ...
   maxPressure (15) -- Maximum braking pressure (93.3 - 100%)"
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-brake-applied-pressure ::= ENUMERATED {
    unavailable (0),
    minpressure (1),
    bklvl-2 (2),
    bklvl-3 (3),
```

```
    bklvl-4 (4),
    bklvl-5 (5),
    bklvl-6 (6),
    bklvl-7 (7),
    bklvl-8 (8),
    bklvl-9 (9),
    bklvl-10 (10),
    bklvl-11 (11),
    bklvl-12 (12),
    bklvl-13 (13),
    bklvl-14 (14),
    maxpressure (15) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.5 vehicle-brake-applied-status

```
vehicle-brake-applied-status ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.brake-applied-status:bin"
ASN-NAME "Vehicle-brake-applied-status"
ASN-OBJECT-IDENTIFIER { j2735DataElements 198 }
DEFINITION     "This data element independently indicates for each of a vehicle's four
wheels whether braking is currently active.  The four wheels are designated Left Front,
Right Front, Left Rear, and Right Rear.  The indicated status of a wheel is set to 1 if
brakes are active on that wheel, or to 0 if brakes are inactive on that wheel.  On a
vehicle with only one front wheel, the brake-applied status is represented by the Left
Front wheel indicator and the Right Front indicator is always set to zero.  Similarly, on
a vehicle with only one rear wheel the brake-applied status is represented by the Left
Rear wheel indicator and the Right Rear indicator is always set to zero."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "On vehicles with only 2 wheels, the left side values shall be used and the right
side set to zero.
  -- B'0000  The condition All Off
  -- B'0001  Left Front Active
  -- B'0010  Left Rear Active
  -- B'0100  Right Front Active
  -- B'1000  Right Rear Active  "
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-brake-applied-status ::=  BIT STRING {
    rightrear (0),
    rightfront (1),
    leftrear (2),
    leftfront (3),
    unavailable (4),
    reserved (5) } (SIZE(6))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.6 vehicle-brake-boost-status

```
vehicle-brake-boost-status ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.brake-boost-status:cd"
ASN-NAME "Vehicle-brake-boost-status"
ASN-OBJECT-IDENTIFIER { j2735DataElements 199 }
DEFINITION     "This is a data element which, when set to the 'on' state, indicates
emergency braking.  This data element is an on/off value which indicates engagement of the
vehicle's brake boost assist function (as well as an unavailable state).  Brake boost
assist is available on some vehicles.  It detects the potential of a situation requiring
maximum braking and pre-charges the brake system before the driver presses the brake
pedal.  This situation is detected either by measuring a rapid release of the accelerator
```

```
pedal or via a forward sensing system.  Some systems also apply full braking when the
driver presses the pedal, even with a light force.  Multiple probe data reports of brake
boost at the same location is an indication of an emergency situation on the road and is
therefore of use to road authorities."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "   unavailable (0) -- B'00  Not Equipped with brake boost assist function or
status is unavailable
   off (1) -- B'01 Brake boost is not engaged
   on (2)  -- B'10  Brake boost is engaged"
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-brake-boost-status ::= ENUMERATED {
    unavailable (0),
    off (1),
    on (2) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.7 vehicle-brake-system-status-per

```
vehicle-brake-system-status-per ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.brake-system-status-per:bin"
ASN-NAME "Vehicle-brake-system-status-per"
ASN-OBJECT-IDENTIFIER { j2735DataElements 200 }
DEFINITION     "The UNALIGNED PER-encoded representation of the VehicleBrakeSystemStatus
Data Frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 164 }  -- vehicleBrakeSystemStatus  }
DATA-TYPE "
    Vehicle-brake-system-status-per ::= OCTET STRING (SIZE(2))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.8 vehicle-bsm-part1-oer

```
vehicle-bsm-part1-oer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.bsm-part1-oer:bin"
ASN-NAME "Vehicle-bsm-part1-oer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 201 }
DEFINITION     "This data element is the OER encoding of the bSMPart1 data frame.  This
data element is used to convey a vehicle's position and motion and other critical data to
be sent in the basicSafetyMessage."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 7 }  -- bSMPart1  }
DATA-TYPE "
    Vehicle-bsm-part1-oer ::= OCTET STRING (SIZE(38))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.9 vehicle-bumper-height-front

```
vehicle-bumper-height-front ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.bumper-height-front:qty"
ASN-NAME "Vehicle-bumper-height-front"
ASN-OBJECT-IDENTIFIER { j2735DataElements 202 }
DEFINITION     "This data element conveys the height of the front bumper of the vehicle.
 In cases of vehicles with complex bumper shapes, the center of the mass of the bumper
(where the bumper can best absorb an impact) should be used.
The accuracy of the front bumper height shall be within 0.2 meters."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-bumper-height-front ::= INTEGER (0..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "0.01 meters"
VALID-VALUE-RULE "The value of 0 shall be used when the value is unavailable."}
```

5.4.51.10 vehicle-bumper-height-rear

```
vehicle-bumper-height-rear ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.bumper-height-rear:qty"
ASN-NAME "Vehicle-bumper-height-rear"
ASN-OBJECT-IDENTIFIER { j2735DataElements 203 }
DEFINITION     "This data element conveys the height of the rear bumper of the vehicle.
In cases of vehicles with complex bumper shapes, the center of the mass of the bumper
(where the bumper can best absorb an impact) should be used.
The accuracy of the rear bumper height shall be within 0.2 meters."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-bumper-height-rear ::= INTEGER (0..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "0.01 meters"
VALID-VALUE-RULE "The value of 0 shall be used when the value is unavailable."}
```

5.4.51.11 vehicle-charge-remaining

```
vehicle-charge-remaining ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.charge-remaining:qty"
ASN-NAME "Vehicle-charge-remaining"
ASN-OBJECT-IDENTIFIER { j2735DataElements 204 }
DEFINITION     "This data element indicates the amount of charge remaining in an electric
vehicle's battery."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-charge-remaining ::= INTEGER (0..10001)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one tenth of a kilowatt hour"
VALID-VALUE-RULE "The value of 10001 shall be used when the value is unknown or
unavailable."}
```

5.4.51.12 vehicle-class

```
vehicle-class ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.class:cd"
ASN-NAME "Vehicle-class"
ASN-OBJECT-IDENTIFIER { j2735DataElements 205 }
DEFINITION     "This data element is constructed of two 4-bit nibbles defined by the
guidelines of NTCIP 1211 (Object Definitions for Signal Control and Prioritization (SCP))
except that the range is extended to be 0..15 for each.
NTCIP 1211 Clause 3.1.1.1.4 defines Priority Request Vehicle Class Type as follows:  This
object is the 'PRG requested' class type (relative priority of a request). The order of
precedence is by class type with 1 highest and 10 (15 for this system) lowest.  A request
with a higher class type will override a lower class type.
NTCIP 1211 Clause 3.1.1.1.5 defines Priority Request Vehicle Class Level as follows: This
object is the 'PRG requested' class level (relative priority of a request within each
class of request). The order of precedence is by class type and then class level.
1 is highest and 10 (15 for this system) lowest.  A request with a higher class level does
NOT override a lower class level.
Note that the value zero is not in fact defined in the NTCIP system."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Note that the integer value range of 1..10 has been extended to become 0..15 in a
one byte octet in the DSRC use of this item."
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-class ::= OCTET STRING (SIZE(1))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.13 vehicle-curve

```
vehicle-curve ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.curve:qty"
ASN-NAME "Vehicle-curve"
ASN-OBJECT-IDENTIFIER { j2735DataElements 206 }
DEFINITION     "This data element represents vehicle trajectories, at a first order of
curvature approximation, as a circle with a radius R and an origin located at (0,R), where
the x-axis is bore sight from the transmitting vehicle's perspective and normal to the
vehicle's vertical axis.  The vehicle's (x,y,z) coordinate frame follows the SAE
convention.  Radius R will be positive for curvatures to the right when observed from the
transmitting vehicle's perspective.  Radii shall be capped at a maximum value supported by
the Path Prediction radius data type.  Overflow of this data type shall be interpreted by
the receiving vehicle as 'a straight path' prediction.  The radius can be derived from a
number of sources including, but not limited to, map databases, rate sensors, vision
systems, and global positioning, the precise algorithm to be used is outside the scope of
this document.  In the case where the radius is derived from instantaneous vehicle
information, such as rate sensors and velocity, and to minimize the effect sensor noise
and 'in-lane driver wandering', the resulting roadway radius estimation will have to be
achieved by using low-pass filtering techniques (time constant typically > 2 seconds)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-curve ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "ten centimeters"
VALID-VALUE-RULE "The value of 32767 shall be used for a straight path trajectory."}
```

5.4.51.14 vehicle-curve-confidence

```
vehicle-curve-confidence ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.curve-confidence:pct"
ASN-NAME "Vehicle-curve-confidence"
ASN-OBJECT-IDENTIFIER { j2735DataElements 207 }
DEFINITION     "This data element is used to provide the confidence level for the
currently reported vehicle-curve, which is reported as part of the path prediction of a
vehicle.  This data element is used to provide an indication of the accuracy due to rapid
change in driver input.  When driver input is in a steady state (straight roadways or
curves with a constant radius of curvature), a high confidence value is reported.  During
non-steady state conditions (curve transitions, lane changes, etc.), confidence is
reduced."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-curve-confidence ::= INTEGER (0..200)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "units of 0.5 percent"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.15 vehicle-driving-wheel-angle

```
vehicle-driving-wheel-angle ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.driving-wheel-angle:qty"
ASN-NAME "Vehicle-driving-wheel-angle"
ASN-OBJECT-IDENTIFIER { j2735DataElements 208 }
DEFINITION     "The angle of the front (steering) wheel, expressed in a signed (to the
right being positive) value in units of 0.3333 degrees and a range of plus or minus 42.33
degrees.  The value of zero shall be when both wheels are pointed such as to drive the
vehicle in a straight ahead direction (the tow-in angle of each side being equal and
canceling each other out)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-driving-wheel-angle ::= INTEGER (-127..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "0.3333 degrees"
VALID-VALUE-RULE "The value of 0 shall be used for when the value is unavailable."}
```

5.4.51.16 vehicle-events

```
vehicle-events ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.events:cd"
ASN-NAME "Vehicle-events"
ASN-OBJECT-IDENTIFIER { j2735DataElements 209 }
DEFINITION     "This data element conveys the sender's state with regard to a set of
events.  For each event, the sender has the option to set the flag to 1 if the stated
criteria are met, but it is not required to do so.  The set of event flags and their
respective minimum criteria are listed below.  These definitions and criteria are
normative.  This data element should not be included in a Basic Safety Message unless at
least one event flag is set to 1.  When one or more criteria associated with an event are
no longer satisfied the sender shall set the flag to zero.  The presence of this element
in a message indicates that an unusual event has occurred.  A vehicle receiving such a
message might decide to process it differently than a message that does not include this
data element.  When a given event flag is set to 1 the message might include related
optional data as well.  Consult each specific application for further details and rules.
```

```
Further normative definitions of when to assert each event are given below.
- Hazard Lights:  The hazard lights are active.
- Stop Line Violation:   The vehicle anticipates it will have a stopline violation.  A
stopline violation occurs if the vehicle is about to move through an intersection crossing
in a potentially unsafe manner, such as performing an unpermitted movement at signalized
intersections or not stopping at a stop sign
- ABS: The vehicle's anti-lock braking system is engaged.
- Traction Control: The vehicle's traction control system is engaged.
- Stability Control: The vehicle's stability control system is engaged.
- Hazardous Materials   The vehicle is known to be carrying hazardous material and is
placarded as such.
- Emergency Response:  The vehicle is a properly authorized public safety vehicle, is
engaged in a service call, and is currently moving (lights and sirens may not be evident).
- Hard Braking:  The vehicle is decelerating at a rate of greater than 0.4g.
- Lights Changed:  The status of the external lighting of the vehicle has changed
recently, defined as within the last five (5) seconds.
- Wipers Changed:  The status of wipers (front or rear) of the vehicle has changed
recently, defined as within the last five (5) seconds.
- Flat tire:  The vehicle has determined that at least one tire has run flat.
- Disabled Vehicle:  The vehicle considers itself disabled.
- Air Bag Deployment:   At least one airbag has been deployed."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "This data element appears in the Part II section of the BSM, and is expected to
be present when various potential dangerous events (such as hard braking) have been
declared by the sender. Additional data elements in the message may provide more detail on
the cause of this event.
-- With bits as defined:
   eventHazardLights                Vehicle-events ::= 1
   eventStopLineViolation           Vehicle-events ::= 2
   eventABSactivated                Vehicle-events ::= 4
   eventTractionControlLoss         Vehicle-events ::= 8
   eventStabilityControlactivated  Vehicle-events ::= 16
   eventHazardousMaterials          Vehicle-events ::= 32
   eventEmergencyResponse           Vehicle-events ::= 64
   eventHardBraking                 Vehicle-events ::= 128
   eventLightsChanged               Vehicle-events ::= 256
   eventWipersChanged               Vehicle-events ::= 512
   eventFlatTire                    Vehicle-events ::= 1024
   eventDisabledVehicle             Vehicle-events ::= 2048
   eventAirBagDeployment            Vehicle-events ::= 4096"
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-events ::= INTEGER (0..8192)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.17 vehicle-fuel-economy

```
vehicle-fuel-economy ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.fuel-economy:rt"
ASN-NAME "Vehicle-fuel-economy"
ASN-OBJECT-IDENTIFIER { j2735DataElements 210 }
DEFINITION     "This data element indicates the average fuel economy, which is the
average number of kilometers traveled per liter of fuel consumed, over the current life of
the vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-fuel-economy ::= INTEGER (0..512)  "
```

```
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "0.1 kilometers per liter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.18 vehicle-fuel-remaining

```
vehicle-fuel-remaining ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.fuel-remaining:qty"
ASN-NAME "Vehicle-fuel-remaining"
ASN-OBJECT-IDENTIFIER { j2735DataElements 211 }
DEFINITION     "This data element indicates the amount of fuel remaining in a tank."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Large vehicles may have multiple 150 gallon tanks.  This data element supports
the equivalent of three (3) 150 gallon tanks."
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-fuel-remaining ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "deciliters"
VALID-VALUE-RULE "The value of 65535 shall be used when the value is unknown or
unavailable."}
```

5.4.51.19 vehicle-fuel-type

```
vehicle-fuel-type ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.fuel-type:cd"
ASN-NAME "Vehicle-fuel-type"
ASN-OBJECT-IDENTIFIER { j2735DataElements 212 }
DEFINITION     "This data element indicates the type of fuel used by the vehicle to power
its engine."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "All bits are set to zero indicates fuel type is unavailable or unknown.
Source: The U.S. Department of Energy (DOE): http://www.afdc.energy.gov/fuels"
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-fuel-type ::=  BIT STRING {
    gasoline (0),
    diesel (1),
    biodiesel (2),
    electricity (3),
    ethanol (4),
    hydrogen (5),
    naturalgas (6),
    propane (7) } (SIZE(8))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.20 vehicle-heading

```
vehicle-heading ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.heading:qty"
ASN-NAME "Vehicle-heading"
ASN-OBJECT-IDENTIFIER { j2735DataElements 213 }
DEFINITION     "This data element represents the current direction of movement of the
center of mass of the vehicle, expressed in unsigned units of 0.0125 degrees from North (A
value of 28799 represents 359.9875 degrees).  North shall be defined as defined by the
WGS-84 coordinate system and its reference ellipsoid.  Headings 'to the east' are defined
as the positive direction (i.e., east is +90.0000 degrees).
The accuracy shall be less than 2 degrees when the vehicle speed is greater than 12.5
m/sec. The accuracy shall be less than 3 degrees when the vehicle speed is between 0.56
```

```
m/sec and 12.5 m/sec.  If the accuracy cannot be met, the value shall be set to
unavailable.  "
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "When the vehicle speed drops below 0.56 m/sec the heading shall be latched to the
last known good heading value above 0.56 m/sec. The heading shall be unlatched after the
vehicle speed exceeds 0.83 m/sec."
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-heading ::= INTEGER (0..28800)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "0.0125 degrees"
VALID-VALUE-RULE "The value of 28800 shall be used when the value is unknown or
unavailable."}
```

5.4.51.21 vehicle-heading-history

```
vehicle-heading-history ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.heading-history:qty"
ASN-NAME "Vehicle-heading-history"
ASN-OBJECT-IDENTIFIER { j2735DataElements 214 }
DEFINITION     "Used for a connected device's path history, this data element represents
the direction of travel (motion) of the connected device at the time the path history
point was collected.  The heading is measured from -190.5 to +190.5 degrees, in +/- 1.5
degrees segments, with North on the WGS-84 coordinate system equal to 0 degrees, and
headings to the east as the positive direction (i.e., east is +90.0 degrees)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-heading-history ::= INTEGER (-128..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "1.5 degrees"
VALID-VALUE-RULE "The value of -128 shall be used when the value is unavailable."}
```

5.4.51.22 vehicle-height

```
vehicle-height ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.height:qty"
ASN-NAME "Vehicle-height"
ASN-OBJECT-IDENTIFIER { j2735DataElements 215 }
DEFINITION     "The height of the vehicle, measured from the ground to the highest
surface, excluding any antennas, and expressed in units of 1 cm.  In cases of vehicles
with adjustable ride heights, camper shells, and other devices which may cause the overall
height to vary, the largest possible height will be used."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-height ::= INTEGER (0..1023)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "1 cm"
VALID-VALUE-RULE "The value of 0 shall be used when the value is unavailable."}
```

5.4.51.23 vehicle-identifier

```
vehicle-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.identifier:id"
ASN-NAME "Vehicle-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 216 }
DEFINITION     "This data element is used to provide identification information about the
motor vehicle.  This may be the vehicle identification number (VIN) or it may be another
```

```
string selected by the owner-operator for fleet needs.  If this data element is NOT equal
to the vehicle's VIN, the vehicle-identifier-source data element shall also be
transmitted.  A shorter value is in general preferred to save bandwidth."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "This is an opt-in component that may be used by vehicle fleets."
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-identifier ::= IA5String (SIZE(1..17))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.24 vehicle-identifier-source

```
vehicle-identifier-source ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.identifier-source:txt"
ASN-NAME "Vehicle-identifier-source"
ASN-OBJECT-IDENTIFIER { j2735DataElements 217 }
DEFINITION     "This data element is used to identify the entity that issued an
identification code in the vehicle-identifier.  This data element is typically used only
for fleet vehicles that are owned by either a government entity or a private fleet
operator."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-identifier-source ::= IA5String (SIZE(40))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.25 vehicle-lessee-oer

```
vehicle-lessee-oer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.lessee-oer:bin"
ASN-NAME "Vehicle-lessee-oer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 218 }
DEFINITION     "This data element is the OER encoding of the namedRegistration data
frame, information.  This data element is used to provide the name and licensing
information for the lessee of the vehicle.  The lessee is the entity that is leasing and
is responsible for the vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "In the United States, for interstate carriers, this is the name or trade name of
the motor carrier company appearing on FMCSA's Form MCS-150."
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 85 }  -- namedRegistration  }
DATA-TYPE "
    Vehicle-lessee-oer ::= NamedRegistration-oer  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.26 vehicle-length

```
vehicle-length ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.length:qty"
ASN-NAME "Vehicle-length"
ASN-OBJECT-IDENTIFIER { j2735DataElements 219 }
```

```
DEFINITION     "The length of the vehicle measured from the edge of the front bumper to
the edge of rear bumper expressed in centimeters, unsigned.  The accuracy of the vehicle
length shall be within 0.2 meters."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element

REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-length ::= INTEGER (0..16383)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "The value of 0 shall be used when the value is unavailable."}
```

5.4.51.27 vehicle-lightbar

```
vehicle-lightbar ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.lightbar:cd"
ASN-NAME "Vehicle-lightbar"
ASN-OBJECT-IDENTIFIER { j2735DataElements 220 }
DEFINITION     "A data element in which the named bits are set to one if any sort of
additional visible lighting-alerting system is currently in use.  This includes light bars
and the various symbols they can indicate as well as arrow boards, flashing lights,
(including back up alerts) and any other form of lighting not found on normal vehicles of
this type or related to safety systems. Used to reflect any type or style of visual
alerting when a vehicle is progressing and transmitting DSRC messages to other nearby
vehicles about its path."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "   unavailable (0) -- Not Equipped or unavailable
   notInUse (1)     -- none active
   reserved (9)    -- for future use
See also the entry for vehicle-lights."
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-lightbar ::= ENUMERATED {
    unavailable (0),
    notinuse (1),
    inuse (2),
    sireninuse (3),
    yellowcautionlights (4),
    schoolbuslights (5),
    arrowsignsactive (6),
    slowmovingvehicle (7),
    freqstops (8),
    reserved (9) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.28 vehicle-lights

```
vehicle-lights ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.lights:cd"
ASN-NAME "Vehicle-lights"
ASN-OBJECT-IDENTIFIER { j2735DataElements 221 }
DEFINITION     "This data element represents the status of the vehicle's various exterior
lights encoded in a bit string which can be used to relate the current vehicle settings.
The status of exterior lights are: parking lights, fog lights, daytime running lights,
automatic light controls, right turn signal, left turn signal, high beam headlights, and
low beam headlights.  "
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
```

```
REMARKS "A value 0 indicates all lights are off. Hazard lights are indicated by setting
Bits 4 (right turn signal) and 5 (left turn signal) simultaneously. "
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-lights ::=  BIT STRING {
    parkinglights (0),
    foglights (1),
    daytimerunninglights (2),
    automaticlightcontrol (3),
    rightturnsignal (4),
    leftturnsignal (5),
    highbeamheadlights (6),
    lowbeamheadlights (7) } (SIZE(8))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.29 vehicle-make

```
vehicle-make ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.make:txt"
ASN-NAME "Vehicle-make"
ASN-OBJECT-IDENTIFIER { j2735DataElements 222 }
DEFINITION     "This data element identifies the manufacturer of the vehicle using the
World Manufacturer Identifier or WMI code, as assigned by ISO 3780, Road Vehicles - World
Manufacturer Identifier (WMI) Code."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-make ::= IA5String (SIZE(40))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.30 vehicle-mass-gross

```
vehicle-mass-gross ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.mass-gross:qty"
ASN-NAME "Vehicle-mass-gross"
ASN-OBJECT-IDENTIFIER { j2735DataElements 223 }
DEFINITION     "This data element provides the mass of the vehicle.  With an LSB of 1 kg,
this produces a max range of 65,534 kg.  Mass should reflect current gross mass of vehicle
and contents if known, otherwise an average laden value should be established."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-mass-gross ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "kilograms"
VALID-VALUE-RULE "The value of 0 shall be used when the value is unavailable.  The value
of 65535 shall be used when the mass is 65,535 kg or greater."}
```

5.4.51.31 vehicle-model

```
vehicle-model ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.model:txt"
ASN-NAME "Vehicle-model"
ASN-OBJECT-IDENTIFIER { j2735DataElements 224 }
```

```
DEFINITION     "This data element identifies the model of the vehicle.  A model is a
particular brand of vehicle sold under a marque by a vehicle manufacturer.  A vehicle
model may also be known as a nameplate."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-model ::= IA5String (SIZE(40))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.32 vehicle-movement-per

```
vehicle-movement-per ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.movement-per:bin"
ASN-NAME "Vehicle-movement-per"
ASN-OBJECT-IDENTIFIER { j2735DataElements 225 }
DEFINITION     "The UNALIGNED PER-encoding of the vehicleMovement Data Frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 172 }  -- vehicleMovement  }
DATA-TYPE "
    Vehicle-movement-per ::= OCTET STRING (SIZE(2))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.33 vehicle-owner-name

```
vehicle-owner-name ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.owner-name:txt"
ASN-NAME "Vehicle-owner-name"
ASN-OBJECT-IDENTIFIER { j2735DataElements 226 }
DEFINITION     "A data element representing the legal name of the entity that owns or is
the lessee of the motor vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "In the United States for interstate carriers, this is the name or trade name of
the motor carrier company appearing on FMCSA's Form MCS-150."
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-owner-name ::= IA5String (SIZE(1..63))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.34 vehicle-owner-oer

```
vehicle-owner-oer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.owner-oer:bin"
ASN-NAME "Vehicle-owner-oer"
ASN-OBJECT-IDENTIFIER { j2735DataElements 227 }
DEFINITION     "This data element is the OER encoding of the namedRegistration data
frame.  This data element is used to provide the name and the licensing information for
the owner of the vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "In the United States, for interstate carriers, this is the name or trade name of
the motor carrier company appearing on FMCSA's Form MCS-150."
```

```
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 85 }  -- namedRegistration  }
DATA-TYPE "
    Vehicle-owner-oer ::= NamedRegistration-oer  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.35 vehicle-request-status

```
vehicle-request-status ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.request-status:cd"
ASN-NAME "Vehicle-request-status"
ASN-OBJECT-IDENTIFIER { j2735DataElements 228 }
DEFINITION     "This data element is used to relate status information about a vehicle
when requesting service from a signalized intersection.  It relates some basic information
about the requester which can be used by the signal systems in its response with changes
to the signal timing plan in use.   Note that this status is used in both priority and
preemption use cases but that the information mapped into the lower 4 bits varies with
each."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "The MSB bit (the brakes-on bit) is used in the general sense of a vehicle which
is not moving or proceeding towards the light.  Examples of use would be a response
vehicle that has stopped short of the light, but more typically a transit vehicle making a
stop to load/unload before reaching the light.  This bit can be used by the signal system
to disregard a request.  Bits set as follows:
   Bit 7 (MSB)   - Brakes-on, see above for use
   Bit 6         - Emergency Use or operation
   Bit 5         - Lights in use (See vehicle-lightbar element)
   Bits 5-0      - When a preempt is requested, map the values of vehicle-lightbar to the
lower 4 bits and set the 5th bit to zero.  When a priority is requested, map the values of
vehicle-transit-status to the lower 5 bits.
 "
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-request-status ::= OCTET STRING (SIZE(1))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.36 vehicle-safety-belt

```
vehicle-safety-belt ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.safety-belt:cd"
ASN-NAME "Vehicle-safety-belt"
ASN-OBJECT-IDENTIFIER { j2735DataElements 229 }
DEFINITION     "This data element provides the state of the safety belt of the driver of
the motor vehicle.  It indicates if the safety belt is functioning or not, and if the
safety belt is buckled.  Typically used with commercial motor vehicles."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-safety-belt ::= ENUMERATED {
    unavailable (0),
    notbuckled (1),
    buckled (2),
    undetermined (3) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.37 vehicle-size-per

```
vehicle-size-per ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.size-per:bin"
ASN-NAME "Vehicle-size-per"
ASN-OBJECT-IDENTIFIER { j2735DataElements 230 }
DEFINITION     "The UNALIGNED PER-encoding of the vehicleSize Data Frame."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
REFERENCED-DATA-FRAMES {
     { j2735DataFrames 177 }  -- vehicleSize  }
DATA-TYPE "
    Vehicle-size-per ::= OCTET STRING (SIZE(3))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.38 vehicle-speed

```
vehicle-speed ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.speed:rt"
ASN-NAME "Vehicle-speed"
ASN-OBJECT-IDENTIFIER { j2735DataElements 231 }
DEFINITION     "This data element represents the vehicle (point) speed expressed in
unsigned units of 0.02 meters per second.  It is typically combined with the transmission
state to form a 2 byte value.  The accuracy of the speed shall be within 0.35
meters/second of the actual speed.  "
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-speed ::= INTEGER (0..8191)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "two-hundredths of meters per second"
VALID-VALUE-RULE "The value of 8191 shall be used when the value is unavailable."}
```

5.4.51.39 vehicle-stability-control-state

```
vehicle-stability-control-state ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.stability-control-state:cd"
ASN-NAME "Vehicle-stability-control-state"
ASN-OBJECT-IDENTIFIER { j2735DataElements 232 }
DEFINITION     "This data element reflects the current state of the stability control
system status.  This data element is intended to inform users whether the vehicle's
stability control unit was engaged.  A typical stability control unit uses the vehicle's
yaw rate to determine how far off-axis a vehicle is while taking a turn.  This data is
correlated with wheel speed, steering angle and acceleration position.  If the vehicle is
determined to be too far off-axis, corrective action is taken by automatically applying
braking force to separate wheels independent of the driver's actions.  The element also
informs the user if the vehicle is not equipped with a stability control system.  If the
vehicle is equipped with a stability control system, the element reports whether the
system is Off, On (but not engaged) or in an Engaged state."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "   unavailable (0) -- B'00  Not Equipped with stability control or status is
unavailable
   off (1)     -- B'01  stability control is Off
   on (2)      -- B'10  stability control is On (but not Engaged)
   engaged (3) -- B'11  stability control is Engaged
 "
```

```
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-stability-control-state ::= ENUMERATED {
    unavailable (0),
    off (1),
    on (2),
    engaged (3) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.40 vehicle-status-type-tag

```
vehicle-status-type-tag ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.status-type-tag:cd"
ASN-NAME "Vehicle-status-type-tag"
ASN-OBJECT-IDENTIFIER { j2735DataElements 233 }
DEFINITION     "This data element is an enumeration of every possible value which can be
found in the snapshotRequest data frame.  It is used to denote that value (and hence also
the length) of the data which follows it."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-status-type-tag ::= ENUMERATED {
    unknown (0),
    lights (1),
    wipers (2),
    brakes (3),
    stab (4),
    trac (5),
    abs (6),
    suns (7),
    rains (8),
    airtemp (9),
    steering (10),
    vertaccelthres (11),
    vertaccel (12),
    hozaccellong (13),
    hozaccellat (14),
    accel4way (16),
    obdist (18),
    obdirect (19),
    yaw (20),
    datetime (22),
    fullpos (23),
    position2d (24),
    position3d (25),
    vehicle (26),
    weather (29),
    emissions (30),
    fuel (31),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "Values to 127 reserved for standard use.  Values 128 to 255 reserved for
local use."}
```

5.4.51.41 vehicle-steering-wheel-angle

```
vehicle-steering-wheel-angle ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.steering-wheel-angle:qty"
ASN-NAME "Vehicle-steering-wheel-angle"
ASN-OBJECT-IDENTIFIER { j2735DataElements 234 }
DEFINITION     "A data element to represent the angle of the steering wheel, expressed in
a signed (to the right being positive) value with units of 1.5 degrees and occupying one
byte.
The accuracy shall be no less than 5 degrees.  If the accuracy value cannot be met, the
value shall be set to unavailable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-steering-wheel-angle ::= INTEGER (-126..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "units of 1.5 degrees"
VALID-VALUE-RULE "The value of -126 shall be used for an angle of -189 degrees or lower.
The value of +126 shall be used for an angle of 189 degrees or greater.  A value of 127
shall be used when the value is unavailable."}
```

5.4.51.42 vehicle-steering-wheel-angle-change

```
vehicle-steering-wheel-angle-change ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.steering-wheel-angle-change:rt"
ASN-NAME "Vehicle-steering-wheel-angle-change"
ASN-OBJECT-IDENTIFIER { j2735DataElements 235 }
DEFINITION     "The rate of change of the angle of the steering wheel, expressed in
signed units of 3 degrees/second over a range of 381 degrees in either direction. To the
right being positive."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-steering-wheel-angle-change ::= INTEGER (-127..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "3 degrees per second"
VALID-VALUE-RULE "The value of -127 shall be used for a rate of change of -381 degrees per
second or greater.  The value of 127 shall used for a rate of change of 381 degrees per
second or greater."}
```

5.4.51.43 vehicle-temporary-identifier

```
vehicle-temporary-identifier ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.temporary-identifier:id"
ASN-NAME "Vehicle-temporary-identifier"
ASN-OBJECT-IDENTIFIER { j2735DataElements 236 }
DEFINITION     "This data element is a 4-byte random device identifier.  This value for a
mobile connected device (unlike a typical wireless or wired 802 device) will periodically
change to ensure the overall anonymity of the mobile connected device.  Because this value
is used as a means to identify the local connected devices that are interacting during an
encounter, it is used in the message set."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-temporary-identifier ::= OCTET STRING (SIZE(4))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
```

```
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.44 vehicle-traction-control-state

```
vehicle-traction-control-state ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.traction-control-state:cd"
ASN-NAME "Vehicle-traction-control-state"
ASN-OBJECT-IDENTIFIER { j2735DataElements 237 }
DEFINITION     "This data element reflects the status of the vehicle's traction control
system.  The element is intended to inform others whether one or more of the vehicle's
drive wheels is slipping during an acceleration.  The element can also inform others that
the vehicle is not equipped with a traction control system.  If the vehicle is equipped
with a traction control system, the element reports whether the system is in an Off, On or
Engaged state."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "   unavailable (0) -- B'00  Not Equipped with traction control or traction
control status is unavailable
   off (1)      -- B'01  traction control is Off
   on (2)       -- B'10  traction control is On  (but not Engaged)
   engaged (3) -- B'11  traction control is Engaged
 "
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-traction-control-state ::= ENUMERATED {
    unavailable (0),
    off (1),
    on (2),
    engaged (3) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.45 vehicle-transit-status

```
vehicle-transit-status ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.transit-status:cd"
ASN-NAME "Vehicle-transit-status"
ASN-OBJECT-IDENTIFIER { j2735DataElements 238 }
DEFINITION     "This data element is used to relate basic information about the transit
run in progress.  This is typically used in a priority request to a signalized system and
can become part of the input processing for how that system will respond to the request."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Most of these values are used to detect that the transit vehicle is not in a
state where movement can occur (and that therefore any priority signal should be ignored
until the vehicle is again ready to depart).  Two bits (bits 4 and 5) are used to relate
the relative occupancy of the vehicle.
   none       (0), -- nothing is active
   anADAuse   (1), -- an ADA access is in progress (wheelchairs, kneeling, etc...)
   aBikeLoad  (2), -- loading of a bicycle is in progress
   doorOpen   (3), -- a vehicle door is open for passenger access
   occM       (4), -- bits 4 and 5 are used to relate the relative occupancy of the
vehicle, with 00 as least full and11 indicating a close-to or full condition.
   occL       (5) -- bits 4 and 5 are used to relate the relative occupancy of the
vehicle, with 00 as least full and11 indicating a close-to or full condition."
STANDARD "SAE J2735"
REFERENCED-DATA-ELEMENTS {
     { j2735DataElements 228 }  -- vehicle-request-status  }
DATA-TYPE "
    Vehicle-transit-status ::= ENUMERATED {
    none (0),
    anadause (1),
    abikeload (2),
```

```
    dooropen (3),
    occm (4),
    occl (5) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.46 vehicle-transmission

```
vehicle-transmission ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.transmission:cd"
ASN-NAME "Vehicle-transmission"
ASN-OBJECT-IDENTIFIER { j2735DataElements 239 }
DEFINITION     "This data element is used to provide the state of the vehicle
transmission.  It is typically combined with the speed value to form a 2 byte value.  When
used with non-equipped vehicles the value 'unavailable' shall be sent.  Also, if the
vehicle has manual transmission, the transmission state shall be set as unavailable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "   neutral         (0), -- Neutral
   park            (1), -- Park
   forwardGears    (2), -- Forward gears, speed relative to the vehicle alignment
   reverseGears    (3), -- Reverse gears, speed relative to the vehicle alignment
   reserved1       (4),
   reserved2       (5),
   reserved3       (6),
   unavailable     (7) -- not-equipped or unavailable value"
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-transmission ::= ENUMERATED {
    neutral (0),
    park (1),
    forwardgears (2),
    reversegears (3),
    reserved1 (4),
    reserved2 (5),
    reserved3 (6),
    unavailable (7) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "The value 0 shall be used when the value is unavailable."}
```

5.4.51.47 vehicle-type

```
vehicle-type ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.type:cd"
ASN-NAME "Vehicle-type"
ASN-OBJECT-IDENTIFIER { j2735DataElements 240 }
DEFINITION     "The type of the vehicle, as defined by the FHWA 13-Category
Classification System."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-type ::= ENUMERATED {
    none (0),
    unknown (1),
    special (2),
    moto (3),
    car (4),
    carother (5),
    bus (6),
    axlecnt2 (7),
```

```
    axlecnt3 (8),
    axlecnt4 (9),
    axlecnt4trailer (10),
    axlecnt5trailer (11),
    axlecnt6trailer (12),
    axlecnt5multitrailer (13),
    axlecnt6multitrailer (14),
    axlecnt7multitrailer (15),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "Values to 127 reserved for standard use.  Values 128 to 255 reserved for
local use."}
```

5.4.51.48 vehicle-vin

```
vehicle-vin ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.vin:id"
ASN-NAME "Vehicle-vin"
ASN-OBJECT-IDENTIFIER { j2735DataElements 241 }
DEFINITION     "This data element is the unique serial number assigned by the automotive
industry to identify the individual motor vehicle. It typically follows one of the
following standards: FMVSS, ISO 3779, SAE J853, or ADR 61/2."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "This is an opt-in component that may be used by public agency vehicle fleets or
commercial motor vehicles for roadside checks."
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-vin ::= IA5String (SIZE(17))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.49 vehicle-vin-source

```
vehicle-vin-source ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.vin-source:txt"
ASN-NAME "Vehicle-vin-source"
ASN-OBJECT-IDENTIFIER { j2735DataElements 242 }
DEFINITION     "This data element indicates the source of the vehicle identification
number (VIN) that is transmitted by a vehicle.  Typically used for commercial motor
vehicles, a power unit may have more than one origin (source) for its VIN, such as its
engine or the vehicle bus."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-vin-source ::= IA5String (SIZE(1..40))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.50 vehicle-width

```
vehicle-width ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.width:qty"
ASN-NAME "Vehicle-width"
ASN-OBJECT-IDENTIFIER { j2735DataElements 243 }
DEFINITION     "This data element represents the width of the vehicle expressed in
centimeters, unsigned.  The width shall be the widest point of the vehicle with all
factory installed equipment."
DESCRIPTIVE-NAME-CONTEXT {""}
```

```
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-width ::= INTEGER (0..1023)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "The value 0 shall be used when the value is unavailable."}
```

5.4.51.51 vehicle-wipers-front

```
vehicle-wipers-front ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.wipers-front:cd"
ASN-NAME "Vehicle-wipers-front"
ASN-OBJECT-IDENTIFIER { j2735DataElements 244 }
DEFINITION     "This data element relates the current status of the wiper system on the
front of the subject vehicle.  This data element is intended to indicate if it is raining
or snowing at the vehicle's current location.  The element also includes whether the
wipers were turned on manually (driver activated) or automatically (rain sensor activated)
to provide additional information as to driving conditions in the area of the vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "  unavailable   (0), -- Not Equipped with wiper status or wiper status is
unavailable
  off   (1),
  intermittent   (2),
  low   (3),
  high   (4),
  washerInUse   (126), -- washing solution being used
  automaticPresent   (127), -- Auto wiper equipped"
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-wipers-front ::= ENUMERATED {
    unavailable (0),
    off (1),
    intermittent (2),
    low (3),
    high (4),
    washerinuse (126),
    automaticpresent (127),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.52 vehicle-wipers-front-rate

```
vehicle-wipers-front-rate ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.wipers-front-rate:rt"
ASN-NAME "Vehicle-wipers-front-rate"
ASN-OBJECT-IDENTIFIER { j2735DataElements 245 }
DEFINITION     "The data element identifying the current rate at which the front wiper
sweeps are taking place on the subject vehicle.  In units of sweeps per minute.  Use a
value of 1 for any sweep rate of less than one sweep per minute, but greater than 0 sweeps
per minute."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-wipers-front-rate ::= INTEGER (0..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "Sweeps per minute"
VALID-VALUE-RULE "The value of 0 shall be used when the wiper is off.
```

```
The value of 1 shall be used when the sweep rate is less than one sweep per minute, but
greater than 0 sweeps per minute."}
```

5.4.51.53 vehicle-wipers-rear

```
vehicle-wipers-rear ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.wipers-rear:cd"
ASN-NAME "Vehicle-wipers-rear"
ASN-OBJECT-IDENTIFIER { j2735DataElements 246 }
DEFINITION     "The current status of the wiper system on the rear of the subject
vehicle.
This data element is intended to indicate whether or not it was raining/snowing at the
vehicles location at the time.  The element also includes whether the wipers were turned
on manually (driver activated) or automatically (rain sensor activated) to provide
additional information as to driving conditions in the area of the vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "  unavailable   (0), -- Not Equipped with wiper status or wiper status is
unavailable
  off   (1),
  intermittent   (2),
  low   (3),
  high   (4),
  washerInUse   (126), -- washing solution being used
  automaticPresent   (127), -- Auto wiper equipped"
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-wipers-rear ::= ENUMERATED {
    unavailable (0),
    off (1),
    intermittent (2),
    low (3),
    high (4),
    washerinuse (126),
    automaticpresent (127),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.51.54 vehicle-year

```
vehicle-year ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Vehicle.year:dt"
ASN-NAME "Vehicle-year"
ASN-OBJECT-IDENTIFIER { j2735DataElements 247 }
DEFINITION     "This data element identifies the model year of the vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    Vehicle-year ::= INTEGER (0..9999)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "year"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.52 VehicleAxle Class Data Elements

5.4.52.1 vehicleAxle-distance

```
vehicleAxle-distance ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleAxle.distance:qty"
ASN-NAME "VehicleAxle-distance"
ASN-OBJECT-IDENTIFIER { j2735DataElements 248 }
DEFINITION     "A data element indicating the distance between the subject vehicle axle
to the previous axle, which is the immediately in front of the subject axle, regardless of
if the previous axle is part of the power unit or a different trailer.  Thus, the first
axle at the front of the vehicle shall have a distance of 0.  The distance is measured
from the center axis to center axis of each axle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleAxle-distance ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "A value of 65535 shall be used when the value is unavailable."}
```

5.4.52.2 vehicleAxle-location

```
vehicleAxle-location ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleAxle.location:cd"
ASN-NAME "VehicleAxle-location"
ASN-OBJECT-IDENTIFIER { j2735DataElements 249 }
DEFINITION     "A data element reused from the SAE J1939 standard and to be encoded as:
Low order 4 bits represent a position number, counting left to right when facing the
direction of normal vehicle travel. The high order 4 bits represent a position number,
counting front to back on the vehicle. 256 states/8 bit, 0 offset, Range: 0-255."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleAxle-location ::= INTEGER (0..127)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.52.3 vehicleAxle-weight

```
vehicleAxle-weight ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleAxle.weight:qty"
ASN-NAME "VehicleAxle-weight"
ASN-OBJECT-IDENTIFIER { j2735DataElements 250 }
DEFINITION     "A data element reused from the SAE J1939 standard and to be encoded as:
0.5kg/bit, 0 offset, Range: 0 - 32,127.5 kg."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleAxle-weight ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "0.5 kg"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.52.4 vehicleAxleBrake-actuator

```
vehicleAxleBrake-actuator ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleAxleBrake-actuator:cd"
ASN-NAME "VehicleAxleBrake-actuator"
ASN-OBJECT-IDENTIFIER { j2735DataElements 251 }
DEFINITION     "This data element indicates the  brake stroke conditions for each wheel
end (tractor and trailer)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Valid values are:
0 (LSB)  Normal operation (OK)
1 Non-functioning
2 Over-stroke
3 Dragging brake
4 Sensor error"
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleAxleBrake-actuator ::= ENUMERATED {
    normaloperation (0),
    nonfunctioning (1),
    overstroke (2),
    draggingbrake (3),
    sensorerror (4) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.52.5 vehicleAxleBrake-left

```
vehicleAxleBrake-left ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleAxleBrake-left:qty"
ASN-NAME "VehicleAxleBrake-left"
ASN-OBJECT-IDENTIFIER { j2735DataElements 252 }
DEFINITION     "This data element represents the braking capability of the left brake for
an axle.  It is a quantitative measure of individual wheel brake forces or overall vehicle
brake performance, irrespective of the brake type, energy supply, or the application
method.  The capability is the ratio of the measured brake force divided by the wheel
load, and is measured to the hundredths of a decimal place."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleAxleBrake-left ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "hundredths"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.52.6 vehicleAxleBrake-lining

```
vehicleAxleBrake-lining ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleAxleBrake-lining:qty"
ASN-NAME "VehicleAxleBrake-lining"
ASN-OBJECT-IDENTIFIER { j2735DataElements 253 }
DEFINITION     "This data element represents the thickness of the brake linings or brake
pad still remaining, measured on the axle.  The thickness is measured in tenths of a
millimeter."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
```

```
DATA-TYPE "
    VehicleAxleBrake-lining ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenth of a millimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.52.7 vehicleAxleBrake-right

```
vehicleAxleBrake-right ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleAxleBrake-right:qty"
ASN-NAME "VehicleAxleBrake-right"
ASN-OBJECT-IDENTIFIER { j2735DataElements 254 }
DEFINITION     "This data element represents the braking capability of the right brake
for an axle.  It is a quantitative measure of individual wheel brake forces or overall
vehicle brake performance, irrespective of the brake type, energy supply, or the
application method.  The capability is the ratio of the measured brake force divided by
the wheel load, and is measured to the hundredths of a decimal place."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleAxleBrake-right ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "hundredths"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.52.8 vehicleAxleBrake-temperature

```
vehicleAxleBrake-temperature ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleAxleBrake-temperature:qty"
ASN-NAME "VehicleAxleBrake-temperature"
ASN-OBJECT-IDENTIFIER { j2735DataElements 255 }
DEFINITION     "This data element provides the average temperature of the service brakes
on a vehicle axle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleAxleBrake-temperature ::= INTEGER (0..1023)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "degrees celsius"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.53 VehicleEnvironment Class Data Elements

5.4.53.1 vehicleEnvironment-air-pressure

```
vehicleEnvironment-air-pressure ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleEnvironment.air-pressure:qty"
ASN-NAME "VehicleEnvironment-air-pressure"
ASN-OBJECT-IDENTIFIER { j2735DataElements 256 }
DEFINITION     "This data element is used to relate the measured ambient pressure
(Barometric Pressure) by a connected device.  With a resolution of 2 hPA, results in a
range of 580 to 1090 hPa."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleEnvironment-air-pressure ::= INTEGER (0..255)  "
```

```
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "2 hPA"
VALID-VALUE-RULE "The value of 0 shall be used when not equipped or the value is
unavailable.  The value of 1 shall be used to indicate a pressure of 580 hPA.  "}
```

5.4.53.2 vehicleEnvironment-precipitation-rate

```
vehicleEnvironment-precipitation-rate ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleEnvironment.precipitation-rate:rt"
ASN-NAME "VehicleEnvironment-precipitation-rate"
ASN-OBJECT-IDENTIFIER { j2735DataElements 257 }
DEFINITION     "The rainfall, or water equivalent of snow, rate in tenths of grams per
square meter per second (for rain, this is approximately to 0.36 mm/hr)."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "REFERENCE: WMO Binary Code Form FM 94 BUFR Table B item 0 13 014."
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleEnvironment-precipitation-rate ::= NTCIP.EssPrecipRate  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenths of grams per square meter per second"
VALID-VALUE-RULE "The value of 65535 shall be used to indicate an error condition or when
the value is unavailable."}
```

5.4.53.3 vehicleEnvironment-precipitation-situation

```
vehicleEnvironment-precipitation-situation ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleEnvironment.precipitation-situation:cd"
ASN-NAME "VehicleEnvironment-precipitation-situation"
ASN-OBJECT-IDENTIFIER { j2735DataElements 258 }
DEFINITION     "This data element is used to relate the ambient weather situation in
terms of precipitation."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleEnvironment-precipitation-situation ::= NTCIP.EssPrecipSituation  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "Intensity    Meaning
slight     < 2mm/h water equivalent
moderate   >= 2 and < 8 mm/h water equivalent
heavy      >= 8 mm/h water equivalent
If one exists, the corresponding BUFR value is indicated for staffed (BUFRs) and automated
(BUFRa) stations. The indicated value can be found in the BUFR Table referenced below.
Defined values are:
Range  BUFRa  BUFRs  Meaning
1                    other
2                    unknown
3                    no precipitation
4                    unidentified slight
5                    unidentified moderate
6                    unidentified heavy
7      171     85    snow slight
8      172     86    snow moderate
9      173     86    snow heavy
10             61    rain slight
11     165     63    rain moderate
12     163     65    rain heavy
13                   frozen precipitation slight
14                   frozen precipitation moderate
15                   frozen precipitation heavy
```

```
The values identified in the above table for BUFRa and BUFRs can be found in WMO Binary
Code Form FM 94 BUFR Table B item 0 20 003."}
```

5.4.53.4 vehicleEnvironment-roadway-friction

```
vehicleEnvironment-roadway-friction ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleEnvironment.roadway-friction:pct"
ASN-NAME "VehicleEnvironment-roadway-friction"
ASN-OBJECT-IDENTIFIER { j2735DataElements 259 }
DEFINITION     "This data element is used to relate the measured coefficient of friction
in percent."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleEnvironment-roadway-friction ::= NTCIP.EssMobileFriction  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "percent friction"
VALID-VALUE-RULE "The value 101 shall be used to indicate an error condition or when the
value is unavailable."}
```

5.4.53.5 vehicleEnvironment-sunlight

```
vehicleEnvironment-sunlight ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleEnvironment.sunlight:qty"
ASN-NAME "VehicleEnvironment-sunlight"
ASN-OBJECT-IDENTIFIER { j2735DataElements 260 }
DEFINITION     "This data element is used to relate the measured level of sunlight by a
connected device."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleEnvironment-sunlight ::= NTCIP.EssInstantaneousSolarRadiation  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "watts per square meter"
VALID-VALUE-RULE "The value of 2049 shall be used when the value is unavailable."}
```

5.4.53.6 vehicleEnvironment-temperature-air

```
vehicleEnvironment-temperature-air ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleEnvironment.temperature-air:qty"
ASN-NAME "VehicleEnvironment-temperature-air"
ASN-OBJECT-IDENTIFIER { j2735DataElements 261 }
DEFINITION     "This data element is used to relate the measured ambient air temperature
by a connected device.  Its measurement range and precision follows that defined by the
relevant OBD-II standards.  This provides for a precision of one degree Celsius and a
range of -40 to +150 degrees encoded in a one byte value.  The value of -40 degrees C is
encoded as zero and every degree above that increments the transmitted value by one
resulting in a transmission range of 0 to 190.  Hence, a measurement value representing 25
degrees Celsius is transmitted as 40+25=65 or Hex 0x41."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleEnvironment-temperature-air ::= INTEGER (0..191)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "degree Celsius"
VALID-VALUE-RULE "In degrees Celsius with a -40 degree offset.   The value 191 shall be
used when the value is unavailable."}
```

5.4.53.7 vehicleEnvironment-vertical-acceleration-flag

```
vehicleEnvironment-vertical-acceleration-flag ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleEnvironment.vertical-acceleration-flag:cd"
ASN-NAME "VehicleEnvironment-vertical-acceleration-flag"
ASN-OBJECT-IDENTIFIER { j2735DataElements 262 }
DEFINITION     "A bit string enumerating when a preset threshold for vertical
acceleration is exceeded at each wheel.  This 'Wheel that exceeded Vertical G Threshold'
element is intended to indicate which vehicle wheel has exceeded a pre-determined
threshold of a percent change in vertical G acceleration per second.  This element is
primarily intended to be used in the detection of potholes and similar road abnormalities.
 When a wheel does exceed the threshold, the element provides details on the particular
wheel by specifying Left Front, Left Rear, Right Front and Right Rear.  If a vehicle has
only one front wheel, the indication shall be represented by the left front wheel.
Similarly, if a vehicle has only one rear wheel, the indication shall be represented by
the left rear wheel.  "
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "  allOff (0) -- All off or not equipped
  reserved0 (1)
  reserved1 (2)
  reserved2 (3)
  rightRear (4) -- Right Rear Event
  rightFront (5) -- Right Front Event
  leftRear (6) -- Left Rear Event
  leftFront (7) -- Left Front Event"
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleEnvironment-vertical-acceleration-flag ::=  BIT STRING {
    alloff (0),
    reserved0 (1),
    reserved1 (2),
    reserved2 (3),
    rightrear (4),
    rightfront (5),
    leftrear (6),
    leftfront (7) } (SIZE(8))  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "The value of zero (0) shall be used to indicate All off or not
equipped."}
```

5.4.54 VehiclePathPoint Class Data Elements

5.4.54.1 vehiclePathPoint-elevation-offset

```
vehiclePathPoint-elevation-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehiclePathPoint.elevation-offset:lctn"
ASN-NAME "VehiclePathPoint-elevation-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 263 }
DEFINITION     "This data element represents the offset along the z-axis (vertical) from
the reference point.  A positive value indicates that the elevation of the point being
described is higher than the reference point from which the offset is made."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehiclePathPoint-elevation-offset ::= INTEGER (-2048..2047)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "decimeters"
```

```
VALID-VALUE-RULE "The value of 2047 shall be used when the value is 2047 or greater.  The
value of -2047 shall be used when the value is -2047 or less.  The value of -2048 shall be
used when the value is unavailable."}
```

5.4.54.2 vehiclePathPoint-latitude-offset

```
vehiclePathPoint-latitude-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehiclePathPoint.latitude-offset:lctn"
ASN-NAME "VehiclePathPoint-latitude-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 264 }
DEFINITION     "This data element represents the offset along the x-axis (latitude) from
the reference point.  The offset value is measured in one-tenth of a microdegree, and a
positive value indicates a location to the north of the reference point from which the
offset is made."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehiclePathPoint-latitude-offset ::= INTEGER (-131072..131071)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one-tenth micro degrees"
VALID-VALUE-RULE "The value of 131071 shall be used when the value is 131071 or greater.
The value of -131071 shall be used when the value is 131071 or less. The value of -131072
shall be used when the value is unavailable."}
```

5.4.54.3 vehiclePathPoint-longitude-offset

```
vehiclePathPoint-longitude-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehiclePathPoint.longitude-offset:lctn"
ASN-NAME "VehiclePathPoint-longitude-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 265 }
DEFINITION     "This data element represents the offset along the y-axis (longitude) from
the reference point.  The offset value is measured in one-tenth of a microdegree, and a
positive value indicates a location to the east of the reference point from which the
offset is made."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehiclePathPoint-longitude-offset ::= INTEGER (-131072..131071)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one-tenth micro degrees"
VALID-VALUE-RULE "The value of 131071 shall be used when the value is 131071 or greater.
The value of -131071 shall be used when the value is -131071 or less. The value of -131072
shall be used when the value is unavailable."}
```

5.4.55 VehicleRequest Class Data Elements

5.4.55.1 vehicleRequest-item

```
vehicleRequest-item ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleRequest.item:cd"
ASN-NAME "VehicleRequest-item"
ASN-OBJECT-IDENTIFIER { j2735DataElements 266 }
DEFINITION     "This data element is used to specify what item (or items) is being
requested in a commonSafetyRequest message transmitted to a connected device.  The
requested item may be broadcast by a connected vehicle in the basicSafetyMessage or the
alacarte message that they transmit."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
```

```
REMARKS "   reserved (0)
   itemA (1) -- consisting of 2 elements:
    -- lights          vehicle-lights
    -- lightBar        vehicle-lightbar
   itemB (2) -- consisting of:
    -- wipers          wiperStatus
   itemC (3) -- consisting of:
    -- brakeStatus     vehicleBrakeSystemStatus
   itemD (4) -- consisting of 2 elements:
    -- brakePressure   vehicle-brake-applied-pressure
    -- roadFriction    vehicleEnvironment-roadway-friction
   itemE (5) -- consisting of 2 elements:
    -- airTemp         vehicleEnvironment-temperature-air
    -- airPres         vehicleEnvironment-air-pressure
   itemF (6) -- consisting of 2 elements:
    -- rate            vehicle-steering-wheel-angle-change
    -- wheels          vehicle-driving-wheel-angle
   itemG (7) -- consisting of:
    -- accel4way       acceleration4way
    -- vertAccelThres  vehicleEnvironment-vertical-acceleration-flag
   itemH (8) -- consisting of:
    -- object          obstacle
   itemI (9) -- consisting of:
    -- fullPos         fullPositionVector
   itemJ (10) -- consisting of:
    -- position2D      The OER-encoding of the location data frame in the WGS-84
coordinate system.  All optional fields of the Location data frame shall not be present.
   itemK (11) -- consisting of:
    -- position3D       The OER-encoding of the location data frame in the WGS-84
coordinate system.  Only the elevation field of the location data frame shall be present.
   itemL (12) -- Reserved
   itemM (13) -- consisting of:
    -- height          vehicle-height
    -- bumper-front    vehicle-bumper-height-front
    -- bumper-rear     vehicle-bumper-height-rear
    -- mass            vehicle-mass-gross
    -- trailerWeight   trailer-weight
   itemN (14) -- consisting of:
    -- vehicleIdent    vehicleIdentification
   itemO (15) -- consisting of:
    -- precipRate      vehicleEnvironment-precipitation-rate
    -- precipSituation vehicleEnvironment-precipitation-situation
    -- solarRadiation  vehicleEnvironment-sunlight
    -- roadFriction    vehicleEnvironment-roadway-friction
   itemP (16) -- consisting of:
    -- breadcrumbs     path-history-point-type-01-list
   itemQ (17) -- consisting of:
    -- gpsStatus       gPSUnit-status
   #LOCAL_CONTENT"
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleRequest-item ::= ENUMERATED {
    reserved (0),
    itema (1),
    itemb (2),
    itemc (3),
    itemd (4),
    iteme (5),
    itemf (6),
    itemg (7),
    itemh (8),
    itemi (9),
    itemj (10),
    itemk (11),
    iteml (12),
```

```
    itemm (13),
    itemn (14),
    itemo (15),
    itemp (16),
    itemq (17),
    ...  }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "Values to 127 reserved for standard use.  Values 128 to 255 reserved for
local use."}
```

5.4.56 VehicleTire Class Data Elements

5.4.56.1 vehicleTire-location

```
vehicleTire-location ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleTire.location:cd"
ASN-NAME "VehicleTire-location"
ASN-OBJECT-IDENTIFIER { j2735DataElements 267 }
DEFINITION     "A data element reused from the SAE J1939 standard and encoded as: Low
order 4 bits represent a position number, counting left to right when facing the direction
of normal vehicle travel.  The high order 4 bits represent a position number, counting
front to back on the vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleTire-location ::= INTEGER (0..255)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.56.2 vehicleTire-pressure

```
vehicleTire-pressure ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleTire.pressure:qty"
ASN-NAME "VehicleTire-pressure"
ASN-OBJECT-IDENTIFIER { j2735DataElements 268 }
DEFINITION     "A data element reused from the SAE J1939 standard and encoded as: 4
kPa/bit, 0 offset, 0-1000 kPa."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleTire-pressure ::= INTEGER (0..1000)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "k/Pa"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.56.3 vehicleTire-temperature

```
vehicleTire-temperature ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleTire.temperature:qty"
ASN-NAME "VehicleTire-temperature"
ASN-OBJECT-IDENTIFIER { j2735DataElements 269 }
DEFINITION     "A data element reused from the SAE J1939 standard and encoded as: .03125
degrees Celsius/bit, -273 degrees Celsius offset, Range: -273 - 1735 degrees Celsius."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
```

```
DATA-TYPE "
    VehicleTire-temperature ::= INTEGER (0..65535)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "Celsius"
VALID-VALUE-RULE "Offset of -273 degrees Celsius."}
```

5.4.56.4 vehicleTire-threshold

```
vehicleTire-threshold ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VehicleTire.threshold:cd"
ASN-NAME "VehicleTire-threshold"
ASN-OBJECT-IDENTIFIER { j2735DataElements 270 }
DEFINITION     "A measure of the relative tire pressure observed.  Encoded as per the
value set used in SAE J1939.  Threshold defaults are set by sensor manufacturer and may be
user configurable."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    VehicleTire-threshold ::= ENUMERATED {
    nodata (0),
    overpressure (1),
    nowarningpressure (2),
    underpressure (3),
    extremeunderpressure (4),
    undefined (5),
    errorindicator (6),
    notavailable (7) }  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.57 NMEA Class Data Elements

5.4.57.1 wdCount

```
wdCount ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "NMEA.WdCount:qty"
ASN-NAME "WdCount"
ASN-OBJECT-IDENTIFIER { j2735DataElements 271 }
DEFINITION     "A data element containing a count of the number of bytes to follow that
defines the stream of bytes in the actual NMEA 0183 message being sent as part of the
nMEA-Corrections message."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    WdCount ::= INTEGER (1..1023)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.58 Zone Class Data Elements

5.4.58.1 zone-width

```
zone-width ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Zone.width:qty"
ASN-NAME "Zone-width"
ASN-OBJECT-IDENTIFIER { j2735DataElements 272 }
DEFINITION     "The data element represents the width of the zone within which a specific
signal priority or signal preemption scheme may be requested."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS "Note that one half the zone width is used to find the 'edge' of the zone, as
measured from the centerline, as described by a set of offset values."
STANDARD "SAE J2735"
DATA-TYPE "
    Zone-width ::= INTEGER (0..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.58.2 zoneNode-x-offset

```
zoneNode-x-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ZoneNode-x-offset:lctn"
ASN-NAME "ZoneNode-x-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 273 }
DEFINITION     "This data element represents the (signed) offset along the x-axis
(latitude) from a reference point.  The initial offset value (starting point) is from an
intersection's reference point.  All subsequent offsets are additive from the last set of
offset values (node).  The distance is measured in units of centimeter.  A positive offset
value represents a location to the east of the previous node."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ZoneNode-x-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.58.3 zoneNode-y-offset

```
zoneNode-y-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ZoneNode-y-offset:lctn"
ASN-NAME "ZoneNode-y-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 274 }
DEFINITION     "This data element represents the (signed) offset along the y-axis
(longitude) from a reference point.  The initial offset value (starting point) is from an
intersection's reference point.  All subsequent offsets are additive from the last set of
offset values (node).  The distance is measured in units of centimeter.  A positive offset
value represents a location to the north of the previous node."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ZoneNode-y-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.4.58.4 zoneNode-z-offset

```
zoneNode-z-offset ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "ZoneNode-z-offset:lctn"
ASN-NAME "ZoneNode-z-offset"
ASN-OBJECT-IDENTIFIER { j2735DataElements 275 }
DEFINITION     "This data element represents the (signed) offset along the z-axis
(vertical) from a reference point.  The initial offset value (starting point) is from an
intersection's reference point.  All subsequent offsets are additive from the last set of
offset values (node).  The distance is measured in units of centimeter.  A positive value
represents an elevation higher along the vertical axis from the previous node."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
REMARKS ""
STANDARD "SAE J2735"
DATA-TYPE "
    ZoneNode-z-offset ::= INTEGER (-32767..32767)  "
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.5 Object Classes

An object class is description of a set of objects that share the same properties, relationships and semantics within a given domain, about which there is a need to represent some information. Examples of object classes may include a person, a place, a concept or an event.

5.5.1 Acceleration4way

```
acceleration4way ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Acceleration4way"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 1 }
DEFINITION "An object class representing the rate at which the velocity of the connected
device is changing with time."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.2 ACM

```
aCM ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "ACM"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 2 }
DEFINITION "An object class representing connected device system interface dialogs and
message content for fleet management interfaces."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.3 Advisory

```
advisory ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Advisory"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 3 }
DEFINITION "An object class representing travel advisory information."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.4 AntennaOffset

```
antennaOffset ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "AntennaOffset"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 4 }
DEFINITION "An object class representing the electrical center of an antenna from a known
location."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.5 Circle

```
circle ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Circle"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 5 }
DEFINITION "An object class representing a circular geographic region."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.6 CMV

```
cMV ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "CMV"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 6 }
DEFINITION "An object class representing connected device system interface dialogs and
message content for commercial vehicle interfaces and applications."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.7 CmvEncounter

```
cmvEncounter ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "CmvEncounter"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 7 }
DEFINITION "An object class representing the data associated with a roadside check event
of a commercial motor vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.8 CmvRequest

```
cmvRequest ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "CmvRequest"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 8 }
DEFINITION "An object class representing a request for information from a commercial motor
vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.9 CmvScreeningAck

```
cmvScreeningAck ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "CmvScreeningAck"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 9 }
DEFINITION "An object class representing an acknowledgement to a request for information
from a commercial motor vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.10 CmvTrip

```
cmvTrip ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "CmvTrip"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 10 }
DEFINITION "An object class representing information about a commercial motor vehicle
trip."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.11 ConnectedDevice

```
connectedDevice ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "ConnectedDevice"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 11 }
DEFINITION "An object class representing a connected device."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.12 DriveAxle

```
driveAxle ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "DriveAxle"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 12 }
DEFINITION "An object class representing the characteristics of a connected vehicle's
drive axle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.13 Driver

```
driver ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Driver"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 13 }
DEFINITION "An object class representing the driver of a connected vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.14 DriverLogEvent

```
driverLogEvent ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "DriverLogEvent"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 14 }
DEFINITION "An object class representing the event log of an electronic on-board recording
device recording the service events of a driver."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.15 DSRCMessage

```
dSRCMessage ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "DSRCMessage"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 15 }
DEFINITION "An object class representing the general characteristics of a DSRC message."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.16 Emissions

```
emissions ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Emissions"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 16 }
DEFINITION "An object class representing the emissions from a connected vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.17 Global

```
global ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Global"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 17 }
DEFINITION "An object class representing generic data content management for connected
device interfaces."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.18 GPS

```
gPS ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "GPS"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 18 }
DEFINITION "An object class representing connected device system interface dialogs and
message content related to global positioning systems."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.19 Intersection

```
intersection ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Intersection"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 19 }
DEFINITION "An object class represents an area where two or more streets or crossings
intersect."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.20 IntersectionSignalized

```
intersectionSignalized ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "IntersectionSignalized"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 20 }
DEFINITION "An object class representing an intersection that is controlled by a traffic
signal."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.21 IntersectionSignalizedRequest

```
intersectionSignalizedRequest ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "IntersectionSignalizedRequest"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 21 }
DEFINITION "An object class representing a request for preferential treatment at a
signalized intersection."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.22 Lane

```
lane ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Lane"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 22 }
DEFINITION "An object class representing the attributes of a lane."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.23 LaneConnection

```
laneConnection ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "LaneConnection"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 23 }
DEFINITION "An object class that pairs a maneuver (movement) at an intersection with one
or more destination lanes."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.24 Location

```
location ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Location"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 24 }
DEFINITION "An object class that describes a point location at a specific instance in
time."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.25 LocationAccuracy

```
locationAccuracy ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "LocationAccuracy"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 25 }
DEFINITION "An object class that describes the accuracy of the positional determination
with respect to each given axis."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.26 Mayday

```
mayday ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Mayday"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 26 }
DEFINITION "An object class representing the attributes of a mayday message."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.27 NamedRegistration

```
namedRegistration ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "NamedRegistration"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 27 }
DEFINITION "An object class that describes the various government registrations or
licenses for a named entity such as a commercial motor carrier."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.28 NMEA

```
nMEA ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "NMEA"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 28 }
DEFINITION "An object class representing the attributes of an NMEA type corrections
message."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.29 Obstacle

```
obstacle ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Obstacle"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 29 }
DEFINITION "An object class that describes an obstacle in the roadway."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.30 OBU

```
oBU ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "OBU"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 30 }
DEFINITION "An object class representing the attributes of an OBU."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.31 Parking

```
parking ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Parking"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 31 }
DEFINITION "An object class representing the attributes of a parking facility."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.32 PathNode

```
pathNode ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "PathNode"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 32 }
DEFINITION "An object class that describes a point along a path."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.33 PathOffset

```
pathOffset ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "PathOffset"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 33 }
DEFINITION "An object class representing a lane whose path is defined by referencing
another lane and an offset."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.34 Polygon

```
polygon ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Polygon"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 34 }
DEFINITION "An object class representing a geographic area defined by a series of points
that define the boundary of the geographic area."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.35 Probe

```
probe ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Probe"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 35 }
DEFINITION "An object class representing connected device system interface dialogs and
message content for probe data management."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.36 Roadsign

```
roadsign ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Roadsign"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 36 }
DEFINITION "An object class representing the attributes of a static road sign."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.37 RSU

```
rSU ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "RSU"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 37 }
DEFINITION "An object class representing the attributes of an RSU."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.38 RTCM

```
rTCM ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "RTCM"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 38 }
DEFINITION "An object class representing the attributes of an RTCM type corrections
message."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.39 Segment

```
segment ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Segment"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 39 }
DEFINITION "An object class that represents a roadway segment."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.40 ShapePoint

```
shapePoint ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "ShapePoint"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 40 }
DEFINITION "An object class that represents a geographic area represented by a series of
points and the width of the geographic area at that point."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.41 SteeringAxle

```
steeringAxle ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "SteeringAxle"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 41 }
DEFINITION "An object class representing the characteristics of a connected vehicle's
steering axle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.42 TrafficSignalMovement

```
trafficSignalMovement ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "TrafficSignalMovement"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 42 }
DEFINITION "An object class representing a controlled movement at a traffic signal that is
timed as a single unit. A movement may include one or more lanes. Vehicle movements are
generally separated from pedestrian movements since they have generally have different
clearance intervals."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.43 TrafficSignalPriority

```
trafficSignalPriority ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "TrafficSignalPriority"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 43 }
DEFINITION "An object class representing preferential treatment for authorized vehicles at
traffic signal controllers."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.44 TravelerInformation

```
travelerInformation ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "TravelerInformation"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 44 }
DEFINITION "An object class representing connected device system interface dialogs and
message content for traveler information."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.45 Vehicle

```
vehicle ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Vehicle"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 45 }
DEFINITION "An object class representing a connected vehicle's system."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.46 VehicleAxle

```
vehicleAxle ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "VehicleAxle"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 46 }
DEFINITION "An object class representing the characteristics of a connected vehicle's
vehicle axle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.47 VehicleEnvironment

```
vehicleEnvironment ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "VehicleEnvironment"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 47 }
DEFINITION "An object class that describes the environment in which the vehicle is
operating."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.48 VehiclePath

```
vehiclePath ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "VehiclePath"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 48 }
DEFINITION "An object class that describes a series of points that define a vehicle's path
of travel."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.49 VehiclePathPoint

```
vehiclePathPoint ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "VehiclePathPoint"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 49 }
DEFINITION "An object class that describes a point along a vehicle's path."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.50 VehicleRequest

```
vehicleRequest ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "VehicleRequest"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 50 }
DEFINITION "An object class that describes a request for information from a connected
vehicle."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.51 VehicleTire

```
vehicleTire ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "VehicleTire"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 51 }
DEFINITION "An object class that describes a vehicle's tires."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.5.52 Zone

```
zone ITS-OBJECT-CLASS ::= {
DESCRIPTIVE-NAME "Zone"
ASN-OBJECT-IDENTIFIER { j2735ObjectClasses 52 }
DEFINITION "An object class representing a geographic area where preferential treatment
from a traffic signal controller can be requested."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE object-class
STANDARD "SAE J2735"
ABSTRACT TRUE  }
```

5.6 External Data Entries

This section defines the structure of the external data concepts reused by this standard. The data concepts in this standard are divided into messages, data frames, and data elements. Messages are made up of content further defined in this document (i.e., made up of entries that are either atomic or complex but which are also defined in this document) and content defined externally to this document. Such external content is reused from other functional areas and standards developed by other groups and SDOs. The contents of this standard (both at the complete message level and its component parts) may be reused by other efforts elsewhere.

All text in this clause is considered normative. Definitions for this message set are presented in the following subclauses. If the definitions in the following subclauses conflict in any way with the definition in the external standard, the definition in the external standard shall take precedence.

The productions of ASN.1 which follow shall be considered normative in nature. While the majority of the normative content is reflected in the actual syntax of the ASN.1, some entries also have additional statements in the ASN.1 comments which shall be considered normative as well. In addition, the textual commentary provided with each entry (in sections marked "use" and "remarks") may also provide additional normative restrictions on the proper use of the entry being described. Users of this standard seeking to be in conformance with it shall follow the normative text outlined here.

5.6.1 ITIS Data Entries

5.6.1.1 ITIScodesAndText

```
iTIScodesAndText ITS-DATA-FRAME ::= {
DESCRIPTIVE-NAME "DF-ITIScodesAndText:frame"
ASN-NAME "ITIScodesAndText"
ASN-OBJECT-IDENTIFIER { j2735DataFrames 110 }
DEFINITION     "A data frame that intersperses the use of ITIS codes with free text.  The
complete set of ITIS codes are defined in the SAE J2540 standard."
REMARKS ""
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-frame
STANDARD "SAE J2540"
REFERENCED-DATA-ELEMENTS {}
DATA-TYPE " ITIScodesAndText ::= CHOICE {  itis ITIScodes,
    text ITIStext,
    ... }"}
```

5.6.1.2 ITIScodes

```
iTIScodes ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Global.iTIScodes:cd"
ASN-NAME "ITIScodes"
ASN-OBJECT-IDENTIFIER { SAE2540:6.17 }
DEFINITION     "A set of over 1,000 items which are used to encode common events and list
items in ITS.  The complete set of ITIS codes can be found in the SAE J2540 standard.  The
defined list of ITIS codes is too long to list here.  Many smaller lists use a sub-set of
these codes as defined elements.  Also, enumerated values expressed as text constant are
very common, and in many deployments the list codes are used as a shorthand for this
text."
REMARKS "Note the ‘over the wire’ format of items in these lists is a 16-bit value in some
systems, hence, the use of INTEGER below, however, it is a numbered union of values and
phrases in other systems."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "SAE J2540"
DATA-TYPE " ITIScodes ::= INTEGER (0..65535)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.1.3 ITIStext

```
iTIStext ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Global.ITIStext:txt"
ASN-NAME "ITIStext"
ASN-OBJECT-IDENTIFIER { SAE2540:6.15 }
DEFINITION     "Simple text used with ITIS codes."
REMARKS ""
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "SAE J2540"
DATA-TYPE " ITIStext ::= IA5String (SIZE(1..500)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
```

```
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.1.4 LaneRoadway

```
laneRoadway ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Global.LaneRoadway:cd"
ASN-NAME " LaneRoadway"
ASN-OBJECT-IDENTIFIER { SAE2540:6.18 }
DEFINITION     "Simple text used with ITIS codes."
REMARKS ""
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "SAE J2540"
DATA-TYPE " LaneRoadway ::= Integer (SIZE(8192..8447)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2 NTCIP Data Entries

5.6.2.1 EssAdjacentSnowDepth

```
essAdjacentSnowDepth ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PrecipitationSensor.EssAdjacentSnowDepth:qty"
ASN-NAME "EssAdjacentSnowDepth"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.8.3 }
DEFINITION     "The depth of snow in centimeters on representative areas other than the
highway pavement, avoiding drifts and plowed areas."
REMARKS "The value 3001 shall indicate an error condition or missing value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
DATA-TYPE " EssAdjacentSnowDepth ::= INTEGER (0..3001)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2.2 EssDewpointTemp

```
essDewpointTemp ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "TemperatureSensorTable.EssDewpointTemp:qty"
ASN-NAME "EssDewpointTemp"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.7.5 }
DEFINITION     "The dewpoint temperature in tenths of degrees Celsius. The temperature is
an instantaneous reading at the height specified by the essTemperatureSensorHeight as
specified in the first row of the essTemperatureTable."
REMARKS "The value 1001 shall indicate an error condition or missing value.
Resolution is based on WMO Binary Code Form FM 94 BUFR Table B item 0 12 003; temperature
in Kelvin is determined by adding 273.15 to this value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
DATA-TYPE " EssDewpointTemp ::= INTEGER (-1000..1001)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenths of degrees Celsius"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2.3 EssInstantaneousSolarRadiation

```
essInstantaneousSolarRadiation ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "RadiationSensor.EssInstantaneousSolarRadiation:qty"
ASN-NAME "EssInstantaneousSolarRadiation"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.9.5 }
```

```
DEFINITION     "The instantaneous ultraviolet, visible, and near-infrared (wavelength of
less than 3.0 micrometers) radiation hitting the earth's surface in watts per square
meter."
REMARKS "The value of 2049 shall indicate a missing value.
Reference: WMO Code Form FM 94 BUFR Table B item 0 14 018""
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
DATA-TYPE " EssInstantaneousSolarRadiation ::= INTEGER (-2048..2049)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "watts per square meter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2.4 EssMobileFriction

```
essMobileFriction ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "MobilePlatform.EssMobileFriction:qty"
ASN-NAME "EssMobileFriction"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.12.1 }
DEFINITION     "Indicates measured coefficient of friction in percent."
REMARKS "The value 101 shall indicate an error condition or missing value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
DATA-TYPE " EssMobileFriction ::= INTEGER (0..101)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "percent friction"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2.5 EssPrecipRate

```
essPrecipRate ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PrecipitationSensor.EssPrecipRate:qty"
ASN-NAME "EssPrecipRate"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.8.7 }
DEFINITION     "The rainfall, or water equivalent of snow, rate in tenths of grams per
square meter per second (for rain, this is approximately to 0.36 mm/hr)."
REMARKS "The value of 65535 shall indicate an error condition or missing value.
REFERENCE: WMO Binary Code Form FM 94 BUFR Table B item 0 13 014."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
DATA-TYPE " EssPrecipRate ::= INTEGER (0..65535)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenths of grams per square meter per second"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2.6 EssPrecipSituation

```
essPrecipSituation ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PrecipitationSensor.EssPrecipSituation:cd"
ASN-NAME "EssPrecipSituation"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.8.9 }
DEFINITION     "Describes the weather situation in terms of precipitation."
REMARKS "Intensity    Meaning
slight         < 2mm/h water equivalent
moderate   >= 2 and < 8 mm/h water equivalent
heavy        >= 8 mm/h water equivalent If one exists, the corresponding BUFR value is
indicated for staffed (BUFRs) and automated (BUFRa) stations. The indicated value can be
found in the BUFR Table referenced below. Defined values are:
Range  BUFRa  BUFRs  Meaning
1                     other
2                     unknown
3                     no precipitation
```

```
4                       unidentified slight
5                       unidentified moderate
6                       unidentified heavy
7         171     85    snow slight
8         172     86    snow moderate
9         173     86    snow heavy
10                61    rain slight
11        165     63    rain moderate
12        163     65    rain heavy
13                      frozen precipitation slight
14                      frozen precipitation moderate
15                      frozen precipitation heavy
The values identified in the above table for BUFRa and BUFRs can be found in WMO Binary
Code Form FM 94 BUFR Table B item 0 20 003."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
DATA-TYPE " EssPrecipSituation ::= ENUMERATED {  other (1),
    unknown (2),
    noprecipitation (3),
    unidentifiedslight (4),
    unidentifiedmoderate (5),
    unidentifiedheavy (6),
    snowslight (7),
    snowmoderate (8),
    snowheavy (9),
    rainslight (10),
    rainmoderate (11),
    rainheavy (12),
    frozenprecipitationslight (13),
    frozenprecipitationmoderate (14),
    frozenprecipitationheavy (15),
    ...  }"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2.7 EssPrecipYesNo

```
essPrecipYesNo ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PrecipitationSensor.EssPrecipYesNo:cd"
ASN-NAME "EssPrecipYesNo"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.8.6 }
DEFINITION     "Indicates whether or not moisture is detected by the sensor.
precip - Moisture is currently being detected by the precipitation sensor.
noPrecip - Moisture is not currently being detected by the precipitation sensor.
error - The sensor is either not connected, not reporting, or is indicating an error."
REMARKS ""
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
DATA-TYPE " EssPrecipYesNo ::= ENUMERATED {  precip (1),
    noprecip (2),
    error (3),
    ...
}"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2.8 EssRoadwaySnowDepth

```
essRoadwaySnowDepth ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PrecipitationSensor.EssRoadwaySnowDepth:qty"
ASN-NAME "EssRoadwaySnowDepth"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.8.4 }
DEFINITION     "The current depth of unpacked snow in centimeters on the driving
surface."
REMARKS "The value 3001 shall indicate an error condition or missing value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
DATA-TYPE " EssRoadwaySnowDepth ::= INTEGER (0..3001)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "centimeters"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2.9 EssSurfaceIceOrWaterDepth

```
essSurfaceIceOrWaterDepth ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PavementSensor.EssSurfaceIceOrWaterDepth:qty"
ASN-NAME "EssSurfaceIceOrWaterDepth"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.11.3.16 }
DEFINITION     "Definition>The current thickness of ice or depth of water on the surface
of the roadway measured in 1/10th of millimeters."
REMARKS "The value 65535 shall indicate an error condition or missing value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
DATA-TYPE " EssSurfaceIceOrWaterDepth ::= INTEGER (0..65535)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one tenth of a millimeter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2.10 EssSurfaceTemperature

```
essSurfaceTemperature ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "PavementSensor.EssSurfaceTemperature:qty"
ASN-NAME "EssSurfaceTemperature"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.11.3.8 }
DEFINITION     "The current pavement surface temperature in tenths of degrees Celsius."
REMARKS "The value 1001 shall indicate an error condition or missing value."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
DATA-TYPE " EssSurfaceTemperature ::= INTEGER (-1000..1001)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "tenths of degrees Celsius""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2.11 EssVisibility

```
essVisibility ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "VisibilitySensor.EssVisibility:qty"
ASN-NAME "EssVisibility"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.10.1 }
DEFINITION     "Surface visibility measured in one tenth of a meter."
REMARKS "The value 1000001 shall indicate an error condition or missing value.
The value for WMO Code Form FM 94 BUFR Table B item 0 20 001 is given by this value
divided by 100."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
```

```
DATA-TYPE " EssVisibility ::= INTEGER (0..1000001)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "one tenth of a meter"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.2.12 WindSensorSpotDirection

```
windSensorSpotDirection ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "WindSensor.WindSensorSpotDirection:qty"
ASN-NAME "WindSensorSpotDirection"
ASN-OBJECT-IDENTIFIER { NTCIP1204:5.6.10.7 }
DEFINITION     "The direction from which the wind is blowing measured in degrees
clockwise from true North as measured by the wind sensor.  For mobile platforms, the wind
direction shall be corrected for vehicle movement.
The value of zero (0) shall indicate 'calm', when the associated speed is zero (0), or
'light and variable,' when the associated speed is greater than zero (0). Normal
observations, as defined by the WMO, shall report a wind direction in the range of 1 to
360 with 90 meaning from the east and 360 meaning from the north. The value of 361 shall
indicate an error condition and shall always be reported if the associated speed indicates
error."
REMARKS ""
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "NTCIP 1204"
DATA-TYPE " WindSensorSpotDirection ::= INTEGER (0..361)"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE "degrees"
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.6.3 IEEE Data Entries

5.6.3.1 IeeeProviderServiceIdentifier

```
ieeeProviderServiceIdentifer ITS-DATA-ELEMENT ::= {
DESCRIPTIVE-NAME "Global.ieeeProviderServiceIdentifer:cd"
ASN-NAME "IeeeProviderServiceIdentifer"
ASN-OBJECT-IDENTIFIER { IEEE1609.12:Table1 }
DEFINITION     "A data element identifying the service(s) provided by the roadside unit
(RSU).  This data element, also known as a Provider Service Identifier (PSID), is a
variable-length octet string, defined in IEEE Std 1609.3 and is the subject of
harmonization with identifiers specified in other intelligent transportation systems,
e.g., under ISO."
REMARKS "The most significant bit(s) indicate the number of bits in the PSID value.  A
zero in the most significant bit indicates a 7-bit PSID value, a binary ‘10’ in the
lengths bits indicates a 14-bit PSID value; a binary ‘110’ in the lengths bits indicate a
21-bit PSID value; and a binary ‘1110’ in the lengths bits indicate a 28-bit PSID value.
The PSID values are defined in Table 1 of IEEE 1609.12."
DESCRIPTIVE-NAME-CONTEXT {""}
DATA-CONCEPT-TYPE data-element
STANDARD "IEEE 1609.12"
DATA-TYPE " IeeeProviderServiceIdentifer ::= OCTET STRING (SIZE(2..5))"
FORMAT "ASN.1 encoding"
UNIT-OF-MEASURE ""
VALID-VALUE-RULE "see the ASN.1 DATA-TYPE"}
```

5.7 Extensions

Extensions to a SAE J2735 SE conformant implementation are discouraged because they break interoperability. However, the standards organizations recognize the need to satisfy functional requirements not supported by this standard. An implementation of the SAE J2735 SE may customize the base ASN.1 by adding optional elements to the end of any type in the normative data concept, such as a message or data frame, provided that the original parts of the base are not changed. These optional elements are depicted using the namespace prefix, "LOCAL.". Implementing an extension, however, results in new elements not being able to be checked during validation of a message (since any additional elements, by definition, are acceptable).

Note that extensions may not modify the dialogs contained in the standard. Where necessary, new dialogs shall be added to support the extensions and such dialogs shall be documented in a manner which is consistent with this standard (See Section 3.3.2.2). Any new dialogs must be documented in ISO 14817 ASN.1 and XML representation.

6. NOTES

6.1 Marginal Indicia

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE DSRC (DEDICATED SHORT RANGE COMMUNICATION) TECHNICAL COMMITTEE

APPENDIX A
REQUIREMENTS TRACEABILITY MATRIX (RTM)
[NORMATIVE]

The Requirements Traceability Matrix (RTM) links the Functional Requirements as presented in Section 3 with the corresponding Dialogs on the same (gray) line. Each Functional Requirement/Dialog relates/uses one or more groups of data concepts. The data concepts, in the form of messages, data frames, and data elements, are listed to the side; the formal definition of each data concept is contained within Section 5. Using this table, each Functional Requirement can thus be traced in a standardized way.

The table can be used by:

- A specification writer to indicate what design content are to be implemented in a project specification;
- The protocol implementer, such as vendors and developers, as a checklist to reduce the risk of failure to conform to the project specification;
- The supplier and user, as a detailed indication of the data concepts to be included in an implementation; and
- The user, including conformance testers, as a basis for initially checking the potential interoperability with another implementation.

Additionally, other interested parties might use this table to determine how particular functions are to be implemented using the standardized dialogs and data concepts.

A.1 NOTATION [INFORMATIVE]

A.1.1 Functional Requirement Columns

The functional requirements are defined within Section 3 and the RTM is based upon the requirements within that Section. The section number and the functional requirement name are indicated within these columns.

A.1.2 Dialog Column

The RTM references the traces from requirements to a standardized dialog. The section number where the standardized dialog is defined is indicated within this column.

A.1.3 Object Columns

The design elements are defined within Section 5. The Object ID references a clause in Section 5, while Object Name is the actual object name.

A.2 INSTRUCTIONS FOR COMPLETING THE RTM [INFORMATIVE]

To find the standardized design content for a functional requirement, search for the requirement identification number and functional requirement under the functional requirements columns. Next to the functional requirements column will be a dialog identification number, identifying a specific dialog to be used to fulfill that requirement. To the right of the dialog identification number are the identification number and name of the data concepts that are referenced or used by the dialog to fulfill the functional requirement. The "Additional Specifications" column will provide additional notes or details about the design content.

A.3 REQUIREMENTS TRACEABILITY MATRIX (RTM) TABLE

Table headings include:

- FR ID - the number assigned to the functional requirement statement.
- Functional Requirement - a short descriptive title identifying the functional requirement.
- Dialog ID - the standardized dialog.
- Object ID - the section number where the object description can be found.
- Object Name - the actual object name.
- Additional Specification - additional notes or details.

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.4	Architectural Requirements				
3.4.1	OBU - Broadcast Information	4.3.1			
3.4.2	RSU - Broadcast Information	4.3.1			
3.4.3	Connected Device Dialogs		IEEE1609.1		For communications using DSRC only.
3.4.4	Forwarded Requests	4.3.2			
3.5	Data Exchange and Operational Environment Requirements				
3.5.1	Vehicle Requirements				
3.5.1.1	Broadcast Vehicle Information - Critical Information				
3.5.1.1.1	Broadcast Vehicle Information - Critical Information - Compact Form	5.1.1.1			dlBasicSafetyMessage
			5.2.1.1	dSRCMessage	
			5.3.1.5	basicSafetyMessage	
3.5.1.1.2	Broadcast Vehicle Information - Critical Information - Verbose	5.1.1.2			dlBasicSafetyMessage Verbose
			5.2.1.1	dSRCMessage	
			5.3.1.6	basicSafetyMessageVerbose	
3.5.1.1.3	Broadcast Vehicle Information - Mandatory Requirements				
3.5.1.1.3.1	Broadcast Vehicle Information - Device Identifier		5.4.51.43	vehicle-temporary-identifier	
3.5.1.1.3.2	Broadcast Vehicle Information - Message Identifier		5.4.15.2	dSRCMessage-sequence-number	
3.5.1.1.3.3	Broadcast Vehicle Information - Position Time		5.3.1.174	vehiclePositionMark	
3.5.1.1.3.4	Broadcast Vehicle Information - Vehicle Position		5.3.1.174	vehiclePositionMark	
3.5.1.1.3.5	Broadcast Vehicle Information - Positional Accuracy		5.3.1.73	locationAccuracy	
3.5.1.1.3.6	Broadcast Vehicle Information - Transmission State		5.4.51.32	vehicle-movement-per	
3.5.1.1.3.7	Broadcast Vehicle Information - Vehicle Speed		5.4.51.32	vehicle-movement-per	
3.5.1.1.3.8	Broadcast Vehicle Information - Vehicle Heading		5.4.51.20	vehicle-heading	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.1.1.3.9	Broadcast Vehicle Information - Steering Wheel Angle		5.4.51.41	vehicle-steering-wheel-angle	
3.5.1.1.3.10	Broadcast Vehicle Information - Vehicle Acceleration		5.3.1.1	acceleration4Way	
3.5.1.1.3.11	Broadcast Vehicle Information - Vehicle Vertical Acceleration		5.3.1.1	acceleration4Way	
3.5.1.1.3.12	Broadcast Vehicle Information - Yaw Rate		5.3.1.1	acceleration4Way	
3.5.1.1.3.13	Broadcast Vehicle Information - Vehicle Brake Status Requirements				
3.5.1.1.3.13.1	Broadcast Vehicle Information - Wheel Braking Activity		5.4.51.7	vehicle-brake-system-status-per	
3.5.1.1.3.13.2	Broadcast Vehicle Information - Vehicle Anti-Lock Brakes Status		5.4.51.7	vehicle-brake-system-status-per	
3.5.1.1.3.13.3	Broadcast Vehicle Information - Vehicle Traction Control Status		5.4.51.7	vehicle-brake-system-status-per	
3.5.1.1.3.13.4	Broadcast Vehicle Information - Vehicle Stability Control Status		5.4.51.7	vehicle-brake-system-status-per	
3.5.1.1.3.13.5	Broadcast Vehicle Information - Braking Boost Status		5.4.51.7	vehicle-brake-system-status-per	
3.5.1.1.3.13.6	Broadcast Vehicle Information - Auxiliary Brake Status		5.4.51.7	vehicle-brake-system-status-per	
3.5.1.1.3.14	Broadcast Vehicle Information - Vehicle Width		5.4.51.37	vehicle-size-per	
3.5.1.1.3.15	Broadcast Vehicle Information - Vehicle Length		5.4.51.37	vehicle-size-per	
3.5.1.1.4	Broadcast Vehicle Information - Optional Requirements				
3.5.1.1.4.1	Broadcast Vehicle Information - Vehicle Type		5.4.51.47	vehicle-type	
3.5.1.1.4.2	Broadcast Vehicle Information - Vehicle Dimensions Requirements				
3.5.1.1.4.2.1	Broadcast Vehicle Information - Front Bumper Height		5.4.51.9	vehicle-bumper-height-front	
3.5.1.1.4.2.2	Broadcast Vehicle Information - Rear Bumper Height		5.4.51.10	vehicle-bumper-height-rear	
3.5.1.1.4.2.3	Broadcast Vehicle Information - Height		5.4.51.22	vehicle-height	
3.5.1.1.4.2.4	Broadcast Vehicle Information - Vehicle Weight		5.4.51.30	vehicle-mass-gross	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.1.1.4.3	Broadcast Vehicle Information - Vehicle Position and Movement Requirements				
3.5.1.1.4.3.1	Broadcast Vehicle Information - GPS Status		5.4.18.1	gPSUnit-status	
3.5.1.1.4.3.2	Broadcast Vehicle Information - Applied Pressure on the Vehicle Brakes		5.4.51.4	vehicle-brake-applied-pressure	
3.5.1.1.4.3.3	Broadcast Vehicle Information - Wheel Vertical Acceleration		5.4.53.7	vehicleEnvironment-vertical-acceleration-flag	
3.5.1.1.4.3.4	Broadcast Vehicle Information - Steering Angle Rate of Change		5.4.51.42	vehicle-steering-wheel-angle-change	
3.5.1.1.4.3.5	Broadcast Vehicle Information - Driving Wheel Angle		5.4.51.15	vehicle-driving-wheel-angle	
3.5.1.1.4.4	Broadcast Vehicle Information - Environmental Sensor Values Requirements				
3.5.1.1.4.4.1	Broadcast Vehicle Information - Vehicle Lights State Requirements				
3.5.1.1.4.4.1.1	Broadcast Vehicle Information - Left Turn Signal State		5.4.51.28	vehicle-lights	
3.5.1.1.4.4.1.2	Broadcast Vehicle Information - Right Turn Signal State		5.4.51.28	vehicle-lights	
3.5.1.1.4.4.1.3	Broadcast Vehicle Information - Daytime Running Lights State		5.4.51.28	vehicle-lights	
3.5.1.1.4.4.1.4	Broadcast Vehicle Information - Hazard Lights State		5.4.51.28	vehicle-lights	
3.5.1.1.4.4.1.5	Broadcast Vehicle Information - Fog Lamps State		5.4.51.28	vehicle-lights	
3.5.1.1.4.4.1.6	Broadcast Vehicle Information - Low Beam Headlights State		5.4.51.28	vehicle-lights	
3.5.1.1.4.4.1.7	Broadcast Vehicle Information - High Beam Headlights State		5.4.51.28	vehicle-lights	
3.5.1.1.4.4.1.8	Broadcast Vehicle Information - Parking Lights State		5.4.51.28	vehicle-lights	
3.5.1.1.4.4.1.9	Broadcast Vehicle Information - Automatic Light Controls State		5.4.51.28	vehicle-lights	
3.5.1.1.4.4.2	Broadcast Vehicle Information - Vehicle Front Wiper Status		5.4.51.51	vehicle-wipers-front	
3.5.1.1.4.4.3	Broadcast Vehicle Information - Vehicle Front Wiper Sweeping Rate		5.4.51.52	vehicle-wipers-front-rate	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.1.1.4.4.4	Broadcast Vehicle Information - Vehicle Rear Wiper Status		5.4.51.53	vehicle-wipers-rear	
3.5.1.1.4.4.5	Broadcast Vehicle Information - Coefficient of Friction		5.4.53.4	vehicleEnvironment-roadway-friction	
3.5.1.1.4.4.6	Broadcast Vehicle Information - Solar Radiation		5.4.53.5	vehicleEnvironment-sunlight	
3.5.1.1.4.4.7	Broadcast Vehicle Information - Ambient Air Temperature		5.4.53.6	vehicleEnvironment-temperature-air	
3.5.1.1.4.4.8	Broadcast Vehicle Information - Ambient Air Pressure		5.4.53.1	vehicleEnvironment-air-pressure	
3.5.1.1.4.4.9	Broadcast Vehicle Information - Precipitation Type		5.4.53.3	vehicleEnvironment-precipitation-situation	
3.5.1.1.4.4.10	Broadcast Vehicle Information - Precipitation Rate		5.4.53.2	vehicleEnvironment-precipitation-rate	
3.5.1.1.4.5	Broadcast Vehicle Information - Obstacle Information		5.3.1.86	obstacle	
3.5.1.1.4.6	Broadcast Vehicle Information - Vehicle Status Change				
3.5.1.1.4.6.1	Broadcast Vehicle Information - Vehicle Hazard Lights		5.4.51.16	vehicle-events	
3.5.1.1.4.6.2	Broadcast Vehicle Information - Vehicle Stopline Violation		5.4.51.16	vehicle-events	
3.5.1.1.4.6.3	Broadcast Vehicle Information - Anti-Lock Brake System Activation		5.4.51.16	vehicle-events	
3.5.1.1.4.6.4	Broadcast Vehicle Information - Traction Control System Activation		5.4.51.16	vehicle-events	
3.5.1.1.4.6.5	Broadcast Vehicle Information - Stability Control System Activation		5.4.51.16	vehicle-events	
3.5.1.1.4.6.6	Broadcast Vehicle Information - Hazardous Materials Present		5.4.51.16	vehicle-events	
3.5.1.1.4.6.7	Broadcast Vehicle Information - Hard Braking Warning		5.4.51.16	vehicle-events	
3.5.1.1.4.6.8	Broadcast Vehicle Information - Change in Vehicle Light State Requirements				
3.5.1.1.4.6.8.1	Broadcast Vehicle Information - Change in Left Turn Signal State		5.4.51.16	vehicle-events	
3.5.1.1.4.6.8.2	Broadcast Vehicle Information - Change in Right Turn Signal State		5.4.51.16	vehicle-events	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.1.1.4.6.8.3	Broadcast Vehicle Information - Change in Fog Lamps State		5.4.51.16	vehicle-events	
3.5.1.1.4.6.8.4	Broadcast Vehicle Information - Change in Low Beam Headlights State		5.4.51.16	vehicle-events	
3.5.1.1.4.6.8.5	Broadcast Vehicle Information - Change in High Beam Headlights State		5.4.51.16	vehicle-events	
3.5.1.1.4.6.8.6	Broadcast Vehicle Information - Change in Parking Lights State		5.4.51.16	vehicle-events	
3.5.1.1.4.6.9	Broadcast Vehicle Information - Change in Wiper Status		5.4.51.16	vehicle-events	
3.5.1.1.4.6.10	Broadcast Vehicle Information - Flat Tire		5.4.51.16	vehicle-events	
3.5.1.1.4.6.11	Broadcast Vehicle Information - Vehicle Is Disabled		5.4.51.16	vehicle-events	
3.5.1.1.4.6.12	Broadcast Vehicle Information - Air Bag Deployment		5.4.51.16	vehicle-events	
3.5.1.1.4.6.13	Broadcast Emergency Response Indication		5.4.51.16	vehicle-events	
3.5.1.1.4.7	Broadcast Vehicle Information - Trailer Weight		5.4.49.5	trailer-weight	
3.5.1.1.4.8	Broadcast Vehicle Information - Vehicle Path History Requirements		5.3.1.172	vehiclePathHistory	
3.5.1.1.4.8.1	Broadcast Vehicle Path History - GPS Status		5.4.18.1	gPSUnit-status	
3.5.1.1.4.8.2	Broadcast Vehicle Path History - Initial Position		5.3.1.174	vehiclePositionMark	
3.5.1.1.4.8.3	Broadcast Vehicle Path History - Time Offset		5.4.46.1	time-offset	
3.5.1.1.4.8.4	Broadcast Vehicle Path History - Position Offset		5.4.54.1	vehiclePathPoint-elevation-offset	
			5.4.54.2	vehiclePathPoint-latitude-offset	
			5.4.54.3	vehiclePathPoint-longitude-offset	
3.5.1.1.4.8.5	Broadcast Vehicle Path History - Heading		5.4.54.21	vehicle-heading-history	
3.5.1.1.4.8.6	Broadcast Vehicle Path History - Transmission		5.3.1.171	vehicleMovement	
3.5.1.1.4.8.7	Broadcast Vehicle Path History - Speed		5.3.1.171	vehicleMovement	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.1.1.4.8.8	Broadcast Vehicle Path History - Positional Accuracy		5.3.1.73	locationAccuracy	
3.5.1.1.4.9	Broadcast Vehicle Information - Vehicle Path Projection		5.3.1.173	vehiclePathPrediction	
3.5.1.1.4.10	Broadcast Vehicle Information - Location Corrections		5.3.1.168	vehicleLocationCorrection	
3.5.1.2	Device Information Request	5.1.1.3			dlCommonSafetyRequest
			5.2.1.1	dSRCMessage	
			5.3.1.32	commonSafetyRequest	
3.5.1.2.1	Request Vehicle Information - Message Identifier		5.4.15.2	dSRCMessage-sequence-number	
3.5.1.2.2	Request Vehicle Information - Device Identifier		5.4.51.43	vehicle-temporary-identifier	
3.5.1.2.3	Request Vehicle Information - Requested Item		5.3.1.175	vehicleRequestItems	
3.5.1.3	Broadcast Intersection Infringement	5.1.1.4			dlIntersectionInfringement
			5.2.1.1	dSRCMessage	
			5.3.1.58	intersectionInfringement	
3.5.1.3.1	Broadcast Intersection Infringement - Message Identifier		5.4.15.2	dSRCMessage-sequence-number	
3.5.1.3.2	Broadcast Intersection Infringement - Device Identifier		5.4.51.43	vehicle-temporary-identifier	
3.5.1.3.3	Broadcast Intersection Infringement - Vehicle Time		5.3.1.174	vehiclePositionMark	
3.5.1.3.4	Broadcast Intersection Infringement - Path History		5.3.1.172	vehiclePathHistory	
3.5.1.3.5	Broadcast Intersection Infringement - Intersection Identifier		5.4.19.2	intersection-identifier	
3.5.1.3.6	Broadcast Intersection Infringement - Lane Number		5.4.22.2	lane-number	
3.5.1.3.7	Broadcast Intersection Infringement - Intersection Violation		5.4.51.16	vehicle-events	
3.5.2	Public Safety Vehicle Requirements				
3.5.2.1	Broadcast Emergency Response Indication				
3.5.2.2	Signal Preemption Requirements				
3.5.2.2.1	Transmit Preempt Request	5.1.6.1			dlSignalRequest

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
			5.2.1.1	dSRCMessage	
			5.3.1.127	signalRequestMessage	
3.5.2.2.2	Request Signal Preempt - Mandatory Requirements				
3.5.2.2.2.1	Request Signal Preempt - Message Identifier		5.4.15.2	dSRCMessage-sequence-number	
3.5.2.2.2.2	Request Signal Preempt - Intersection Identifier		5.4.19.2	intersection-identifier	
3.5.2.2.2.3	Request Signal Preempt - Operational Strategy		5.4.21.5	intersectionSignalizedRequest-number	
3.5.2.2.3	Request Signal Preempt - Optional Requirements				
3.5.2.2.3.1	Request Signal Preempt - Approach Lane		5.4.21.1	intersectionSignalizedRequest-approach	
3.5.2.2.3.2	Request Signal Preempt - Egress Lane		5.4.21.4	intersectionSignalizedRequest-egress	
3.5.2.2.3.3	Request Signal Preempt - Validation		5.4.21.3	intersectionSignalizedRequest-codeword	
3.5.2.2.3.4	Request Signal Preempt - Vehicle Class		5.4.51.12	vehicle-class	
3.5.2.2.3.5	Request Signal Preempt - Time of Service		5.3.1.67	intersectionSignalizedRequestTime	
3.5.2.2.3.6	Request Signal Preempt - End of Service		5.3.1.66	intersectionSignalizedRequestEnd	
3.5.2.2.3.7	Request Signal Preempt - Vehicle Identity		5.3.1.165	vehicleIdentification	
3.5.2.2.3.8	Request Signal Preempt - Vehicle Location and Speed		5.4.51.8	vehicle-bsm-part1-oer	
3.5.2.2.3.9	Request Signal Preempt - Vehicle Status		5.4.51.35	vehicle-request-status	
3.5.2.2.3.10	Request Signal Preempt - Cancellation		5.4.21.2	intersectionSignalizedRequest-cancel	
3.5.3	Commercial Vehicle Requirements				
3.5.3.1	Commercial Credentials Information Requirements				
3.5.3.1.1	Commercial Vehicle Information Request	5.1.3.1			dlCommercialVehicleCredentialsRequest
			5.2.1.1	dSRCMessage	
			5.3.1.31	commercialVehicleRequest	

This SAE Information Report is a compilation of engineering reference data and educational material from various sources deemed useful to the technical community. Normative language contained herein should not be considered as an SAE Recommended Practice or SAE Standard.

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.3.1.1.1	Request Commercial Vehicle Information - Mandatory Requirements				
3.5.3.1.1.1.1	Request Commercial Vehicle Information - Vehicle Identification		5.4.7.4	cmvRequest-item	
3.5.3.1.1.2	Request Commercial Vehicle Information - Optional Requirements				
3.5.3.1.1.2.1	Request Commercial Vehicle Information - Driver Identification		5.4.7.4	cmvRequest-item	
3.5.3.1.1.2.2	Request Commercial Vehicle Information - Driver Hours of Service Data		5.4.7.4	cmvRequest-item	
3.5.3.1.1.2.3	Request Commercial Vehicle Information - Trailer Data		5.4.7.4	cmvRequest-item	
3.5.3.1.1.2.4	Request Commercial Vehicle Information - Cargo Data		5.4.7.4	cmvRequest-item	
3.5.3.1.1.2.5	Request Commercial Vehicle Information - Specific Vehicles		5.3.1.22	cmvRequestTarget	
3.5.3.1.1.3	Request Commercial Vehicle Information - Presentation Requirements		5.3.1.21	cmvRequestRegions	
3.5.3.1.1.3.1	Request Commercial Vehicle Information - Default Anchor Point Position		5.3.1.20	cmvRequestAnchor	
3.5.3.1.1.3.2	Request Commercial Vehicle Information - Heading Slice		5.4.36.1	region-orientation	
3.5.3.1.1.3.3	Request Commercial Vehicle Information - Circular Region - Radius		5.4.4.1	circle-radius	
3.5.3.1.1.3.4	Request Commercial Vehicle Information - Circular Region - Anchor Point		5.3.1.12	circleAnchor	
3.5.3.1.1.3.5	Request Commercial Vehicle Information - Polygon Region - Offsets		5.3.1.105	polygonOffsetNodes	
3.5.3.1.1.3.6	Request Commercial Vehicle Information - Polygon Region - Anchor Point		5.3.1.103	polygonAnchor	
3.5.3.1.1.3.7	Request Commercial Vehicle Information - Shape Point Set - Default Direction		5.4.7.1	cmvRequest-default-direction	

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.3.1.1.3.8	Request Commercial Vehicle Information - Shape Point Set - Default Width		5.4.7.2	cmvRequest-default-width	
3.5.3.1.1.3.9	Request Commercial Vehicle Information - Shape Point Set - Offsets		5.3.1.126	shapePointOffsetNodes	
3.5.3.1.1.3.10	Request Commercial Vehicle Information - Shape Point Set - Direction		5.4.41.1	shapePoint-direction	
3.5.3.1.1.3.11	Request Commercial Vehicle Information - Shape Point Set - Width		5.4.41.2	shapePoint-width	
3.5.3.1.1.3.12	Request Commercial Vehicle Information - Shape Point Set - Node Width		5.4.41.3	shapePointOffsetNode-width	
3.5.3.1.1.3.13	Request Commercial Vehicle Information - Shape Point Set - Anchor Point		5.3.1.124	shapePointAnchor	
3.5.3.1.2	Transmit Commercial Vehicle Information	5.1.3.1			dlCommercialVehicleCredentialsRequest
			5.2.1.1	dSRCMessage	
			5.3.1.30	commercialVehicleData	
3.5.3.1.2.1	Transmit Commercial Vehicle Information - Mandatory Requirements				
3.5.3.1.2.1.1	Transmit Commercial Vehicle Power Unit - License Plate Data		5.3.1.167	vehicleLicensePlate	
3.5.3.1.2.1.2	Transmit Commercial Vehicle Power Unit - VIN		5.4.51.48	vehicle-vin	
3.5.3.1.2.1.3	Transmit Commercial Vehicle Power Unit - Owner Carrier Name		5.4.51.34	vehicle-owner-oer	
3.5.3.1.2.2	Transmit Commercial Vehicle Information - Optional Requirements				
3.5.3.1.2.2.1	Transmit Commercial Vehicle Power Unit - Optional Requirements				
3.5.3.1.2.2.1.1	Transmit Commercial Vehicle Power Unit - VIN Source		5.4.51.49	vehicle-vin-source	
3.5.3.1.2.2.1.2	Transmit Commercial Vehicle Power Unit - Owner Registration Number		5.4.51.34	vehicle-owner-oer	
3.5.3.1.2.2.1.3	Transmit Commercial Vehicle Power Unit - Lessee Registration Number		5.4.51.25	vehicle-lessee-oer	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.3.1.2.2.2	Transmit Commercial Vehicle Power Unit - Lessee Carrier Name		5.4.51.25	vehicle-lessee-oer	
3.5.3.1.2.2.3	Transmit Commercial Vehicle Driver Identification Data				
3.5.3.1.2.2.3.1	Transmit Commercial Vehicle Driver - Name		5.4.33.2	person-name-first	
			5.4.33.3	person-name-last	
3.5.3.1.2.2.3.2	Transmit Commercial Vehicle Driver - License Number		5.3.1.36	driverLicense	
3.5.3.1.2.2.3.3	Transmit Commercial Vehicle Driver - Date of Birth		5.4.33.1	person-date-of-birth-oer	
3.5.3.1.2.2.3.4	Transmit Commercial Vehicle Driver - PIN		5.4.12.1	driver-pin	
3.5.3.1.2.2.4	Transmit Commercial Vehicle Information - Trailer Requirements				
3.5.3.1.2.2.4.1	Transmit Trailer Information - VIN		5.4.49.4	trailer-vin	
3.5.3.1.2.2.4.2	Transmit Trailer Information - License Plate Data		5.3.1.151	trailerLicensePlate	
3.5.3.1.2.2.4.3	Transmit Trailer Information - Number of Axles		5.4.49.1	trailer-count-axle	
3.5.3.1.2.2.4.4	Transmit Trailer Information - Number of Trailer Tires		5.4.49.2	trailer-count-tire	
3.5.3.1.2.2.4.5	Transmit Trailer Information - Weight		5.4.49.5	trailer-weight	
3.5.3.1.2.2.5	Transmit Commercial Vehicle Information - Cargo Requirements				
3.5.3.1.2.2.5.1	Transmit Cargo Information - Shipment ID		5.4.5.1	cmv-current-trip-oer	
3.5.3.1.2.2.5.2	Transmit Cargo Information - Hazmat Codes		5.4.5.1	cmv-current-trip-oer	
3.5.3.1.2.2.5.3	Transmit Cargo Information - Placards		5.4.5.1	cmv-current-trip-oer	
3.5.3.1.2.2.6	Transmit Commercial Vehicle Information - Vehicle Requirements				
3.5.3.1.2.2.6.1	Transmit Commercial Vehicle Information - Device Time		5.3.1.174	vehiclePositionMark	
3.5.3.1.2.2.6.2	Transmit Commercial Vehicle Information - Vehicle Position		5.3.1.174	vehiclePositionMark	
3.5.3.1.2.2.6.3	Transmit Commercial Vehicle Information - Positional Accuracy		5.3.1.73	locationAccuracy	

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.3.1.2.2.6.4	Transmit Commercial Vehicle Information - Vehicle Speed		5.4.51.32	vehicle-movement-per	
3.5.3.1.2.2.6.5	Transmit Commercial Vehicle Information - Vehicle Heading		5.4.51.20	vehicle-heading	
3.5.3.2	Commercial Vehicle Screening Information Requirements				
3.5.3.2.1	Transmit Screening Activity Result	5.1.3.2			dlCommercialVehicleScreeningResults
			5.2.1.1	dSRCMessage	
			5.3.1.26	commercialScreeningData	
3.5.3.2.1.1	Transmit Screening Activity Result - Mandatory Requirements				
3.5.3.2.1.1.1	Transmit Screening Activity Result - VIN		5.4.51.48	vehicle-vin	
3.5.3.2.1.1.2	Transmit Screening Activity Result - Encounter ID		5.4.6.1	cmvEncounter-identifier	
3.5.3.2.1.1.3	Transmit Screening Activity Result - Encounter Date and Time		5.3.1.19	cmvEncounterTime	
3.5.3.2.1.1.4	Transmit Screening Activity Result - Encounter Location		5.3.1.16	cmvEncounterLocationOer	
3.5.3.2.1.1.5	Transmit Screening Activity Result - Check Type		5.4.6.4	cmvEncounter-type	
3.5.3.2.1.1.6	Transmit Screening Activity Result - Check Value		5.4.15.1	dSRCMessage-crc	
3.5.3.2.1.2	Transmit Screening Activity Result - Optional Requirements				
3.5.3.2.1.2.1	Transmit Screening Activity Result - Vehicle Polling Date and Time		5.3.1.17	cmvEncounterPollTime	
3.5.3.2.1.2.2	Transmit Screening Activity Result - Encounter Station		5.4.6.3	cmvEncounter-station	
3.5.3.2.1.2.3	Transmit Screening Activity Result - Vehicle Measurements Requirements				
3.5.3.2.1.2.3.1	Transmit Screening Activity Result - Vehicle Weight		5.4.51.30	vehicle-mass-gross	
3.5.3.2.1.2.3.2	Transmit Screening Activity Result - Vehicle Height		5.4.51.22	vehicle-height	
3.5.3.2.1.2.3.3	Transmit Screening Activity Result - Vehicle Width		5.4.51.37	vehicle-size-per	
3.5.3.2.1.2.3.4	Transmit Screening Activity Result - Vehicle Length		5.4.51.37	vehicle-size-per	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.3.2.1.2.4	Transmit Screening Activity Result - Tire Information Requirements				
3.5.3.2.1.2.4.1	Transmit Screening Activity Result - Tire Pressure		5.4.56.1	vehicleTire-location	
			5.4.56.2	vehicleTire-pressure	
3.5.3.2.1.2.4.2	Transmit Screening Activity Result - Tire Temperature		5.4.56.1	vehicleTire-location	
			5.4.56.3	vehicleTire-temperature	
3.5.3.2.1.2.4.3	Transmit Screening Activity Result - Tire Pressure Threshold		5.4.56.1	vehicleTire-location	
			5.4.56.4	vehicleTire-threshold	
3.5.3.2.1.2.5	Transmit Screening Activity Result - Axle Information Requirements				
3.5.3.2.1.2.5.1	Transmit Screening Activity Result - Vehicle Weight on the Axle		5.4.52.2	vehicleAxle-location	
			5.4.52.3	vehicleAxle-weight	
3.5.3.2.1.2.5.2	Transmit Screening Activity Result - Distance Between Vehicle Axles		5.4.52.1	vehicleAxle-distance	
			5.4.52.2	vehicleAxle-location	
3.5.3.2.1.2.6	Transmit Screening Activity Result - Vehicle Brake Requirements				
3.5.3.2.1.2.6.1	Transmit Screening Activity Result - Left Brake Measure		5.4.52.2	vehicleAxle-location	
			5.4.52.5	vehicleAxleBrake-left	
3.5.3.2.1.2.6.2	Transmit Screening Activity Result - Right Brake Measure		5.4.52.2	vehicleAxle-location	
			5.4.52.7	vehicleAxleBrake-right	
3.5.3.2.1.2.6.3	Transmit Screening Activity Result - Brake Actuator		5.4.52.2	vehicleAxle-location	
			5.4.52.4	vehicleAxleBrake-actuator	
3.5.3.2.1.2.6.4	Transmit Screening Activity Result - Brake Lining Thickness		5.4.52.2	vehicleAxle-location	
			5.4.52.6	vehicleAxleBrake-lining	
3.5.3.2.1.2.6.5	Transmit Screening Activity Result - Brake Temperature		5.4.52.2	vehicleAxle-location	
			5.4.52.8	vehicleAxleBrake-temperature	
3.5.3.2.1.2.7	Transmit Screening Activity Result - Safety Belt		5.4.51.36	vehicle-safety-belt	

This SAE Information Report is a compilation of engineering reference data and educational material from various sources deemed useful to the technical community. Normative language contained herein should not be considered as an SAE Recommended Practice or SAE Standard.

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.3.2.1.2.8	Transmit Commercial Vehicle Driver Hours of Service Data		5.3.1.37	driverLog	
3.5.3.2.2	Screening Activity Results Acknowledgement	5.1.3.2			dlCommercialVehicleScreeningResults
			5.2.1.1	dSRCMessage	
			5.3.1.25	commercialScreeningAcknowledgement	
3.5.3.2.2.1	Transmit Screening Activity Acknowledgement - Mandatory Requirements				
3.5.3.2.2.1.1	Transmit Screening Activity Result - VIN		5.4.51.48	vehicle-vin	
3.5.3.2.2.1.2	Transmit Screening Activity Result - Encounter ID		5.4.6.1	cmvEncounter-identifier	
3.5.3.2.2.1.3	Transmit Screening Activity Result - Encounter Date and Time		5.3.1.19	cmvEncounterTime	
3.5.3.2.2.1.4	Transmit Screening Activity Result - Check Value		5.4.8.1	cmvScreeningAck-encounter-crc	
3.5.3.2.3	Commercial Screening Information Request	5.1.3.4			dlCommercialVehicleScreeningExchange
			5.2.1.1	dSRCMessage	
			5.3.1.31	commercialVehicleRequest	
3.5.3.2.3.1	Commercial Screening Information Request - Mandatory Requirements				
3.5.3.2.3.1.1	Commercial Screening Information Request - Vehicle Identification		5.3.1.22	cmvRequestTarget	
3.5.3.2.3.2	Commercial Screening Information Request - Optional Requirements				
3.5.3.2.3.2.1	Request Commercial Screening Information - Encounter ID		5.4.7.3	cmvRequest-encounter-identifier	
3.5.3.2.4	Transmit Previous Screening Activity Result	5.1.3.4			dlCommercialVehicleScreeningExchange
			5.2.1.1	dSRCMessage	
			5.3.1.27	commercialScreeningResults	
3.5.3.2.4.1	Transmit Previous Screening Activity Result - Mandatory Requirements				
3.5.3.2.4.2	Transmit Previous Screening Activity Result - Optional Requirements				
3.5.3.3	Commercial Vehicle Clearance Requirements				

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.3.3.1	Transmit Instructions	5.1.3.3			dlCommercialVehicleClearance
			5.2.1.1	dSRCMessage	
			5.3.1.29	commercialVehicleClearance	
3.5.3.3.1.1	Transmit Instructions - VIN		5.4.51.48	vehicle-vin	
3.5.3.3.1.2	Transmit Instructions - Instructions				
3.5.3.3.1.2.1	Transmit Instructions - Bypass		5.4.5.3	cmv-instructions	
3.5.3.3.1.2.2	Transmit Instructions - Pull-In Location		5.3.1.16	cmvEncounterLocationOer	
3.5.3.3.1.3	Transmit Instructions - Optional Requirements				
3.5.3.3.1.3.1	Transmit Instructions - Pull-In Location Name		5.4.6.3	cmvEncounter-station	
3.5.3.3.1.3.2	Transmit Instructions - Pull-In Location Description		5.4.6.2	cmvEncounter-location-description	
3.5.3.3.2	Transmit Instructions Acknowledgement	5.1.3.3			dlCommercialVehicleClearance
			5.2.1.1	dSRCMessage	
			5.3.1.28	commercialVehicleAcknowledgement	
3.5.3.3.2.1	Transmit Instructions Acknowledgement - Mandatory Requirements				
3.5.3.3.2.1.1	Transmit Instructions Acknowledgement - VIN		5.4.51.48	vehicle-vin	
3.5.3.3.2.2	Transmit Instructions Acknowledgement - Optional Requirements				
3.5.3.3.2.2.1	Transmit Instructions Acknowledgement - Pull-In Location		5.3.1.16	cmvEncounterLocationOer	
3.5.3.3.2.2.2	Transmit Instructions Acknowledgement - Pull-In Location Name		5.4.6.3	cmvEncounter-station	
3.5.4	Transit Vehicle Requirements				
3.5.4.1	Request Signal Priority Requirements				
3.5.4.1.1	Transmit Priority Request	5.1.6.1			dlSignalRequest
			5.2.1.1	dSRCMessage	
			5.3.1.127	signalRequestMessage	
3.5.4.1.2	Transmit Priority Request - Mandatory Requirements				
3.5.4.1.2.1	Transmit Priority Request - Message Identifier		5.4.15.2	dSRCMessage-sequence-number	

This SAE Information Report is a compilation of engineering reference data and educational material from various sources deemed useful to the technical community. Normative language contained herein should not be considered as an SAE Recommended Practice or SAE Standard.

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.4.1.2.2	Transmit Priority Request - Intersection Identifier		5.4.19.2	intersection-identifier	
3.5.4.1.2.3	Transmit Priority Request - Operational Strategy		5.4.21.5	intersectionSignalizedRequest-number	
3.5.4.1.3	Transmit Priority Request - Optional Requirements				
3.5.4.1.3.1	Transmit Priority Request - Approach Lane		5.4.21.1	intersectionSignalizedRequest-approach	
3.5.4.1.3.2	Transmit Priority Request - Egress Lane		5.4.21.4	intersectionSignalizedRequest-egress	
3.5.4.1.3.3	Transmit Priority Request - Validation		5.4.21.3	intersectionSignalizedRequest-codeword	
3.5.4.1.3.4	Transmit Priority Request - Vehicle Class		5.4.51.12	vehicle-class	
3.5.4.1.3.5	Transmit Priority Request - Time of Service		5.3.1.67	intersectionSignalizedRequestTime	
3.5.4.1.3.6	Transmit Priority Request - End of Service		5.3.1.66	intersectionSignalizedRequestEnd	
3.5.4.1.3.7	Transmit Priority Request - Vehicle Identity		5.3.1.165	vehicleIdentification	
3.5.4.1.3.8	Transmit Priority Request - Vehicle Location and Speed		5.4.51.8	vehicle-bsm-part1-oer	
3.5.4.1.3.9	Transmit Priority Request - Service Information		5.4.51.35	vehicle-request-status	
3.5.4.1.3.10	Transmit Priority Request Cancellation		5.4.21.2	intersectionSignalizedRequest-cancel	
3.5.5	Probe Data Requirements				
3.5.5.1	Probe Data Request	5.1.5.2			dlProbeDataExchange
			IEEE1609.3	WAVE Service Advertisement (WSA)	If the RSU is using IEEE 1609 for communications
			5.2.1.2	serviceAdvertisementMsg	If the RSU is NOT using IEEE 1609 for communications.
3.5.5.2	Transmit Probe Data Message	5.1.5.2			dlProbeDataExchange
			5.2.1.1	dSRCMessage	
			5.3.1.109	probeVehicleData	
3.5.5.2.1	Transmit Probe Data Information - Mandatory Requirements				

This SAE Information Report is a compilation of engineering reference data and educational material from various sources deemed useful to the technical community. Normative language contained herein should not be considered as an SAE Recommended Practice or SAE Standard.

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.5.2.1.1	Transmit Probe Data - Probe Segment Number		5.4.35.2	probe-segment-number	
3.5.5.2.1.2	Transmit Probe Data - Position		5.3.1.174	vehiclePositionMark	
3.5.5.2.1.3	Transmit Probe Data - Snapshots		5.3.1.137	snapshots	
3.5.5.2.2	Transmit Probe Data Information - Optional Requirements				
3.5.5.2.2.1	Transmit Probe Data - Vehicle Type		5.4.51.47	vehicle-type	
3.5.5.2.2.2	Transmit Probe Data - Identifier		5.3.1.165	vehicleIdentification	
3.5.5.2.2.3	Transmit Probe Data Information - Weather Report				
3.5.5.2.2.3.1	Transmit Probe Data - Wind Direction		5.4.45.8	snapshotWeather-wind-direction	
3.5.5.2.2.3.2	Transmit Probe Data - Wind Speed		5.4.45.9	snapshotWeather-wind-speed	
3.5.5.2.2.3.3	Transmit Probe Data - Dewpoint Temperature		5.4.45.1	snapshotWeather-dewpoint	
3.5.5.2.2.3.4	Transmit Probe Data - Total Radiation		5.4.45.3	snapshotWeather-radiation	
3.5.5.2.2.3.5	Transmit Probe Data - Visibility		5.4.45.7	snapshotWeather-visibility	
3.5.5.2.2.3.6	Transmit Probe Data - Surface Temperature		5.4.45.6	snapshotWeather-surface-temperature	
3.5.5.2.2.3.7	Transmit Probe Data - Roadway Water/Ice Depth		5.4.45.2	snapshotWeather-precipitation-depth	
3.5.5.2.2.3.8	Transmit Probe Data - Roadway Snow Depth		5.4.45.4	snapshotWeather-snow-depth	
3.5.5.2.2.3.9	Transmit Probe Data - Adjacent Snow Depth		5.4.45.5	snapshotWeather-snow-depth-adjacent	
3.5.5.2.2.4	Transmit Probe Data Information - Fuel				
3.5.5.2.2.4.1	Transmit Probe Data - Fuel Type		5.4.51.19	vehicle-fuel-type	
3.5.5.2.2.4.2	Transmit Probe Data - Fuel Economy		5.4.51.17	vehicle-fuel-economy	
3.5.5.2.2.4.3	Transmit Probe Data - Fuel Remaining		5.4.51.18	vehicle-fuel-remaining	
3.5.5.2.2.4.4	Transmit Probe Data - Charge Remaining		5.4.51.11	vehicle-charge-remaining	
3.5.5.2.2.5	Transmit Probe Data Information - Emissions				
3.5.5.2.2.5.1	Transmit Probe Data - CO Emissions (Running)		5.4.17.2	emissions-carbonmonoxide-running	
3.5.5.2.2.5.2	Transmit Probe Data - CO Emissions (Idling)		5.4.17.1	emissions-carbonmonoxide-idling	
3.5.5.2.2.5.3	Transmit Probe Data - NOx Emissions (Running)		5.4.17.6	emissions-nox-running	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.5.2.2.5.4	Transmit Probe Data - NOx Emissions (Idling)		5.4.17.5	emissions-nox-idling	
3.5.5.2.2.5.5	Transmit Probe Data - SO2 Emissions (Running)		5.4.17.12	emissions-so2-running	
3.5.5.2.2.5.6	Transmit Probe Data - SO2 Emissions (Idling)		5.4.17.11	emissions-so2-idling	
3.5.5.2.2.5.7	Transmit Probe Data - CO2 Emissions (Running)		5.4.17.4	emissions-co2-running	
3.5.5.2.2.5.8	Transmit Probe Data - CO2 Emissions (Idling)		5.4.17.3	emissions-co2-idling	
3.5.5.2.2.5.9	Transmit Probe Data - PM10 Emissions (Running)		5.4.17.8	emissions-pm10-running	
3.5.5.2.2.5.10	Transmit Probe Data - PM10 Emissions (Idling)		5.4.17.7	emissions-pm10-idling	
3.5.5.2.2.5.11	Transmit Probe Data - PM2.5 Emissions (Running)		5.4.17.10	emissions-pm25-running	
3.5.5.2.2.5.12	Transmit Probe Data - PM2.5 Emissions (Idling)		5.4.17.9	emissions-pm25-idling	
3.5.5.2.2.5.13	Transmit Probe Data - VOC Emissions (Running)		5.4.17.14	emissions-voc-running	
3.5.5.2.2.5.14	Transmit Probe Data - VOC Emissions (Idling)		5.4.17.13	emissions-voc-idling	
3.5.5.3	Broadcast Probe Management Information	5.1.5.1			dlProbeDataManagement
			5.2.1.1	dSRCMessage	
			5.3.1.106	probeDataManagement	
3.5.5.3.1	Broadcast Probe Management Information - Mandatory Requirements				
3.5.5.3.1.1	Manage Probe - Sample Size		5.3.1.107	probeSample	
3.5.5.3.1.2	Manage Probe - Configure Termination Parameters				
3.5.5.3.1.2.1	Manage Probe - Termination Time		5.4.35.7	probeTermination-time	
3.5.5.3.1.2.2	Manage Probe - Termination Distance		5.4.35.6	probeTermination-distance	
3.5.5.3.1.3	Manage Probe - Configure Snapshot Generation Parameters				
3.5.5.3.1.3.1	Manage Probe - Generation by Time		5.3.1.139	snapshotTime	
3.5.5.3.1.3.2	Manage Probe - Generation by Distance		5.3.1.131	snapshotDistance	
3.5.5.3.2	Broadcast Probe Management Information - Optional Requirements				

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.5.3.2.1	Manage Probe - Heading Slice		5.4.35.1	probe-orientation	
3.5.5.3.2.2	Manage Probe - Interval Between Transmissions		5.4.35.3	probe-transmission-interval	
3.5.5.3.2.3	Manage Probe - Start and Stop Snapshots				
3.5.5.3.2.3.1	Manage Probe - Stop Time Threshold		5.4.44.5	snapshotStop-time	
3.5.5.3.2.3.2	Manage Probe - Last Stop Threshold		5.4.44.3	snapshotStop-last	
3.5.5.3.2.3.3	Manage Probe - Start Speed Threshold		5.4.44.4	snapshotStop-start	
3.5.5.3.2.4	Manage Probe - Event Triggered Snapshots				
3.5.5.3.2.4.1	Manage Probe - Support Reading		5.3.1.135	snapshotRequest	
3.5.5.3.2.4.2	Manage Probe - Support Greater Than Event		5.3.1.135	snapshotRequest	
3.5.5.3.2.4.3	Manage Probe - Support Less Than Event		5.3.1.135	snapshotRequest	
3.5.6	Broadcast Roadway Geometrics Requirements				
3.5.6.1	Broadcast Roadway Geometrics	5.1.4.3			dlMapData
			5.2.1.1	dSRCMessage	
			5.3.1.76	mapData	
3.5.6.1.1	Broadcast Roadway Geometrics - Message Identifier		5.4.15.2	dSRCMessage-sequence-number	
3.5.6.2	Broadcast Details of an Intersection Geometric				
3.5.6.2.1	Broadcast Intersection - Mandatory Requirements				
3.5.6.2.1.1	Broadcast Intersection - Identifier		5.4.19.2	intersection-identifier	
3.5.6.2.1.2	Broadcast Intersection - Reference Point		5.3.1.54	intersectionAnchor	
3.5.6.2.1.3	Broadcast Intersection - Lane Default Width		5.4.19.1	intersection-default-lane-width	
3.5.6.2.1.4	Broadcast Intersection - Lane Description Requirements				
3.5.6.2.1.4.1	Broadcast Intersection - Egress Lanes		5.3.1.57	intersectionEgresses	
3.5.6.2.1.4.2	Broadcast Intersection - Approach Lanes		5.3.1.55	intersectionApproaches	
3.5.6.2.1.4.3	Broadcast Intersection - Lane Number		5.4.22.2	lane-number	
3.5.6.2.1.4.4	Broadcast Intersection - Lane Centerline Coordinates		5.3.1.99	pathNodes	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.6.2.1.5	Broadcast Intersection - Lane Attributes Requirements				
3.5.6.2.1.5.1	Broadcast Intersection - Vehicle Lane Movements		5.4.22.6	lane-vehicle-attributes	
3.5.6.2.1.5.2	Broadcast Intersection - Pedestrian Lane Movements		5.4.22.1	lane-crosswalk-attributes	
3.5.6.2.1.5.3	Broadcast Intersection - Special Lane Movements		5.4.22.5	lane-special-attributes	
3.5.6.2.2	Broadcast Intersection - Optional Requirements				
3.5.6.2.2.1	Broadcast Intersection - Version Identifier		5.4.19.5	intersection-version	
3.5.6.2.2.2	Broadcast Intersection - Computed Lane		5.3.1.100	pathOffset	
3.5.6.2.2.3	Broadcast Intersection - Crossings		5.3.1.56	intersectionCrossings	
3.5.6.2.2.4	Broadcast Intersection - Lane Width		5.4.22.7	lane-width	
3.5.6.2.2.5	Broadcast Intersection - Node Lane Width		5.4.32.2	pathNode-width	
3.5.6.2.2.6	Broadcast Intersection - Egress Connection		5.3.1.71	laneConnections	
3.5.6.2.2.7	Broadcast Intersection - Computed Intersection		5.3.1.60	intersectionReference	
3.5.6.2.2.8	Broadcast Signal Control Zone Requirements				
3.5.6.2.2.8.1	Broadcast Preempt or Priority Scheme		5.4.48.2	trafficSignalPriority-number	
3.5.6.2.2.8.2	Broadcast Preempt or Priority Scheme - Valid Lane		5.3.1.147	trafficSignalPriorityLanes	
3.5.6.2.2.8.3	Broadcast Preempt or Priority Scheme - Valid Zone		5.3.1.149	trafficSignalPriorityZones	
3.5.6.3	Broadcast Details of a Roadway Segment				
3.5.6.3.1	Broadcast Roadway Segment - Mandatory Requirements				
3.5.6.3.1.1	Broadcast Roadway Segment - Identifier		5.4.40.2	segment-identifier	
3.5.6.3.1.2	Broadcast Roadway Segment - Reference Point		5.3.1.119	segmentAnchor	
3.5.6.3.1.3	Broadcast Roadway Segment - Lane Default Width		5.4.40.1	segment-default-lane-width	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.6.3.1.4	Broadcast Roadway Segment - Lane Description Requirements				
3.5.6.3.1.4.1	Broadcast Roadway Segment - Lane Number		5.4.22.2	lane-number	
3.5.6.3.1.4.2	Broadcast Roadway Segment - Lane Path				
3.5.6.3.1.4.2.1	Broadcast Roadway Segment - Lane Centerline Coordinates		5.3.1.99	pathNodes	
3.5.6.3.1.4.2.2	Broadcast Roadway Segment - Computed Lane		5.3.1.100	pathOffset	
3.5.6.3.1.4.3	Broadcast Roadway Segment - Lane Attributes		5.4.22.4	lane-segment-attributes	
3.5.6.3.2	Broadcast Roadway Segment - Optional Requirements				
3.5.6.3.2.1	Broadcast Roadway Segment - Version Identifier		5.4.40.3	segment-version	
3.5.6.3.2.2	Broadcast Roadway Segment - Lane Width		5.4.22.7	lane-width	
3.5.6.3.2.3	Broadcast Roadway Segment - Node Lane Width		5.4.31.2	pathNode-width	
3.5.6.3.2.4	Broadcast Roadway Segment - Superelevation		5.4.31.1	pathNode-superelevation	
3.5.6.4	Broadcast Location Correction Details				
3.5.6.4.1	Broadcast Location Corrections Detail - NMEA	5.1.4.1			dlLocationCorrections-NMEA
			5.2.1.1	dSRCMessage	
			5.3.1.85	nMEACorrections	
3.5.6.4.2	Broadcast Location Corrections Detail - RTCM	5.1.4.2			dlLocationCorrections-RTCM
			5.2.1.1	dSRCMessage	
			5.3.1.114	rTCMCorrections	
3.5.7	Signalized Intersection Requirements				
3.5.7.1	Broadcast Signal Phase and Timing Information	5.1.6.2			dlSPAT
			5.2.1.1	dSRCMessage	
			5.3.1.141	spat	
3.5.7.1.1	Broadcast Signal Phase and Timing - Mandatory Requirements				

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.7.1.1.1	Broadcast Signal Phase and Timing - Message Identifier		5.4.15.2	dSRCMessage-sequence-number	
3.5.7.1.1.2	Broadcast Signal Phase and Timing - Intersection Identifier		5.4.19.2	intersection-identifier	
3.5.7.1.1.3	Broadcast Signal Phase and Timing - Intersection Status		5.4.20.3	intersectionSignalized-state	
3.5.7.1.1.4	Broadcast Signal Phase and Timing - Timestamp		5.4.20.4	intersectionSignalized-time	
3.5.7.1.2	Broadcast Signal Phase and Timing - Optional Requirements				
3.5.7.1.2.1	Broadcast Signal Phase and Timing - Preempt State		5.4.20.1	intersectionSignalized-preempt	
3.5.7.1.2.2	Broadcast Signal Phase and Timing - Priority State		5.4.20.2	intersectionSignalized-priority	
3.5.7.1.3	Broadcast Signal Phase and Timing - Movement Data Requirements				
3.5.7.1.3.1	Broadcast Movement - Mandatory Requirements				
3.5.7.1.3.1.1	Broadcast Movement - Lane Data		5.4.47.9	trafficSignalMovementLanes	
3.5.7.1.3.1.2	Broadcast Movement - Movement State				
3.5.7.1.3.1.2.1	Broadcast Movement - Vehicular State		5.4.47.6	trafficSignalMovement-indication-vehicle	
3.5.7.1.3.1.2.2	Broadcast Movement - Pedestrian State		5.4.47.4	trafficSignalMovement-indication-crosswalk	
3.5.7.1.3.1.2.3	Broadcast Movement - Special State		5.4.47.5	trafficSignalMovement-indication-special	
3.5.7.1.3.1.3	Broadcast Movement - Time of Change - Minimum		5.4.47.2	trafficSignalMovement-expiration-early	
3.5.7.1.3.1.4	Broadcast Movement - Time of Change - Maximum		5.4.47.3	trafficSignalMovement-expiration-late	
3.5.7.1.3.2	Broadcast Movement - Optional Requirements				
3.5.7.1.3.2.1	Broadcast Movement - Succeeding Signal Indications		5.3.1.144	trafficSignalMovementClearanceIndication	
3.5.7.1.3.2.2	Broadcast Movement - Succeeding Signal Indication Time of Change		5.4.47.1	trafficSignalMovement-clearance-duration	
3.5.7.1.3.2.3	Broadcast Movement - Pedestrian Detect		5.4.47.8	trafficSignalMovement-pedestrian-detect	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.7.1.3.2.4	Broadcast Movement - Pedestrian Call		5.4.47.7	trafficSignalMovement-pedestrian-call	
3.5.7.2	Broadcast Signal Preferential Treatment Status	5.1.6.1			dlSignalRequest
			5.2.1.1	dSRCMessage	
			5.3.1.128	signalStatusMessage	
3.5.7.2.1	Broadcast Preferential Treatment - Message Identifier		5.4.15.2	dSRCMessage-sequence-number	
3.5.7.2.2	Broadcast Preferential Treatment - Intersection Identifier		5.4.19.2	intersection-identifier	
3.5.7.2.2.1	Broadcast Preferential Treatment - Intersection Status		5.4.20.3	intersectionSignalized-state	
3.5.7.2.2.2	Broadcast Preferential Treatment - Preempt State		5.3.1.63	intersectionSignalizedPreempts	
3.5.7.2.2.3	Broadcast Preferential Treatment - Priority State		5.3.1.64	intersectionSignalizedPriorities	
3.5.7.2.2.4	Broadcast Preferential Treatment - Vehicle Source		5.3.1.165	vehicleIdentification	
3.5.8	Traveler Information Requirements				
3.5.8.1	Broadcast Traveler Information	5.1.7.1			dlTravelerInformation
			5.2.1.1	dSRCMessage	
			5.3.1.153	travelerInformation	
3.5.8.2	Broadcast Traveler Information - Mandatory Requirements				
3.5.8.2.1	Broadcast Traveler Information - Packet Identifier		5.4.50.1	travelerInformation-identifier	
3.5.8.2.2	Broadcast Traveler Information - Message Identifier Requirements				
3.5.8.2.2.1	Broadcast Traveler Advisories - Message Identifier		5.4.2.1	advisory-identifier	
3.5.8.2.2.2	Broadcast Road Sign - Message Identifier		5.3.1.112	roadsignIdentifier	
3.5.8.3	Broadcast Traveler Information - Optional Requirements				
3.5.8.3.1	Broadcast Road Sign - MUTCD Type		5.4.38.2	roadsign-type	
3.5.8.3.2	Broadcast Traveler Information - Start Time		5.4.50.7	travelerInformationItem-start-minute	
3.5.8.3.3	Broadcast Traveler Information - Start Year		5.4.50.8	travelerInformationItem-start-year	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.8.3.4	Broadcast Traveler Information - Validity Duration		5.4.50.5	travelerInformationItem-duration	
3.5.8.3.5	Broadcast Traveler Information - Importance		5.4.50.6	travelerInformationItem-priority	
3.5.8.3.6	Broadcast Traveler Information - Presentation Requirements		5.3.1.158	travelerInformationItemRegions	
3.5.8.3.6.1	Broadcast Traveler Information - Default Anchor Point Position		5.3.1.155	travelerInformationItemAnchor	
3.5.8.3.6.2	Broadcast Traveler Information - Heading Slice		5.4.36.1	region-orientation	
3.5.8.3.6.3	Broadcast Traveler Information - Circular Valid Region Requirements				
3.5.8.3.6.3.1	Broadcast Traveler Information - Circular Region - Radius		5.4.4.1	circle-radius	
3.5.8.3.6.3.2	Broadcast Traveler Information - Circular Region - Anchor Point		5.3.1.12	circleAnchor	
3.5.8.3.6.4	Broadcast Traveler Information - Polygon Valid Region Requirements				
3.5.8.3.6.4.1	Broadcast Traveler Information - Polygon Region - Offsets		5.3.1.105	polygonOffsetNodes	
3.5.8.3.6.4.2	Broadcast Traveler Information - Polygon Region - Anchor Point		5.3.1.103	polygonAnchor	
3.5.8.3.6.5	Broadcast Traveler Information - Valid Shape Point Set Region Requirements				
3.5.8.3.6.5.1	Broadcast Traveler Information - Shape Point Set - Default Direction		5.4.50.3	travelerInformationItem-default-direction	
3.5.8.3.6.5.2	Broadcast Traveler Information - Shape Point Set - Default Width		5.4.50.4	travelerInformationItem-default-width	
3.5.8.3.6.5.3	Broadcast Traveler Information - Shape Point Set - Offsets		5.3.1.126	shapePointOffsetNodes	
3.5.8.3.6.5.4	Broadcast Traveler Information - Shape Point Set - Direction		5.4.41.1	shapePoint-direction	
3.5.8.3.6.5.5	Broadcast Traveler Information - Shape Point Set - Width		5.4.41.2	shapePoint-width	
3.5.8.3.6.5.6	Broadcast Traveler Information - Shape Point Set - Node Width		5.4.41.3	shapePointOffsetNode-width	
3.5.8.3.6.5.7	Broadcast Traveler Information - Shape Point Set - Anchor Point		5.3.1.124	shapePointAnchor	
3.5.8.3.7	Broadcast Traveler Advisories - Content		5.3.1.156	travelerInformationItemContent	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
3.5.8.3.8	Broadcast Road Sign - Content		5.3.1.156	travelerInformationItemContent	
3.5.8.3.9	Broadcast Traveler Information - Uniform Resource Locator		5.4.50.10	travelerInformationItem-url-short	
			5.4.50.9	travelerInformation-url-base	
3.5.8.3.10	Broadcast Traveler Information - Valid Vehicle Type		5.4.50.2	travelerInformationItem-applicable-vehicles	
3.5.8.3.11	Broadcast Traveler Information - Parking Availability				
3.5.8.3.11.1	Broadcast Parking Availability - Mandatory Requirements		5.3.1.87	parkingInformation	
3.5.8.3.11.2	Broadcast Parking Availability - Optional Requirements				
3.5.8.3.11.2.1	Broadcast Parking Availability - Location Description		5.4.30.1	parkingInformation-description	
3.5.8.3.11.2.2	Broadcast Parking Availability - Availability Time		5.3.1.91	parkingSpacesFromTime	
3.5.8.3.11.2.3	Broadcast Parking Availability - Availability End Time		5.3.1.94	parkingSpacesToTime	
3.5.9	Vehicle Mayday Transmission				
3.5.9.1	Broadcast Mayday Message	5.1.1.6			dlMaydayForward
			5.2.1.1	dSRCMessage	
			5.3.1.79	maydayMessage	
3.5.9.1.1	Broadcast Mayday Message - Mandatory Requirements				
3.5.9.1.1.1	Broadcast Mayday - Vehicle Location		5.3.1.80	maydayPosition	
3.5.9.1.1.2	Broadcast Mayday - Timestamp		5.3.1.81	maydayTime	
3.5.9.1.1.3	Broadcast Mayday - Event		5.4.26.2	mayday-type	
3.5.9.1.2	Broadcast Mayday - Optional Requirements				
3.5.9.1.2.1	Broadcast Mayday - Number of Airbags		5.4.51.1	vehicle-airbags-deployed	
3.5.9.1.2.2	Broadcast Mayday - Vehicle Make Model and Fuel Type		5.3.1.170	vehicleModel	
3.5.9.1.2.3	Broadcast Mayday - Hazmat Codes		5.3.1.52	hazmatList	
3.5.9.1.2.4	Broadcast Mayday - Placards		5.3.1.101	placardList	
3.5.9.2	Forward Mayday				
3.5.9.2.1	Receive Mayday Broadcasts	5.1.1.5			dlMaydayForward
			5.2.1.1	dSRCMessage	
			5.3.1.79	maydayMessage	
3.5.9.2.2	Forward Mayday Broadcasts		5.2.1.1	dSRCMessage	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
			5.3.1.47	forwardedMessage	
3.5.10	Vehicle Manufacturers / Fleet Operator Requirements				
3.5.10.1	Transfer Fleet Data to a Connected Vehicle	5.1.2.1			dlAlaCarte
			5.2.1.1	dSRCMessage	
			5.3.1.2	alaCarte	
3.5.10.2	Transfer Fleet Data from a Connected Vehicle	5.1.2.1			dlAlaCarte
			5.2.1.1	dSRCMessage	
			5.3.1.2	alaCarte	
3.6	Supplemental Non-Communications Requirements				
3.6.1	Performance Requirements				
3.6.1.1	Transmission Requirements				
3.6.1.2	Device Identifier				
3.6.1.2.1	Change Device Identifier on Security Certificate	5.1.1.1			dlBasicSafetyMessage
			5.4.51.8	vehicle-bsm-part1-oer	
3.6.1.2.2	Change Device Identifier on Identifier Conflict		5.4.51.8	vehicle-bsm-part1-oer	
3.6.1.2.3	Randomized Change - Device Identifier		5.4.51.8	vehicle-bsm-part1-oer	
3.6.1.3	Message Identifier	5.1.1.1			dlBasicSafetyMessage
			5.4.51.8	vehicle-bsm-part1-oer	
3.6.1.4	Path History				
3.6.1.4.1	Path History - Data Points	5.1.1.1			dlBasicSafetyMessage
			5.4.54.2	vehiclePathPoint-latitude-offset	
			5.4.54.3	vehiclePathPoint-longitude-offset	
			5.4.54.1	vehiclePathPoint-elevation-offset	
3.6.1.4.2	Path History - Position Error Tolerance		5.3.1.97	pathHistoryPointType01List	
			5.3.1.73	locationAccuracy	
3.6.1.5	Probe Data				
3.6.1.5.1	Snapshot Generation				
3.6.1.5.1.1	Initial Snapshot	5.1.5.2			dlProbeDataExchange
			5.3.1.137	snapshots	
3.6.1.5.1.2	Periodic Snapshot				
3.6.1.5.1.2.1	Periodic Snapshot - Default		5.3.1.137	snapshots	

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
			5.3.1.130	snapshotControl	
3.6.1.5.1.2.2	Periodic Snapshot - Stops		5.3.1.137	snapshots	
			5.3.1.138	snapshotStop	
3.6.1.5.1.3	Event Snapshot		5.3.1.137	snapshots	
3.6.1.5.1.4	Start and Stop Snapshots				
3.6.1.5.1.4.1	Snapshot - Vehicle Stop		5.3.1.137	snapshots	
			5.4.44.3	snapshotStop-last	
			5.4.44.5	snapshotStop-time	
3.6.1.5.1.4.2	Snapshot - Vehicle Start		5.3.1.137	snapshots	
			5.4.44.4	snapshotStop-start	
3.6.1.5.2	Snapshot Deletion				
3.6.1.5.2.1	Delete Snapshot - Transmission	5.1.5.2			dlProbeDataExchange
			5.3.1.129	snapshot	
3.6.1.5.2.2	Delete Snapshot - Expiration		5.3.1.129	snapshot	
3.6.1.5.2.3	Delete Snapshot - Vehicle Turned Off		5.3.1.129	snapshot	
3.6.1.5.3	Probe Segment Number (PSN)				
3.6.1.5.3.1	Change PSN	5.1.5.2			dlProbeDataExchange
			5.4.35.2	probe-segment-number	
3.6.1.5.3.2	PSN - Gap		5.4.35.2	probe-segment-number	
3.6.2	Security Requirements				
3.6.2.1	Authentication	4.3.1	IEEE 1609.2		
3.6.2.2	Data Integrity	4.3.1	IEEE 1609.2		
3.6.2.3	Uniqueness	4.3.1	IEEE 1609.2		
G.2	Performance Requirements - Message Transmission Rates				
G.2.1	Transmission Rates - Broadcast Vehicle Information				
G.2.1.1	Requirements to Broadcast Vehicle Information	5.1.1.1			dlBasicSafetyMessage
			5.2.1.1	dSRCMessage	
			5.3.1.5	basicSafetyMessage	
G.2.1.2	Transmission Rate Requirements - Broadcast Vehicle Information (Critical)				
G.2.1.2.1	Minimum Transmission Rate - Broadcast Vehicle Information (Critical)		5.2.1.1	dSRCMessage	
			5.3.1.5	basicSafetyMessage	

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
G.2.1.2.2	Maximum Transmission Rate - Broadcast Vehicle Information (Critical)		5.2.1.1	dSRCMessage	
			5.3.1.5	basicSafetyMessage	
G.2.1.2.3	Default Transmission Rate - Broadcast Vehicle Information (Critical)		5.2.1.1	dSRCMessage	
			5.3.1.5	basicSafetyMessage	
G.2.1.3	Transmission Rate Requirements - Broadcast Vehicle Information				
G.2.1.3.1	Minimum Transmission Rate - Broadcast Vehicle Information		5.2.1.1	dSRCMessage	
			5.3.1.5	basicSafetyMessage	
G.2.1.3.2	Maximum Transmission Rate - Broadcast Vehicle Information		5.2.1.1	dSRCMessage	
			5.3.1.5	basicSafetyMessage	
G.2.1.3.3	Default Transmission Rate - Broadcast Vehicle Information		5.2.1.1	dSRCMessage	
			5.3.1.5	basicSafetyMessage	
G.2.2	Transmission Rate Requirements - Request Vehicle Information				
G.2.2.1	Maximum Transmission Rate - Request Vehicle Information	5.1.1.3			dlCommonSafetyRequest
			5.2.1.1	dSRCMessage	
			5.3.1.32	commonSafetyRequest	
G.2.2.2	Maximum Response Time - Request Vehicle Information		5.2.1.1	dSRCMessage	
			5.3.1.32	commonSafetyRequest	
G.2.3	Transmission Rate Requirements - Broadcast Intersection Infringement				
G.2.3.1	Minimum Transmission Rate - Broadcast Intersection Infringement	5.1.1.4			dlIntersectionInfringement
			5.2.1.1	dSRCMessage	
			5.3.1.58	intersectionInfringement	
G.2.3.2	Maximum Transmission Rate - Broadcast Intersection Infringement		5.2.1.1	dSRCMessage	
			5.3.1.58	intersectionInfringement	
G.2.3.3	Default Transmission Rate - Broadcast Intersection Infringement		5.2.1.1	dSRCMessage	
			5.3.1.58	intersectionInfringement	

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
G.2.4	Transmission Rates - Signal Preferential Treatment				
G.2.4.1	Maximum Transmission Rate - Request Signal Preferential Treatment	5.1.6.1			dlSignalRequest
			5.2.1.1	dSRCMessage	
			5.3.1.127	signalRequestMessage	
G.2.4.2	Maximum Response Time - Request Signal Preferential Treatment		5.2.1.1	dSRCMessage	
			5.3.1.127	signalRequestMessage	
G.2.5	Transmission Rate Requirements - Commercial Vehicle Information				
G.2.5.1	Maximum Broadcast Rate - Commercial Vehicle Information[7]	5.1.3.1			
			5.2.1.2	serviceAdvertisementMsg	
			IEEE1609.2:8.2	WaveServiceAdvertisement	
		5.1.3.4			
			5.2.1.2	serviceAdvertisementMsg	
			IEEE1609.2:8.2	WaveServiceAdvertisement	
G.2.5.2	Default Broadcast Rate - Commercial Vehicle Information[7]	5.1.3.1			
			5.2.1.2	serviceAdvertisementMsg	
			IEEE1609.2:8.2	WaveServiceAdvertisement	
		5.1.3.4			
			5.2.1.2	serviceAdvertisementMsg	
			IEEE1609.2:8.2	WaveServiceAdvertisement	
G.2.5.3	Maximum Response Time - Commercial Vehicle Information Requests[7]	5.1.3.1			
			5.2.1.1	dSRCMessage	

[7] This requirement may apply to more than one dialog. The requirement applies to a dialog only if the dialog is needed to fulfill another requirement. For example, if Requirement 3.5.3.1.1 is selected in the PRL, then Dialog ID 5.1.3.1 is needed to fulfill Requirement 3.5.3.1.1. Thus, Requirement G.2.5.1 applies to Dialog ID 5.1.3.1. If Dialog ID 5.1.3.4 is not needed to fulfill any requirement in the PRL, then Requirement G.2.5.1 does not apply Dialog ID 5.1.3.4.

Requirements Traceability Matrix (RTM)					
FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
			5.3.1.30	commercialVehicleData	
		5.1.3.2			
			5.2.1.1	dSRCMessage	
			5.3.1.25	commercialScreeningAcknowledgement	
		5.1.3.3			
			5.2.1.1	dSRCMessage	
			5.3.1.28	commercialVehicleAcknowledgement	
		5.1.3.4			
			5.2.1.1	dSRCMessage	
			5.3.1.27	commercialScreeningResults	
G.2.5.4	Default Re-Transmission Rate - Commercial Vehicle Information (RSU) [7]	5.1.3.1			
			5.2.1.1	dSRCMessage	
			5.3.1.31	commercialVehicleRequest	
			5.3.1.29	commercialVehicleClearance	
		5.1.3.2			
			5.2.1.1	dSRCMessage	
			5.3.1.26	commercialScreeningData	
		5.1.3.3			
			5.2.1.1	dSRCMessage	
			5.3.1.29	commercialVehicleClearance	
		5.1.3.4			
			5.2.1.1	dSRCMessage	
			5.3.1.31	commercialVehicleRequest	
G.2.5.5	Default Re-Transmission Rate - Commercial Vehicle Information (CMV) [7]	5.1.3.2			
			5.2.1.1	dSRCMessage	
			5.3.1.25	commercialScreeningAcknowledgement	
G.2.5.6	Maximum Re-Transmission Time - Commercial Vehicle Information[7]	5.1.3.1			
			5.2.1.1	dSRCMessage	
			5.3.1.31	commercialVehicleRequest	
			5.3.1.29	commercialVehicleClearance	
		5.1.3.2			

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
			5.2.1.1	dSRCMessage	
			5.3.1.26	commercialScreeningData	
		5.1.3.3			
			5.2.1.1	dSRCMessage	
			5.3.1.29	commercialVehicleClearance	
		5.1.3.4			
			5.2.1.1	dSRCMessage	
			5.3.1.31	commercialVehicleRequest	
G.2.6	Transmission Rate Requirements - Sharing Probe Data				
G.2.6.1	Maximum Transmission Rate - Broadcast Probe Data Service	5.1.5.2			dlProbeDataExchange
			5.2.1.1	dSRCMessage	
			5.3.1.109	probeVehicleData	
G.2.6.2	Default Transmission Rate - Broadcast Probe Data Service	5.1.5.2			dlProbeDataExchange
			5.2.1.1	dSRCMessage	
			5.3.1.109	probeVehicleData	
G.2.7	Transmission Rate Requirements - Probe Data Management				
G.2.7.1	Maximum Transmission Rate - Broadcast Probe Data Management	5.1.5.1			dlProbeDataManagem ent
			5.2.1.1	dSRCMessage	
			5.3.1.106	probeDataManagement	
G.2.7.2	Default Transmission Rate - Broadcast Probe Data Management	5.1.5.1			dlProbeDataManagem ent
			5.2.1.1	dSRCMessage	
			5.3.1.106	probeDataManagement	
G.2.8	Transmission Rate Requirements - Broadcast Roadway Geometrics Information				
G.2.8.1	Minimum Transmission Rate - Broadcast Roadway Geometrics Information	5.1.4.3			dlMapData
			5.2.1.1	dSRCMessage	
			5.3.1.76	mapData	
G.2.8.2	Maximum Transmission Rate - Broadcast Roadway Geometrics Information	5.1.4.3			dlMapData

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
			5.2.1.1	dSRCMessage	
			5.3.1.76	mapData	
G.2.8.3	Default Transmission Rate - Broadcast Roadway Geometrics Information	5.1.4.3			dlMapData
			5.2.1.1	dSRCMessage	
			5.3.1.76	mapData	
G.2.9	Transmission Rate Requirements - Location Corrections Detail Broadcasts				
G.2.9.1	Minimum Transmission Rate - Location Corrections Detail Broadcasts[8]	5.1.4.1			dlLocationCorrections-NMEA
			5.2.1.1	dSRCMessage	
			5.3.1.85	nMEACorrections	
G.2.9.1	Minimum Transmission Rate - Location Corrections Detail Broadcasts[8]	5.1.4.2			dlLocationCorrections-RTCM
			5.2.1.1	dSRCMessage	
			5.3.1.114	rTCMCorrections	
G.2.9.2	Default Transmission Rate - Location Corrections Detail Broadcasts[8]	5.1.4.1			dlLocationCorrections-NMEA
			5.2.1.1	dSRCMessage	
			5.3.1.87	nMEACorrections	
G.2.9.2	Default Transmission Rate - Location Corrections Detail Broadcasts[8]	5.1.4.2			dlLocationCorrections-RTCM
			5.2.1.1	dSRCMessage	
			5.3.1.114	rTCMCorrections	
G.2.10	Transmission Rate Requirements - Broadcast Signal Phase and Timing Information				
G.2.10.1	Minimum Transmission Rate - Broadcast Signal Phase and Timing Information	5.1.6.2			dlSPAT
			5.2.1.1	dSRCMessage	
			5.3.1.141	spat	

[8] This requirement may apply to more than one dialog. The requirement applies to a dialog only if the dialog is needed to fulfill another requirement. For example, if Requirement 3.5.6.4.1 is selected in the PRL, then Dialog ID 5.1.4.1 is needed to fulfill Requirement 3.5.6.4.1. Thus, Requirement G.2.9.1 applies to Dialog ID 5.1.4.1. If Dialog ID 5.1.4.1 is not needed to fulfill any requirement in the PRL, then Requirement G.2.9.1 does not apply Dialog ID 5.1.4.1.

Requirements Traceability Matrix (RTM)

FR ID	Functional Requirement	Dialog ID	Object ID	Object Name	Additional Specifications
G.2.10.2	Maximum Transmission Rate - Broadcast Signal Phase and Timing Information	5.1.6.2			dlSPAT
			5.2.1.1	dSRCMessage	
			5.3.1.141	spat	
G.2.10.3	Default Transmission Rate - Broadcast Signal Phase and Timing Information	5.1.6.2			dlSPAT
			5.2.1.1	dSRCMessage	
			5.3.1.141	spat	
G.2.11	Transmission Rate Requirements - Broadcast Traveler Information				
G.2.11.1	Maximum Transmission Rate - Broadcast Traveler Information	5.1.7.1			dlTravelerInformation
			5.2.1.1	dSRCMessage	
			5.3.1.153	travelerInformation	
G.2.11.2	Default Transmission Rate - Broadcast Traveler Information	5.1.7.1			dlTravelerInformation
			5.2.1.1	dSRCMessage	
			5.3.1.153	travelerInformation	
G.2.12	Transmission Rate Requirements - Broadcast Mayday				
G.2.12.1	Minimum Transmission Rate - Broadcast Mayday	5.1.1.6			dlMayday
			5.2.1.1	dSRCMessage	
			5.3.1.79	maydayMessage	
G.2.12.2	Maximum Transmission Rate - Broadcast Mayday	5.1.1.6			dlMayday
			5.2.1.1	dSRCMessage	
			5.3.1.79	maydayMessage	
G.2.12.3	Default Transmission Rate - Broadcast Mayday	5.1.1.6			dlMayday
			5.2.1.1	dSRCMessage	
			5.3.1.79	maydayMessage	
G.2.13	Maximum Response Time - Ad Hoc Messages	5.1.2.1			dlAlaCarte
			5.2.1.1	dSRCMessage	
			5.3.1.2	alaCarte	

APPENDIX B
OBJECT TREE
[INFORMATIVE]

Appendix B is reserved for the assignment of object identifiers for the SAE J2735 standard. If object identifiers are assigned, it is expected that SAE would be responsible for assigning a root node for SAE J2735 in the future. SAE will also be responsible for managing OID assignments of SAE J2735 data concepts below the SAE J2735 root node.

APPENDIX C
TEST PROCEDURES
[NORMATIVE]

Appendix C is reserved for the test procedures for the SAE J2735 standard.

APPENDIX D
DOCUMENTATION OF REVISIONS
[INFORMATIVE]

Appendix D identifies the changes that have been made to SAE J2735 to develop the J2735 SE candidate. The primary purpose of J2735 SE is to provide a systems engineering version of the SAE J2735 standard. As part of the systems engineering process a set of user needs were defined based upon the data concepts currently in SAE J2735 version 2 and additional inputs provided by stakeholders. From these user needs a set of requirements were defined that fully address the user needs and are mapped to the data concepts. While the user needs and requirements of SAE J2735 SE did not exist in SAE J2735 version 2, the scope of interface definition covered by SAE J2735 SE covers the scope implied by the designs of SAE J2735 version 2, with additions in the following areas:

- Commercial vehicle credentialing, clearance, and inspection
- Transit related safety applications including vehicle crash warning and pedestrian and Turning Vehicle Crash Warning
- Road weather (additional data concepts relating to weather forecasting)
- Environmental data (additional data concepts to support Aeris applications)

The following changes were made in the SAE J2735 SE candidate design content (dialogs, messages, data frames and data elements) compared with SAE J2735 version 2:

- **ISO14817.** The definition of each data concept was changed to meet the ISO 14817 standard in the SAE J2735 SE candidate. The most substantial change is that ISO 14817 defines a naming convention for data concepts. Thus, many of the names for the existing data concepts in SAE J2735 version 2 have been changed to meet this requirement.
- **Dialogs.** Standardized dialogs were added to the SAE J2735 SE candidate - SAE J2735 v2 does not include the concept of dialogs. Dialogs define the sequence of events and message. Dialogs were developed to satisfy every user need defined in SAE J2735 SE candidate - a single dialog might satisfy multiple user needs.
- **Messages.**
  - The structure of the messages was updated in the SAE J2735 SE candidate. In SAE J2735 v2, the messages are not truly single protocol ASN.1 messages - i.e., an off the shelf ASN.1 tool cannot be used to decode the messages because the ASN.1 does not include the explicit logic to distinguish among message types. There is currently a data element called message-type, but it is a field in the message. An off-the-shelf parser will not understand the meaning of this field, it only knows that it is a field - but since that field is dictating the format of the rest of the message, the rest of the message cannot properly be decoded.
  - Two messages were deleted from the SAE J2735 v2 in the SAE J2735 SE candidate - MSG_EmergencyVehicleAlert and MSG_RoadsideAlert. No user needs (and thus no requirements) were defined for either message in SAE J2735 SE. There were some requirements that could potentially be fulfilled by MSG_RoadsideAlert, but they were fulfilled by MSG_TravelerInformationMessage instead. To support requirements and needs previously fulfilled by MSG_RoadsideAlert, some previously mandatory data elements in the MSG_TravelerInformationMessage were made optional.
  - Several new messages were added in the SAE J2735 SE candidate. A pair of messages were added based on the user needs related to mayday. Seven messages were added to support user needs related to commercial vehicles.

- Data Frames:
  - Several new data frames were added based on user needs defined for SAE J2735 SE. candidate. For example, a data frame was added to support weather data, based on user needs and requirements provided by the USDOT Road Weather Information program.
  - Some data frames were modified to remove redundant information. The philosophy was that a piece of information should be transmitted only once. For example, MSG_BasicSafetyMessage consists of a data frame DF_VehicleSafetyExtension, which contains another data frame DF_RTCMPackage. However, DF_RTCMPackage consists of another data frame, DF_FullPositionVector, which contains data elements that already exist elsewhere in the MSG_BasicSafetyMessage. Since all the information in DF_FullPositionVector already exists in MSG_BasicSafetyMessage, the DF_FullPositionVector data frame was removed from DF_RTCMPackage in SAE J2735 SE.
  - Some data frames were updated so that the encoding rules for each data concept can be applied consistently, not only within the data frame, but also for messages that reference that data frame.
- Data Elements:
  - Data elements were added if SAE J2735 v2 did not define a data concept that fully fulfilled a requirement defined in the SAE J2735 SE candidate.
  - Data elements were deleted if no user needs (or requirements) were defined for that data element. For example, no requirements were defined for confidence data elements, such as DE_AccelerationConfidence, DE_ElevationConfidence, DE_HeadingConfidence, and DE_PositionConfidence, thus they were removed.

Data elements were modified only if errors were found; to fully fulfill a requirement defined in SAE J2735 SE candidate, or if a potentially better solution was defined. A solution was defined to be better if there were some limitations with the existing data concept that were removed, or if it improves bandwidth efficiency.

APPENDIX E
USER REQUESTS
[INFORMATIVE]

This appendix documents user requests that are not included in this standard. The requests were identified during the stakeholder review process but represent capabilities that will not be implemented for several years. In many cases the exact nature of their implementation is a subject of ongoing research.

E.1 ELECTRONIC PAYMENTS

The requirements of an on-board financial transaction based on an electronic wallet or credit card are not included in the standard. These transactions typically require multiple interactions between the vehicle, the payment processor and a bank. Such dialogs will require timely transactions from systems outside of the DSRC environment that are outside the control of the standard. This document does provide for off-board transactions where the accounting function is outside of the connected vehicle environment and only a unique identifier is transmitted. This identifier is then used for transactions outside the Connected Vehicle environment.

E.2 V2V USER NEEDS

E.2.1 Tailgating Advisory

The host vehicle needs to receive an advisory when the host vehicle is too close to a remote vehicle in front of it. This feature enables the host vehicle to warn the driver if the host vehicle is following another vehicle too closely, creating an unsafe driving condition.

E.2.2 Enter a Platoon

The host vehicle needs to determine the conditions of nearby remote vehicles in order to enter into a platoon formation. This capability is intended to enable advanced cruise control, where vehicles can effectively create a platoon, which relieves stress on the driver and provides efficiencies in fuel usage.

E.2.3 Operate in a Platoon

TBD - these specific needs will be developed later.

E.2.4 Leave a Platoon

TBD - these specific needs will be developed later.

E.3 V2I USER NEEDS

E.3.1 Commercial Vehicle User Needs

E.3.1.1 Container/ Chassis Operating Data

The commercial vehicle operator needs to monitor the operating status of container(s) and chassis (es) (or trailer) being transported. This capability allows the commercial vehicle driver (and fleet operator) to monitor the operating status of the containers or chassis. Such data may include temperature, humidity, battery levels, etc. This capability could be implemented through the power unit providing information for the containers or chasses, or the information could be transmitted from each container or chassis directly to the infrastructure.

E.3.1.2 Container Contents

Security and public safety agencies need to identify the contents of a container. This capability enables law enforcement and security agencies to identify container contents in support of security and incident response functions. This capability is particularly relevant at ports and international borders.

E.3.2 Traveler Related User Needs

E.3.2.1 Electric Charging Stations Management

Transportation agencies (or private companies operating electric charging stations) need information from the electric vehicle to manage the charging operation. This capability enables the agency or company operating the electric vehicle charging station to manage the charging process. The agency or company can use vehicle information such as the capability of the vehicle (e.g., operational status of the electrical system, how many amps can the vehicle handle, and % charge complete) to determine that the charge is being properly applied and determine an estimated time to complete charging.

E.3.2.2 Pedestrian Awareness

Pedestrians need to be aware of the situational status of an intersection. This capability improves pedestrian safety by providing situational status information to pedestrians, including signal status and the status of approaching vehicles.

E.3.2.3 Payment for Services

The driver and travelers need to be able to pay for a variety of transportation related services. This capability enables travelers to pre-pay or pay for tolling, parking, fuel/electric charging purchase, VMT, and other fee based services where a payment mechanism is needed.

E.3.3 Transit Operation Needs

E.3.3.1 Garage Parking Management

Transit operators need to manage transit vehicle pull-in to the garage or vehicle queuing upon pull-out from the garage. This capability enables transit agencies to improve the management of transit vehicles pulling into or exiting transit garages. This capability also supports dynamic assignment of routes for buses pulling into the garage.

E.3.3.2 Connection Protection

Transit vehicle drivers need to receive dynamic schedule adjustments to support connection protection for transit users. This capability will enable transit agencies to better manage and schedule the connection process (e.g., change from bus to bus or bus to another mode) for transit passengers. This capability allows the transit driver to receive dynamic schedule adjustments to facilitate travelers transferring from one route (or mode) to another.

E.3.3.3 Transit Stop Request

Transit vehicles need to know if a transit stop is requested by a transit user at a roadside stop. This capability allows a transit vehicle to know that a passenger has requested a transit stop from an infrastructure device. This capability could impact the granting of a transit signal priority request.

E.3.3.4 Transit Operations Information

Transit agencies need to provide transit operations information to the transit vehicles. This capability enables transit agencies, either via V2V or V2I communications, to send to the transit vehicle transit operations information, such as schedule updates, connection information, and stop announcements to transit vehicles and to the transit driver.

E.3.3.5 Vehicle Data for Transit Operations

E.3.3.5.1 Passenger Data

Transit agencies need to collect passenger data from the transit vehicle to support operations and reporting requirements. This capability supports the reporting requirements for transit agencies, which include the collection of the numbers and type of passengers on-board a transit vehicle. Passenger data could also include information such as the ADA seating availability and the number of open bicycle rack places. Passenger data is also used to support transportation demand management strategies, fare collection determination, transit planning purposes, and support improvements in the operations of the transit system.

E.3.3.5.2 Transit Vehicle Location

Transit agencies need to collect transit vehicle location information. This capability enables a transit agency to determine schedule performance and to provide transit arrival announcements at transit stops. Frequent transit vehicle location updates also provide improved performance and efficiency for the transit agency.

E.3.3.5.3 Transit Vehicle Operating Data

Transit agencies need to collect vehicle data to support vehicle maintenance operations. This capability enables transit agencies to improve transit vehicle maintenance practices, by allowing transit vehicles to be brought into the maintenance garage if needed, or allowing the transit vehicle to stay in service if it doesn't need maintenance. Vehicle data includes operating data (e.g. oil temperature) and diagnostic data (e.g., oil temperature alarm) available on the transit vehicles.

APPENDIX F
INFORMATIVE APPENDICIES
[INFORMATIVE]

F.1 MESSAGE PRIORITY

When a message is passed to lower layers for transmission its Message Priority should be made available as well so that the lower layers can properly account for the message's urgency and importance when scheduling its transmission. This is the only common management information defined in SAE J2735.

F.1.1 Priority Related Term

It is important for this discussion to note the meanings and differences between some priority-related terms used in various standards:

- **User Priority:** As described within IEEE WG 1609 (1609.3 and 1609.4), a three bit field represents User Priority which determines how a given Medium Access Control (MAC) sub layer frame competes with other MAC frames for access to the wireless medium. The priorities range from zero to seven (0-7) where 7 is highest. Transmission priority 0 is higher than transmission priorities 2 and 1 due to historical IEEE development evolution as a way to add a 'new' lowest priority. Note that the default transmission priority is 0. Please note that SAE J2735 priorities are not limited to the case where messages are carried in 1609 packets.

- **Access Category:** As defined in the IEEE 802.11 standard, an access category is related to the user priority and ranges from 0 to 3 where 3 is highest. Access Category is related to transmission priority as follows:

    - Transmission Priorities 7 and 6 are Access Category 3.
    - Transmission Priorities 5 and 4 are Access Category 2.
    - Transmission Priorities 3 and 0 are Access Category 1.
    - Transmission Priorities 2 and 1 are Access Category 0.

The following table lists all Transmission Priorities from highest to lowest as well as their corresponding Access Category:

TABLE F1 - TRANSMISSION PRIORITY VERSUS ACCESS CATEGORY

Priority		Access Category
7	Highest	AC3
6		
5		AC2
4		
3		AC1
0		
2		AC0
1	Lowest	

- **Message Priority (as considered in this Appendix):** The Message Priority is a function only of the message type and the message contents. It represents the combination of message urgency and importance. It is independent of lower layer protocols. Recommended Message Priorities are shown below, using a scale of 1 to 7, with 7 representing the highest priority. Conformance to this standard does not require that an implementation support Message Priority, or that it use the specific values in this appendix. Message Priority is not defined as a data element or conveyed within any of the message sets of this standard.

The main purpose of the Message Priority is to serve as input to the protocol at the next lower layer in a transmitting device. If the lower layer protocol supports a prioritization behavior, it might use the Message Priority in determining how to treat a given message. This standard recommends that the interface between the message layer and the lower layer allow the Message Priority to be passed down along with a message. Note that the criteria used in determining Message Priority may not match the service objectives of a lower layer priority mechanism, so caution should be observed in using the Message Priority. In particular, the similarity between the Message Priority scale (1 to 7) and the IEEE 1609 User Priority scale (0 to 7) does not imply that a simple mapping is appropriate.

Message Priority is a relative metric. The comparison of the Message Priorities of two messages is only appropriate if they contend for access on the same channel. If messages composed according to this standard are transmitted over IEEE 1609 lower layers that recognize the Control Channel (CCH) and Service Channel (SCH) designations, there is no relevance to the comparison of the Message Priority of a message sent on the CCH (e.g. a Basic Safety Message) to the Message Priority of a message sent on one of the SCHs (e.g. electronic toll collection).

- **Provider Service Identifier (PSID):** As described within IEEE WG 1609.3, the PSID is a number that identifies a service provided by an application. A PSID has no relevance for the SAE J2735 defined message priority. It is related to service priority and is considered out of scope here.

- **Display Priority:** A receiver may define a priority associated with displaying messages. This would likely be proprietary to the OEM deploying the receiver and is out of scope for this discussion.

- **travelerInformationItem-priority:** This data element is used in a DSRC message set to establish the relative importance of certain traveler information items (messages) with respect to other similar items of the same type. It is not a display priority (although it may factor into display ordering algorithms), nor is it a transmission priority for lower layers.

- **Other Priorities:** This section is limited to those priority concepts that are contained in this standard or may directly interface with it. Other priority concepts exist that are relevant to somebody using this standard, such as may appear in applications or lower layers, but these are not defined here.

F.1.1.1 Message Priority Enforcement

This appendix is intended only to provide guidance for recommended priority assignments to messages and message sets. Neither the Technical Committee nor its associated subcommittees are chartered to police or enforce the J2735 defined application layer priorities detailed here; such enforcement will be, in all likelihood, the responsibility of an empowered governmental agency. This appendix and its associated table are simply a tool to promote harmony and communication within a DSRC community.

F.1.1.2 Message Priority Table

J2735 Message Priority is based upon a balance between the importance and urgency of a message to be transmitted; the interpretation of the terms being as follows:

- **Importance:** The first level of priority is associated with societal and/or safety impact, and prioritizes safety above all other applications and/or communications. The greater the potential for saving life or preventing injury, the higher the importance the message and message sets receive. Though this is as per the USA Federal Communications Commission, there is no intent to limit this guideline to any single country.

- **Urgency:** Many applications are predicated upon allowable communications latency. The range of that latency defines the urgency of the message; if the message requires quick transfer from sender to listener, it has a higher associated urgency.

Each row in the Message Priorities table includes an example application and suggested message priority. In addition, an estimate of the allowable latency is provided as an indication of urgency.

F.1.1.3 Adjusting Priority

Although the J2735 Message Priority table indicates a single priority for each message set, in practice priority is an attribute of a specific message. The priority of a specific message can be raised or lowered, compared to the default priority in the table, according to the policies of the transmitting device. For example, the priority of a Basic Safety Message (BSM) that includes a “hard brake" status might be set higher than the priority of a BSM without such an indication.

F.1.1.4 Latency Ranges

In this appendix, three latency (urgency) ranges are used:

- Less than 10 ms (ms)
- Between 10 and 20 ms
- Greater than 20 ms

In some cases the transmission channel may be unavailable upon the occurrence of an event, e.g., if a device occasionally switches to another channel. In general, the latency interval begins at the later of the event time and the channel availability time.

F.1.1.5 General Message Priority Scheme

The general message priority scheme is:

TABLE F2 - GENERAL MESSAGE PRIORITY SCHEME

Importance		**Urgency**	
	< 10 msec	from 10 to 20 msec	>20 msec
Safety of Life	7	5	3
Public Safety	6	4	3
Non-Priority	2	1	1

F.1.1.6 Message Priority Table

The Message Priority Table below incorporates the current and probable message sets (designated as examples):

TABLE F3 - MESSAGE PRIORITY TABLE

Importance Level from USA FCC Policy		Description (When to apply a specific urgency level)	Latency for Reception (urgency)		J2735 Message Sets and Example(s)	Default Message Priority
1 = Safety of Life Applies to those Messages and Message Sets associated with societal and/or safety impact related to human life.		Emergency Impact mitigation and injury avoidance/mitigation	< 10 ms		Crash-Pending Notification (Example)	7
		Emergency Potential-event impact and/or injury mitigation and avoidance	< 10 ms		Pre-Crash (Example)	7
		Urgent Warning Events (using Event Flags)	< 10 ms		Basic Safety + Hard-Brake (Collision Warning, EEBL, Anti -Lock, etc.)	7
		Periodic public safety status information	10 to 20 ms		Basic Safety Message	5
		Urgent warning of impending local situation	10 to 20 ms		Emergency Vehicle Alert	5
		Situation-based status information of uninvolved local interest	10 to 20 ms		ATIS Roadside Alerts (e.g. Accident)	5
		Potential-situation information of uninvolved local interest	> 20 ms		ATIS Probable-situation (e.g. Rapidly deteriorating dangerous conditions)	3
2 = Public Safety (Safety not in 1) Applies to Road Side Units (RSU) and On-Board Units (OBUs) operated by state or local governmental entities presumptively engaged in public safety priority communications. (Includes Mobility and Traffic Management Features)		Urgent public safety downloads (Intersection Information)	< 10 ms		SPAT (Signal Phase and Timing)	6
		Public safety data transactions, exchanges	< 10 ms		Electronic Toll Collection (Example)	6
		Public safety geospatial context information	10 to 20 ms		GID message (Geospatial Context)	4
		Semi-urgent public safety link establishment	10 to 20 ms		Lane Coordination; Cooperative ACC (Example)	4
		Public safety RTCM GPS correction information	10 to 20 ms		RTCM GPSC (GPS Correction)	4
		Semi-urgent public safety data and application enabler	> 20 ms		Services Table, Digital Map Download (Example)	3
		Important Traffic Management status information enabler	> 20 ms		ATIS Alerts (e.g., Highway Closed Ahead)	3
		Important Announcement of Services	> 20 ms		WSA message (WAVE Service Announcement)	3
		Non-urgent Traffic Management Foundational Data	> 20 ms		Probe Messages, Localized warning zones update	3
3 = Non-Priority Communications (Not in 1 or 2) Applies to Fleet Management, Traveler Information Services and Private Systems.		Urgent, private mobility message	< 10 ms		On-Board Navigation Reroute Instructions	2
		Urgent, private and commercial electronic transactions	< 10 ms		Electronic Payments	2
		Semi-Urgent, private mobility data and electronic transactions	10 to 20 ms		Commercial applications (e.g., GPS driving instructions)	1
		Important, private and commercial electronic transactions	10 to 20 ms		Large commercial transactions (E-Commerce)	1

Importance Level from USA FCC Policy		Description (When to apply a specific urgency level)	Latency for Reception (urgency)		J2735 Message Sets and Example(s)	Default Message Priority
		Background, private mobility data downloads and upgrades	> 20 ms		Area map or database download or upgrade	1

Note that the relative priority of this message represents SAE J2735's judgment of the importance and urgency of this type of message. However, when sent over the 1609/802.11 stack there is likely to be no choice but to send it in the highest priority access category. This is because 802.11 mandates that management frames be in this category (i.e., AC_VO), and a WSA will almost certainly be encapsulated in one or another type of 802.11 management frame.

F.2 THE SAFETY MESSAGE HANDLER

This appendix describes examples of vehicle safety applications aimed at preventing collisions. The Safety Message Handler is focused on that same type of safety application, though it can also be applied more broadly. These safety applications generally compare the state of a host vehicle with the states of remote vehicles, and take some action, e.g. driver warning, when a threat of collision is detected. Each application tracks a set of state variables, many of which are of common concern to other applications, and some of which are application-specific. As the name implies, the basicSafetyMessage (BSM) is designed to support the collective communication needs of a set of safety applications. Rather than transmit a series of single-application messages, a vehicle sends one BSM whose contents convey all aspects of the vehicle's current state that are relevant to at least one application. This feature of the communication architecture saves bandwidth resources by suppressing redundant information and avoiding extra per-packet protocol overhead. It also saves processing resources in the sender and especially in the receiver. Finally, it simplifies application designs by separating them from details of the communication system like message structure and data element format.

This separation of the applications from the communication system implies an intermediate function. The purpose of this appendix is to describe at a high level how that function, which is called here a Safety Message Handler (MH), could be designed to send and receive messages in support of safety applications.

A given vehicle both transmits its state and receives state updates from other vehicles. As noted in Appendix F.3, the state information from each vehicle might be updated via periodic broadcasts of the BSM. The message period could be modified in response to network conditions or changing application requirements. The periodic messages could also be supplemented by an occasional message upon the occurrence of a specific event (e.g., hard-brake event).

Each application running on a vehicle has requirements for the state information that it needs to communicate to other vehicles. For each state element, the application also has a requirement for the broadcast update frequency. The job of the MH on the sender side is to compose and dispatch messages with contents and at intervals that satisfy the collective needs of the applications. This process is illustrated in Figure F1[9]. Three applications are shown on the left of the figure. For each, a set of data elements is listed; these represent the state information that each application requires to be broadcast. The MH composes messages whose content represents the union of the required elements. Note that an element like Position that is required by multiple applications is sent only once in each message.

The MH might use a BSM to send the required information. In that case, any required element that is included in Part I of the BSM is automatically sent. Any required element that is not included in Part I of the BSM is explicitly included in Part II. Alternatively, a MH might use an alaCarte (ALC) message to send the required information. The ALC has all of the flexibility of the BSM, but with no mandatory part. If the MH chose to send an ALC message, every required element is explicitly included. The choice of whether to use a BSM or an ALC may depend on how much of the BSM Part I information is in the set of required information. Part I of the BSM is specifically designed to include the information most likely to be useful for safety applications, so one can expect the BSM to be a good message choice for a MH most of the time.

The transmit and receive parts of each application running on a vehicle have a dual structure. Just as the transmit part has requirements for information to be sent, the receive part has a set of elements that it desires to receive. The receive side of the MH shown in Figure F1 performs an inverse operation of the send side. Upon receipt of a safety message, the MH parses the message to extract the component elements. Every received element is provided to each application that desires to receive it. Received elements that no application needs are ignored.

---

[9] In this appendix, all references to specific applications, data elements, and message rates are purely illustrative.

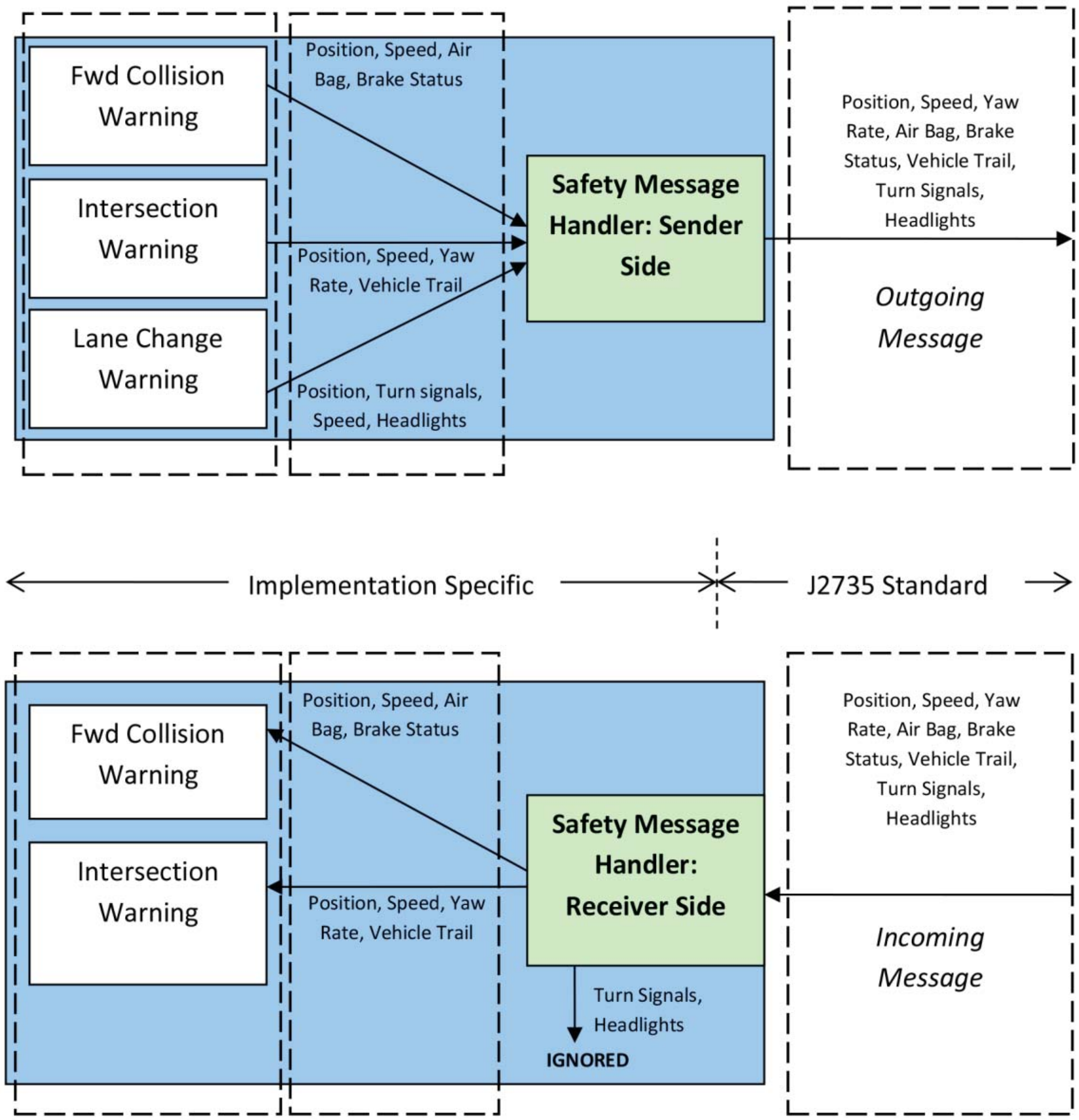


FIGURE F1 - EXAMPLE VEHICLE DSRC SAFETY SYSTEM WITH SAFETY MESSAGE HANDLER

Figure F1 illustrates how a MH chooses outgoing message content based on the collective requirements of the vehicle's safety applications. An aspect of the MH functionality not shown is the determination of message transmission time. The simplest case is a regular message schedule with uniform content in each message. A more complex case arises if some information is sent more frequently than others. A MH may opt to compose messages with different content to match the specific information rate requirements of the applications. For example, if in Figure F1 the Lane Change Warning application only requires half the information rate as the Forward Collision Warning and Intersection Warning applications, the message shown on the right side of the figure might be sent every other message interval, interleaved with messages that omit the Turn Signals and Headlights data elements.

F.3 OPERATION WITH THE BASIC SAFETY MESSAGE IN VEHICLES

F.3.1 Application and Research Implementation Background

The basicSafetyMessage (BSM) in this Standard was developed based on analysis of communications requirements for seven high-priority vehicle-to-vehicle application scenarios with significant anticipated safety benefits. These application scenarios and the research implementation of some of the applications are:

- F.3.2: Intersection Collision Warning
- F.3.3: Emergency Electronic Brake Lights
- F.3.4: Pre-Crash Sensing
- F.3.5: Cooperative Forward Collision Warning
- F.3.6: Left Turn Assistant
- F.3.7: Stop Sign Movement Assistance
- F.3.8: Lane Change Warning
- F.3.9: CAMP VSC-A Implementation of V2V Safety Applications Using DSRC BSM

The use of the basicSafetyMessage in the relevant vehicle safety application scenarios is described in this appendix in Sections F.3.2 through F.3.8. These sections of the appendix present vehicle safety application scenarios and are meant to illustrate the use of the BSM specified in this Standard, rather than to specify or prescribe these applications or to recommend the best way to deploy these applications. It is expected that the message sets in this Standard will fully or partially enable the development of additional vehicle safety applications. Illustrations of such applications may be added to this appendix in future versions of this Standard.

Section F.3.9 presents the V2V Safety Application Implementation by Vehicle Safety Communication - Applications (VSC-A) project using DSRC BSM, under a collaborative effort between the United States Department of Transportation (USDOT) and the Vehicle Safety Communications 2 Consortium (VSC 2 Consortium - Ford, General Motors, Honda, Mercedes-Benz, and Toyota). This section provides a brief introduction of the VSC-A project and the V2V safety applications implemented in the project, as well as the system structure and the over-the-air (OTA) BSM structure and its use in the VSC-A project.

Future vehicle safety applications may require additional message sets, data frames and data elements that have not yet been specified in this Standard. The intention of the DSRC Technical Committee is for these additional elements to be identified by the Technical Committee, analyzed, specified and added to future versions of this Standard in order to support interoperability for an increasingly diverse range of vehicle safety applications. These additions are likely to be especially noticeable in the area of future vehicle-to/from-infrastructure safety applications that are envisioned. Some of these will likely be vehicle safety applications and others are likely to be public safety applications. The technical committee intends for this Standard to support the interoperability of all these safety applications between and among vehicles from different manufacturers and roadside infrastructure operators/manufacturers throughout the entire region of expected vehicle travel.

The basic premise of the initial vehicle safety applications is the use of frequent broadcasts of basic information about each individual vehicle to enhance the awareness of vehicles that are in the vicinity. The frequency of these broadcasts is expected to at least meet the requirements of vehicle safety systems implemented using this technology, and if possible to exceed these requirements in order to compensate for the inherently unreliable nature of radio frequency communications.

Due to the potential cumulative effect of many vehicles broadcasting within the same local area (in particular during heavy traffic conditions), the DSRC communication channel is likely to encounter excessive channel loading on occasion. For this reason, it has been the focus of the technical committee to limit the required information in these common messages to a concise set, and to provide effective coding to minimize the size of the message payload. The common message set that was developed by the committee to meet the requirements of the initial vehicle safety application scenarios is the basicSafetyMessage, which has a mandatory section (Part I) and an optional section (Part II):

- Part I of the basicSafetyMessage contains a fixed data structure comprising the information that must be updated most frequently or which must be known to determine the meaning of the frequently-changing data. Part I is mandatory in the BSM, and so might be broadcast more frequently than the optional Part II. The transmission frequency of the BSM might be chosen so that it provides an update rate that is consistent with the scan rates for on-board vehicle safety system sensors.

- Part II of the basicSafetyMessage is optional, and so might be included in only a subset of the messages. The additional data provided in Part II is either required less frequently by vehicle safety applications, or is less important, or both. Part II information, when present, might vary from message to message. Part II can be included periodically or triggered by an event or a request. Locally defined content can be sent in Part II as well, although this requires additional definition in the ASN and XML used.

F.3.1.1 Applicable Documents

A detailed description of the identification and selection of the high-priority vehicle safety applications, as well as the background descriptions of the application scenarios, are included in the “Vehicle Safety Communications Project Task 3 Final Report: Identify Intelligent Vehicle Safety Applications Enabled by DSRC", published by the National Highway Traffic Safety Administration in March 2005 and publicly available from National Technical Information Service, Springfield, Virginia 22161.

F.3.1.2 Application Message Sequences

The repetitive broadcast of vehicle safety messages is expected to increase the range of vehicle environmental awareness beyond the range of any on-board sensors. Each vehicle will broadcast its relevant information frequently via the BSM and receive the equivalent messages from all DSRC-equipped vehicles in the immediate vicinity. Messages from other vehicles can then be analyzed by on-board processors to identify impending situations that would warrant warning the driver or initiating other actions, for example, pre-tensioning of seat belts.

F.3.1.3 Application Use with DSRC

BasicSafetyMessages will usually be transmitted using the Wave Short Message Protocol (WSM) stack on a pre-agreed channel, to other devices (typically other mobile on-board units (OBUs)) which have determined to receive this type of message. It will not be necessary for a sender to advertise a service, nor for a receiver to undertake any confirm or join operation.

Receivers are expected to process all such messages. Upon receipt, a BSM is examined for message content and relevance at the application layer of the protocol stack.

BSMs are expected to be broadcast at a rate sufficient to provide a level of data quality, including data freshness, similar to that provided by on-board sensors used for vehicle safety systems. However, to help prevent the possibility of vehicle broadcast messages congesting a channel, the frequency of transmissions may need to be adjusted in dense traffic environments based on speed, number of vehicles in close proximity or other parameters (e.g., a toll plaza).

In all seven of the following application scenarios, a working GPS unit[10] and a connection to the vehicle data bus, in addition to a DSRC radio unit, are necessary to send out the correct information to, and receive the necessary information from, other vehicles.

[10] Which is presumed to be able to provide position, velocity, and current time values for the vehicle.

F.3.2 Intersection Collision Warning

F.3.2.1 Application Description

This application warns drivers when a side-impact or straight crossing path collision at an intersection is probable. DSRC communications can be used to allow a vehicle approaching an intersection to detect all nearby vehicles, their position, velocity, acceleration, and turning status. The in-vehicle unit analyzes these parameters for the other vehicles as contained in their BSMs and projects future vectors for these vehicles. If this analysis determines that a collision is likely, an appropriate warning is issued to the driver.

F.3.2.2 Flow of Events

Flow of Events					
1. Vehicle "A" sends basicSafetyMessage					
2. Vehicle "B" receives message					
3. Vehicle "B" processes the message from Vehicle A and determines that Vehicle A's message is relevant (crossing road segment via map and/or heading)					
4. Vehicle "B" alerts its driver to a straight crossing path hazard					
Hardware Devices:	DSRC radio Positional and vehicle sensors Human-Machine Interface				
Actors: (What entities play an active role in use)	**Vehicle System**	**Occupant**		**Service Provider**	**Road Department (Optional - for Relaying)**
		Driver	**Passenger**		
	X	X			
Support information:	CAMP-VSC Task 3 Report, 2003				

F.3.2.3 Implementation Example

For this application, it is assumed that all identified subject vehicles would be equipped with DSRC units. It is also assumed that messages from each vehicle would be received by conflicting vehicles on other intersection legs, a process that might involve high transmission power or relaying techniques if the transmitter and receiver do not have clear line of sight.

Upon receipt of each BSM, the recipient needs to implement an algorithm to determine if a crossing path conflict is present. Once a conflict is determined the vehicle could use appropriate human machine interface (HMI) techniques aboard the vehicle to issue a warning to the driver.

In some cases, an RSU associated with a traffic signal may be used to relay the vehicle status. In such cases, if the traffic signal status is provided as well, it could include improper signal operation - such as when there is a conflict monitor flag. One method for relaying messages that could be used at signalized intersections is that developed in CICAS-V. This method, not elaborated here, requires the road department to become active in alerting vehicles to possible collisions that would occur as a result of an imminent right of way violation.

F.3.2.4 Sensors and Other System Needs

A map database could help to provide information about whether crossing path vehicles are in the vicinity of an intersection. If lane resolution is possible, lane position of the crossing path vehicle can be used in the algorithm, e.g., if a crossing path vehicle is in a left-turn pocket and it is known in advance that the left-turn and straight-through phases are different, then the left-turning vehicle is no longer a likely threat.

F.3.3 Emergency Electronic Brake Lights

F.3.3.1 Application Description

When a vehicle brakes hard, the Emergency Electronic Brake Light application conveys this information to surrounding vehicles via one or more basicSafetyMessages. This application will help the driver of a following vehicle by giving an early notification that the lead vehicle is braking hard even when the driver's visibility is limited (e.g. a large truck blocks the driver's view, heavy fog, rain).

The current brake lamp goes on when the driver applies the brake. The Emergency Electronic Brake Light application might not only enhance the range of a hard braking message but also might provide important information such as acceleration/deceleration rate and duration. At present, brake lamps do not differentiate level of deceleration and are only useful as far rearward as line of sight allows.

F.3.3.2 Flow of Events

<table>
<tr><th colspan="7">Flow of Events</th></tr>
<tr><td colspan="7">1. Vehicle “A" sends basicSafetyMessage, possibly with additional data associated with the hard braking event, such as a hard-braking event flag</td></tr>
<tr><td colspan="7">2. Vehicle “B" receives message</td></tr>
<tr><td colspan="7">3. Vehicle “B" processes the message from Vehicle A and determines that Vehicle A's message is relevant (similar heading in advance of Vehicle B's path) and a significant braking event is occurring per the message information (e.g., deceleration, brake pressure, event flag)</td></tr>
<tr><td colspan="7">4. Vehicle “B" alerts its driver to the braking event and provides some indication of braking severity</td></tr>
<tr><td>Hardware Devices:</td><td colspan="6">DSRC radio
Positional and vehicle sensors
Human-Machine Interface</td></tr>
<tr><td rowspan="3">Actors: (What entities play an active role in use)</td><td rowspan="2">Vehicle System</td><td colspan="2">Occupant</td><td rowspan="2">Service Provider</td><td rowspan="2" colspan="2">Road Department</td></tr>
<tr><td>Driver</td><td>Passenger</td></tr>
<tr><td>X</td><td>X</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Support information:</td><td colspan="6">CAMP-VSC Task 3 Report, 2003</td></tr>
</table>

F.3.3.3 Implementation Example

For this application, it is assumed that the vehicle in a hard braking situation would be equipped with a DSRC unit. It is also assumed that the message from the vehicle would be received by the following vehicles, including any that could have a collision with the braking vehicle.

The message sender needs to have an algorithm to decide if a hard brake was performed (defined as a deceleration greater than 0.4g), and if a non-routine event message transmission is advisable. If a vehicle determines that it is braking hard then it could inform the surrounding vehicles by sending a BSM, possibly including an optional “hard-brake" event flag. The message could be sent at the next scheduled transmission time, or earlier, and it could use a higher priority level than the routine broadcast of a BSM.

In order to determine if a hard braking message is relevant, the listening vehicle needs to know the relative location from which the message originated (e.g., front, rear, left, right). This can be done based on its GPS information and the GPS information of the braking vehicle. The listening vehicle may not necessarily inform the driver of such an event if the braking vehicle is traveling in an adjacent lane.

F.3.3.4 Sensors and Other System Needs

A map database, where available, may help to provide specific, relevant information related to current road segments. This could allow, for example, intersection geometry or road curvature to be taken into account when an application host vehicle evaluates the received BSM to see if an alert to the driver is necessary.

F.3.4 Pre-crash Sensing

F.3.4.1 Application Description

Pre-crash sensing can be used to prepare for imminent, unavoidable collisions. This application could use DSRC communication in combination with other sensors to mitigate the severity of a crash. Countermeasures may include pre-tightening of seatbelts, airbag pre-arming, front bumper extension, etc.

F.3.4.2 Flow of Events

<table>
<tr><th colspan="6">Flow of Events</th></tr>
<tr><td colspan="6">1. Vehicle “A" sends basicSafetyMessage</td></tr>
<tr><td colspan="6">2. Vehicle “B" receives message</td></tr>
<tr><td colspan="6">3. Vehicle “B" processes the message from Vehicle A and determines that Vehicle A’s message is relevant and, per the message information (e.g., location, speed, heading, deceleration, brake pressure, etc.), that trajectories of Vehicles “A" and “B" will likely intersect imminently</td></tr>
<tr><td colspan="6">4. Vehicle “B" automatically initiates pre-crash countermeasure(s)</td></tr>
<tr><td>Hardware Devices:</td><td colspan="5">DSRC radio
Positional and vehicle sensors
Human-Machine Interface</td></tr>
<tr><td rowspan="3">Actors: (What entities play an active role in use)</td><td rowspan="2">Vehicle System</td><td colspan="2">Occupant</td><td rowspan="2">Service Provider</td><td rowspan="2">Road Department</td></tr>
<tr><td>Driver</td><td>Passenger</td></tr>
<tr><td>X</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Support information:</td><td colspan="5">CAMP-VSC Task 3 Report, 2003</td></tr>
</table>

F.3.4.3 Implementation Example

As in most of the other vehicle safety application scenarios, DSRC communications is used to allow the host vehicle to detect position, velocity, heading, acceleration, and control parameters for all equipped vehicles in the immediate vicinity. The in-vehicle unit analyzes these parameters for the other vehicles as contained in their BSMs and projects future vectors for these vehicles. If this analysis determines that a collision is imminent and unavoidable, the vehicle may deploy countermeasures, such as pre-tightening of seatbelts. This further information might be used for such potential purposes as determining the need to lower the bumper on a high-profile vehicle to minimize the damage to a smaller, lower vehicle, or to support a sensor-based decision to pre-deploy side-impact airbags if the collision vector determination indicates an imminent side-impact.

F.3.4.4 Sensors and Other System Needs

On-board sensors, such as airbag accelerometers or radar systems, could be used to confirm the imminent collision determination derived from the DSRC communications analysis.

F.3.5 Cooperative Forward Collision Warning

F.3.5.1 Application Description

The cooperative forward collision warning (CFCW) system application is a vehicle-to-vehicle (V2V) communication-based safety feature that issues a warning to the driver of the host vehicle in case of an impending front-end collision with a vehicle ahead in traffic in the same lane and direction of travel. CFCW will help drivers in avoiding or mitigating front-to-rear vehicle collisions in the forward path of travel. The system does not attempt to control the host vehicle in order to avoid an impending collision.

F.3.5.2 Flow of Events

<table>
<tr><th colspan="6">Flow of Events</th></tr>
<tr><td colspan="6">1. Vehicle “A" sends the basicSafetyMessage, periodically</td></tr>
<tr><td colspan="6">2. Vehicle “B" receives and processes messages, and determines if Vehicle A is traveling ahead in traffic in the same lane and direction of travel</td></tr>
<tr><td colspan="6">3. If so determined, Vehicle “B" processes the message information further to determine the threat level of a front-end crash with Vehicle A</td></tr>
<tr><td colspan="6">4. Based on the threat level determined, Vehicle “B" warns its driver of the potential front-end crash</td></tr>
<tr><td>Hardware Devices:</td><td colspan="5">DSRC radio
Positional and vehicle sensors
Human-Machine Interface</td></tr>
<tr><td rowspan="3">Actors: (What entities play an active role in use)</td><td rowspan="2">Vehicle System</td><td colspan="2">Occupant</td><td rowspan="2">Service Provider</td><td rowspan="2">Road Department</td></tr>
<tr><td>Driver</td><td>Passenger</td></tr>
<tr><td>X</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Support information:</td><td colspan="5">CAMP-VSC Task 3 Report, 2003</td></tr>
</table>

F.3.5.3 Implementation Example

This application is similar to the Emergency Electronic Brake Light scenario (Appendix F.3.3). In the CFCW scenario, however, the application warns the driver when the possibility of a collision with a vehicle in front of the host vehicle becomes likely, whereas the brake light application simply informs the driver of the onset of “hard" braking based on an indication of braking rate. The concept of operation of the CFCW application can be explained as follows: Every vehicle that is equipped with DSRC will broadcast the BSM, including the optional path history, at a certain frequency (path history might be included in a subset of all BSMs). The CFCW application in the host vehicle receives safety messages and uses the contents to track the state (i.e., position, velocity, and acceleration, etc.) of remote vehicles within its communication range. Using such information, along with its own state and its assessment of the relevance of the target location, the host vehicle determines the likelihood of a front-end collision with a remote vehicle ahead in its lane and calculates the threat level. The threat level is used to further determine the appropriate warning through the vehicle’s driver vehicle interface.

F.3.5.4 Sensors and Other System Needs

On-board sensors, such as radar or lidar systems, could be used to confirm the collision determination derived from the DSRC communications analysis.

A map database, where available, may help to provide specific, relevant information related to current road segments. This could allow, for example, intersection geometry or road curvature to be taken into account.

F.3.6 Left Turn Assistant

F.3.6.1 Application Description

The Left Turn Assistant provides information to drivers about gaps and speeds of oncoming cars to help them make a left turn across traffic safely. This application warns drivers when a collision is probable if the left turn movement is initiated.

F.3.6.2 Flow of Events

<table>
<tr><th colspan="6">Flow of Events</th></tr>
<tr><td colspan="6">1. Oncoming Vehicle “A" sends basicSafetyMessage</td></tr>
<tr><td colspan="6">2. Turning Vehicle “B" receives message</td></tr>
<tr><td colspan="6">3. Vehicle “B" processes the message from Vehicle A and determines that Vehicle A’s message is relevant (crossing road segment via map and/or heading and indication of turn)</td></tr>
<tr><td colspan="6">4. Vehicle “B" alerts its driver to an oncoming vehicle hazard</td></tr>
<tr><td>Hardware Devices:</td><td colspan="5">DSRC radio
Positional and vehicle sensors
Human-Machine Interface</td></tr>
<tr><td rowspan="3">Actors: (What entities play an active role in use)</td><td rowspan="2">Vehicle System</td><td colspan="2">Occupant</td><td rowspan="2">Service Provider</td><td rowspan="2">Road Department</td></tr>
<tr><td>Driver</td><td>Passenger</td></tr>
<tr><td>X</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Support information:</td><td colspan="5">CAMP-VSC Task 3 Report, 2003</td></tr>
</table>

F.3.6.3 Implementation Example

DSRC communications is used to allow the turning vehicle to detect all equipped vehicles in the vicinity. Furthermore, it allows the turning vehicle to receive the position, velocity, acceleration, and control parameters, among others, for potential threat vehicles. The in-vehicle unit, based upon the host vehicle’s left turn signal initiation (and/or possibly other control parameters such as steering wheel angle or yaw rate) constructs a predicted travel path for the host vehicle and analyzes the received parameters for the approaching vehicles. The unit also constructs expected future travel path for these vehicles. If this analysis determines that a collision would be likely if the left turn movement is initiated, an appropriate warning is issued to the driver.

F.3.6.4 Sensors and Other System Needs

On-board sensors to determine the host vehicle’s intent to turn left, e.g., left turn signal or other control parameters, may be required.

A map database could help to provide information about whether vehicles are in the vicinity of an intersection. If lane resolution is possible, lane position of left-turning and opposite path vehicles can be used in the algorithm, e.g., if a left-turning vehicle is in a left-turn pocket and the opposite path vehicle is in a through lane, then the left-turn warning should actuate.

F.3.7 Stop Sign Movement Assistance

F.3.7.1 Application Description

This application provides a warning to a vehicle that is about to cross through an intersection after having stopped at a stop sign. This may prevent collisions with traffic approaching the intersection. In particular, this application warns drivers when a collision is probable if the indicated start-from-stop is initiated.

F.3.7.2 Flow of Events

Flow of Events
1. Vehicle “A", starting from stop, sends basicSafetyMessage
2. Vehicle “B" receives message
3. Vehicle “B" recognizes that Vehicle A’s message is relevant and, per the message information (e.g. location, speed, heading, acceleration, throttle position, etc.), that trajectories of Vehicles “A" and “B" will likely intersect.
4. Vehicle “B" alerts its driver to a straight crossing path hazard
5. Vehicle “B" sends basicSafetyMessage
6. Vehicle “A" receives message
7. Vehicle “A" processes the message from Vehicle A and determines that Vehicle B’s message is relevant (crossing road segment via map and/or heading)
8. Vehicle “A" alerts its driver to a start-from-stop hazard

Hardware Devices:	DSRC radio Positional and vehicle sensors Human-Machine Interface				
Actors: (What entities play an active role in use)	**Vehicle System**	**Occupant**		**Service Provider**	**Road Department**
		Driver	**Passenger**		
	X	X			
Support information:	CAMP-VSC Task 3 Report, 2003				

F.3.7.3 Implementation Example

DSRC communications is used to allow the stopped vehicle to be informed of the presence of other vehicles in the immediate vicinity. The frequently broadcast BSMs from vehicles in the area allow the stopped vehicle to receive the position, velocity, acceleration, and control parameters, among others, from these vehicles. The in-vehicle unit, based upon the host vehicle’s stopped condition and combination of release of brake and application of throttle, for example, constructs a predicted travel path for the host vehicle and also constructs expected travel path for the other detected vehicles by analyzing their received parameters. If the in-vehicle unit determines that a collision would be likely if the start-from-stop maneuver is initiated, an appropriate warning is issued to the driver.

F.3.7.4 Sensors and Other System Needs

On-board sensors to determine the host vehicle’s stopped condition and combination of release of brake and application of throttle are also needed.

A map database could help to provide information whether crossing path vehicles are in the vicinity of an intersection. If lane resolution is possible, lane position of the crossing path vehicle can be determined and used in the algorithm.

F.3.8 Lane Change Warning

F.3.8.1 Application Description

This application provides a warning to a vehicle that is about to change lanes. The warning is provided in order to avoid a collision with vehicles in the intended lane destination of the host vehicle.

F.3.8.2 Flow of Events

Flow of Events					
1. Overtaking Vehicle “A" sends basicSafetyMessage					
2. Lane-changing Vehicle “B" receives message					
3. Vehicle “B" processes the message from Vehicle A and determines that Vehicle A’s message is relevant (by location in adjacent lane, proximity or rate of overtaking)					
4. Based upon the host vehicle’s turn signal indication and /or possibly other control parameters like steering movements, Vehicle “B" alerts its driver to a potential overtaking vehicle hazard					
Hardware Devices:	DSRC radio Positional and vehicle sensors Human-Machine Interface				
Actors: (What entities play an active role in use)	**Vehicle System**	**Occupant**		**Service Provider**	**Road Department**
		Driver	**Passenger**		
	X	X			
Support information:	CAMP-VSC Task 3 Report, 2003				

F.3.8.3 Implementation Example

As with the other vehicle safety application scenarios in this appendix, DSRC communications is used to allow the host vehicle to detect all equipped vehicles in the immediate vicinity. As well, the lane-changing vehicle receives the position, velocity, acceleration, and control parameters, among others, for all these vehicles through their BSMs. The in-vehicle unit, based upon the host vehicle’s turn signal and/or possibly other control parameters like steering wheel movements, constructs a potential vector for the host vehicle and analyzes the received parameters to construct expected future vectors for other vehicles in the immediate vicinity. If the in-vehicle unit determines that a collision would be likely if the indicated lane change maneuver is initiated, an appropriate warning is issued to the driver.

F.3.8.4 Sensors and Other System Needs

On-board sensors to determine the host vehicle’s intent to change lanes, e.g., turn signal or other control parameters, will also be needed.

A map database, if available, could help to provide information about whether vehicles are in adjacent lanes. In addition, the road curvature can be taken into account when an application host vehicle evaluates the presence of an approaching or existing vehicle in the adjacent lane.

F.3.9 Implementation of V2V Safety Applications Using DSRC BSM

F.3.9.1 Background

In December 2006, the United States Department of Transportation (USDOT) and the Vehicle Safety Communications 2 Consortium (VSC 2 Consortium - Ford, General Motors, Honda, Mercedes-Benz, and Toyota) initiated a collaborative effort in the area of wireless-based safety applications under the Vehicle Safety Communications - Applications (VSC-A) project. The goal of the three-year VSC-A project is to develop and test communications-based vehicle safety systems to determine if Dedicated Short Range Communications (DSRC) at 5.9 GHz, in combination with vehicle positioning could improve upon autonomous vehicle-based safety systems and/or enable new communications-based safety applications.

In order to address the goal of the VSC-A project as stated above, it was necessary, among other things, to develop the suitable messaging framework, i.e., safety message contents and frequency of broadcast, which ensures reliable performance of the Vehicle Safety Communications (VSC) applications. A messaging framework, derived from requirements of VSC applications, that is necessary to achieve interoperability and cohesiveness among different vehicle manufacturers has been developed. The objective is to standardize this messaging framework under Society of Automotive Engineers (SAE) J2735 to facilitate future deployment of VSC systems.

This appendix briefly discusses some of the relevant activities in the VSC-A project and the development of the Over-The-Air (OTA) message framework. The message framework has been implemented in a fleet of vehicle test beds and the performance of the VSC applications has been successfully verified.

F.3.9.2 Crash Imminent Scenarios for Safety Applications

The USDOT evaluated pre-crash scenarios based on the 2004 General Estimated System (GES) crash database in order to provide a list of potential crash imminent safety scenarios. This list served as a starting point and reference for the selection of the safety applications to be studied under the VSC-A project. The list included crash imminent safety scenarios based on the following USDOT rankings:

- Crash rankings by frequency
- Crash rankings by cost
- Crash rankings by functional years lost
- Composite crash rankings

The first three rankings listed above are self-explanatory. The composite crash rankings were determined by taking the average of the crash rankings by frequency, cost and functional years lost for each scenario and sorted the crash scenarios based on the composite ranking. These crash imminent safety scenarios were then analyzed to evaluate whether autonomous safety systems and/or vehicle safety communications would offer the best opportunity to adequately address the scenarios.

From the composite ranking list of crash scenarios, the top five (5) scenarios for each crash frequency, crash cost, and functional years lost that could be addressed by VSC-A were selected. This was done in order to focus on the most frequent crashes, while keeping the program scope to a manageable level. Table F4 contains the final set of crash imminent scenarios, as agreed between the VSC-A team and the USDOT, to be addressed under the VSC-A project.

TABLE F4 - VSC-A SELECTED CRASH IMMINENT SCENARIOS

	Crash Imminent Scenario	High Frequency	High Cost	High Years
1	Lead Vehicle Stopped	✓	✓	✓
2	Control Loss without Prior Vehicle Action	✓	✓	✓
3	Vehicle(s) Turning at Non-Signalized Junctions	✓	✓	
4	Straight Crossing Paths at Non-Signalized Junctions			✓
5	Lead Vehicle Decelerating	✓	✓	
6	Vehicle(s) Not Making a Maneuver - Opposite Direction			✓
7	Vehicle(s) Changing Lanes - Same Direction	✓		

✓ Denotes Top Five Ranking

Table F4 only shows four of the top five ranking crash scenarios for high cost and high functional years lost. This is due to the #2 ranking for these categories being ‘Road Edge Departure without Prior Vehicle Maneuver’ which was not deemed as a viable scenario to be addressed under the VSC-A program. Thus this scenario is not included in Table F4.

F.3.9.3 Safety Applications

The VSC-A Team and USDOT analyzed the crash imminent scenarios in Table F4 and analyzed potential safety applications that could be developed to address them using vehicle safety communications. This analysis resulted in the identification and selection of the following safety applications developed as part of the VSC-A system:

- Emergency Electronic Brake Lights (EEBL)

  The EEBL application enables a host vehicle to broadcast a self-generated emergency brake event to surrounding remote vehicles. Upon receiving such event information, the remote vehicle determines the relevance of the event and provides a warning to the driver if appropriate. This application is particularly useful when the driver's line of sight is obstructed by other vehicles or bad weather conditions (e.g. fog, heavy rain).

- Forward Collision Warning (FCW)

  The FCW application is intended to warn the driver of the host vehicle in case of an impending rear-end collision with a remote vehicle ahead in traffic in the same lane and direction of travel. FCW is intended to help drivers in avoiding or mitigating rear-end vehicle collisions in the forward path of travel.

- Blind Spot Warning + Lane Change Warning (BSW + LCW)

  The BSW+LCW application is intended to warn the driver of the host vehicle during a lane change attempt if the blind spot zone into which the host vehicle intends to switch is, or will soon be, occupied by another vehicle traveling in the same direction. Moreover, the application provides advisory information that is intended to inform the driver of the host vehicle that a vehicle in an adjacent lane is positioned in a blind spot zone of the host vehicle when a lane change is not being attempted.

- Do Not Pass Warning (DNPW)

  The DNPW application is intended to warn the driver of the host vehicle during a passing maneuver attempt when a slower moving vehicle, ahead and in the same lane, cannot be safely passed using a passing zone which is occupied by vehicles with the opposite direction of travel. In addition, the application provides advisory information that is intended to inform the driver of the host vehicle that the passing zone is occupied when a passing maneuver is not being attempted.

- Intersection Movement Assist (IMA)

  The IMA application is intended to warn the driver of a host vehicle when it is not safe to enter an intersection due to high collision probability with other remote vehicles. Initially, IMA is intended to help drivers avoid or mitigate vehicle collisions at stop sign controlled and uncontrolled intersections.

- Control Loss Warning (CLW)

  The CLW application enables a host vehicle to broadcast a self-generated control loss event to surrounding remote vehicles. Upon receiving such event information, the remote vehicle determines the relevance of the event and provides a warning to the driver, if appropriate.

Table F5 below illustrates the mapping between the crash imminent scenarios identified in Table F4 and the list of safety applications developed and built under the VSC-A program.

TABLE F5 - CRASH IMMINENT SCENARIO TO VSC-A PROGRAM APPLICATION MAPPING

	Safety Applications / Crash Scenarios	EEBL	FCW	BSW	LCW	DNPW	IMA	CLW
1	Lead Vehicle Stopped		✓					
2	Control Loss without Prior Vehicle Action							✓
3	Vehicle(s) Turning at Non-Signalized Junctions						✓	
4	Straight Crossing Paths at Non-Signalized Junctions						✓	
5	Lead Vehicle Decelerating	✓	✓					
6	Vehicle(s) Not Making a Maneuver - Opposite Direction					✓		
7	Vehicle(s) Changing Lanes - Same Direction			✓	✓			

F.3.9.4 Safety System Structure

In order to support the functionality of the safety applications above and their development, the following major subsystems with their corresponding system framework modules were identified and developed under VSC-A:

1. The Interface Module Subsystem:
    - The Vehicle Controller Area Network (CAN) to On-Board Equipment (OBE) Interface
    - The DSRC Radio
    - The Wireless Message Handler (WMH)
    - The Sensor Data Handler (SDH)
2. The Core Module Subsystem:
    - The Vehicle Path History Module (PH)
    - The Host Vehicle Path Prediction Module (HVPP)
    - The Target Classification Module (TC)
3. The Vehicle Positioning and Security Subsystem:
    - Global Positioning System (GPS) Receiver Unit
    - Relative Positioning Platform
    - The Security Module
4. The Supporting Module Subsystem
    - The Basic Threat Arbitration Module (TA)
    - The Driver-Vehicle Interface Notifier (DVIN)
    - The Data Logger
    - The Engineering Graphical User Interface (EGUI)
    - The Data Logger and Visualization Tools

Taking the combined list of safety applications and system framework modules, a VSC-A System Block Diagram was developed, as shown in Figure F2. This System Block Diagram provides an initial framework that is part of a comprehensive DSRC+Positioning-based safety system.

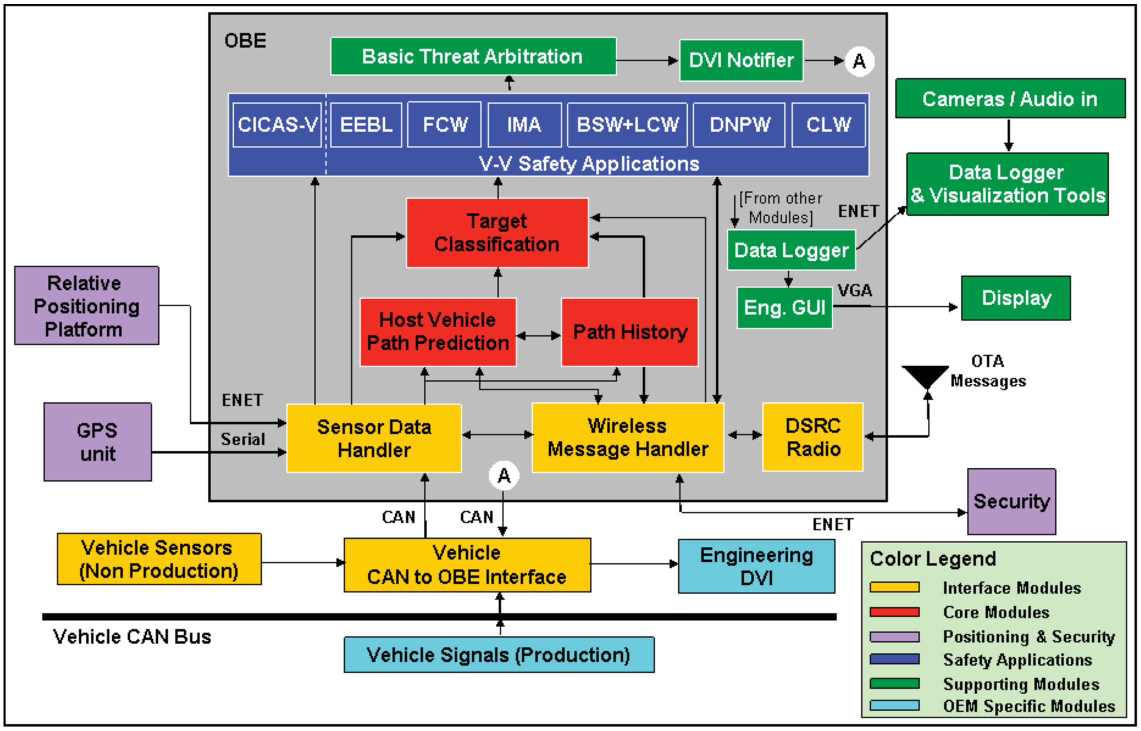


FIGURE F2 - VSC-A SYSTEM BLOCK DIAGRAM

F.3.10 Over-The-Air Safety Message Format

To support the safety applications described in the previous sections, an OTA message set format was developed that would ensure safety application performance, and system interoperability between different automotive Original Equipment Manufacturers (OEMs). The message format consists of specific sections and data elements consistent with the current SAE J2735 Message Set Standard. Its primary objective is to support the VSC-A test bed system implementation and to gain insight into the necessary elements to allow for safety communication interoperability and required application performance.

In the case of VSC-A, each DSRC equipped vehicle broadcasts this message (or parts of it as necessary) at a frequency required by the safety applications. This message is also broadcast, asynchronously, due to events triggered by some of the safety applications. The proposed message format, derived from the current basicSafetyMessage structure, contains the following sets of data elements:

- Standard vehicle data elements (BSM Part I)
- Event Trigger Flags for EEBL and CLW applications (in BSM Part II)
- Data elements necessary to define vehicle path history (in BSM Part II)
- Data elements necessary to define vehicle path prediction (in BSM Part II)
- Data Elements to support exchange of GPS information that enables relative positioning between vehicles (in BSM Part II)

TABLE F6 - VSC-A (SAE J2735-BASED) OTA MESSAGE

VSC-A Basic Safety Message	
Part I	**Basic Vehicle State** • **Message Sequence Number** • **Temporary ID** • **Time** • **Position Latitude, Longitude, Elevation, Accuracy** • **Vehicle Speed, Heading, Steering Wheel Angle** • **Vehicle Accelerations, Yaw Rate** • **Brake Status** • **Vehicle Length, Width**
Part II	**Vehicle Events Object**
	Vehicle Path History Object
	Vehicle Path Prediction Object
	Vehicle Relative Positioning RTCM 1002 Data Object

F.3.10.1 Part I Data Elements

These data elements are consistent with the Part I data elements defined in the BSM of the SAE J2735 DSRC Message Set Dictionary. The nominal broadcast frequency used in the VSC-A implementation is 10 Hz.

A sample basicSafetyMessage containing the Part 1 structure is shown below:

TABLE F7 - EXAMPLE ENCODING OF A BSM MESSAGE[11]

Encoding	Field	Data Concept	Description
30 2A	DSRCMessage		TL; L = 42
	msgCount	DSRCMessage-sequence-number	always omitted for BSM
A1 28	contents	DSRCMessageContents	TL; L = 40 bytes
81 26	part1	BSM-part1-oer	TL; L = 38 bytes
01	msgCnt	DSRCMessage-sequence-number	V = 1
20 21 22 23	id	Vehicle-temporary-identifier	V = 32.33.34.35
	position	VehiclePositionMark	T and L are implicit in OER
92 9B	secMark	Location-secMark	V = 37.531 s
14 DC 93 80	latitude	Location-latitude	V = 35.0000000 degrees N
B8 79 74 00	longitude	Location-longitude	V = 120.0000000 degrees W
27 10	elevation	Location-elevation	V = 1000.0 m
	accuracy	LocationAccuracy	T and L are implicit in OER
0A	major	LocationalAccuracy-major	V = 10 = 0.5 m
05	minor	LocationalAccuracy-minor	V = 5 = 0.25 m
00 B6	orientation	LocationalAccuracy-orientation	V = 182 = 1 degree
49 C4	movement	Vehicle-movement-per	V = B 0100 1001 1100 0100 defined as follows
	transmission	Vehicle-transmission	V = B 010 = forward gears (2)
	speed	Vehicle-speed	V = B 0 1001 1100 0100 = 2500 = 50 m/s
38 40	heading	Vehicle-heading	V = 14400 = 180 degrees
F0	angle	Vehicle-steering-wheel-angle	V = 16 = 24 degrees
	accelSet	Acceleration4Way	T and L are implicit in OER
00 64	longitudinal	Acceleration4Way-longitudinal	V = 1.00 m/s^2 forward
FF F6	latitudinal	Acceleration4Way-latitudinal	V = 0.10 m/s^2 leftward
31	vertical	Acceleration4Way-vertical	V = 49 = 9.8 m/s^2 downward
00 01	yaw	Acceleration4Way-yaw	V = 1 = 0.01 degrees/sec
82 A8	brakes	Vehicle-brake-system-status-per	V = B 1000 0010 1010 1000 defined as follows
	wheelBrakes	Vehicle-brake-applied-status	V = B 1000 00 = Bit 0 set = right rear
	traction	Vehicle-traction-control-state	V = B 10 = on (2)
	abs	Vehicle-antilock-brake-state	V = B 10 = on (2)
	scs	Vehicle-stability-control-state	V = B 10 = on (2)
	brakeBoost	Vehicle-brake-boost-status	V = B 10 = on (2)
	auxBrakes	Vehicle-auxiliary-brakes-status	V = B 00 = unavailable (0)
37 02 9E	size	Vehicle-size-per	V = B 0011 0111 0000 0010 1001 1110 as follows
	width	Vehicle-width	V = B 0011 0111 00 = 220 cm
	length	Vehicle-length	V = B 00 0010 1001 1110 = 670 cm
	safetyExt	veh-safety-extension	omitted
	status	vehicle-status	omitted
	localBasicSafetyMessage	Local.BasicSafetyMessage	omitted
	…	extension for future versions of std	omitted
	crc	DSRCMessage-crc	always omitted for BSM
	…	extension for future versions of std	omitted

[11]Throughout this appendix, sample message encodings are provided; in each case, the samples use a consistent layout of information. The first column, "Encoding," provides the hexadecimal encoding of the data packet sent to the lower layers. The second column, "Field Name," identifies the field within the message being encoded in that row of the table. The third column, "Data Concept," provides the ASN.1 name of the data concept (e.g., data frame, data element, etc.) within the field. The final column, "Description," provides a human readable description of the encoding.

The shading of the "Encoding" cells indicate the encoding rules used to encode the corresponding field. A white shading indicates that the field is encoded according to the Distinguished variant of the ASN.1 BasicEncoding Rules (BER), as defined in ISO 8825-1. A light gray shading indicates that the field is encoded according to the Octet Encoding Rules (OER), as defined in NTCIP 1102. A dark gray shading indicates that the field is encoded according to the UNALIGNED variant of the Packed Encoding Rules (PER), as defined in 8825-2; in this case, the full encoding is provided on the line of the parent structure and the Description column explains the bit-level encoding.

All three encoding rules rely heavily upon the concept of encoding each field with its data "Type", the "Length" of the encoded value,and the encoded "Value" itself. In BER, all three of these components are always present; the other encoding rules omit these values when they are known by context. Each row of the "Description" column indicates which of the components are encoded within the row by using the abbreviations "T", "L", and "V." The column also provides a description of the meaning of the value. In some cases, the abbreviation "B" is used to indicate that a binary value follows, which is typically then translated into a decimal value so that the reader can fully appreciate how the data is being encoded.

F.3.10.2 Part II Data Elements

F.3.10.2.1 Vehicle Events Object

This object corresponds to the vehicle-events (called 'DE_EventFlags' in SAE J2735 v2) data element. The vehicle events object allows a vehicle to notify remote vehicles that a safety event has taken place that the remote vehicles may want to be aware of. The possible events that can be set under the VSC-A project are the EEBL event (corresponds to 'eventHardBraking') and CLW event (corresponds to 'eventABSactivated', 'eventTractionControlLoss', and 'eventStabilityControlactivated'). This object is sent only when the specified vehicle events are generated and remain active.

F.3.10.2.2 Vehicle Path History Object

This object corresponds to the VehiclePathHistory (called 'DF_PathHistory' in SAE J2735 v2) data frame. The vehicle path history object allows a vehicle to share an adaptable concise representation of its recent movement over a certain distance with remote vehicles. The generation of a sequence of path history positions (typically, a concise representation form of vehicle motion) covering a desired distance necessary for vehicle safety applications (typically 300 meters, as determined through extensive VSC-A application testing) is carried by the Path History Module shown in Figure F2.

In this representation, each path history position is subtracted from the current vehicle position (from BSM Part I). The representation is ordered such that the first element in the data set is the path history position that is closest in time to the time corresponding to the current vehicle position (from BSM Part I), the second element in the data set is the next closest in time, and so on. In other words, the path history data proceed backwards in time to create previous positions in a path the vehicle has traveled. In the VSC-A project, this object when transmitted periodically at a nominal frequency of 10 Hz has provided the needed performance of safety applications developed. Research is currently underway to determine the optimal frequency of transmission for this object that takes into account the application performance.

In the VSC-A OTA message, this object includes a count of the number of concise path history points included in the object, followed by a sequence of path history data points (one per path history position), each typically comprising the following:

- **latOffset:** This is the difference between the current vehicle latitude position (from BSM Part I) and the latitude at which the path history position was originally collected.

- **longOffset:** This is the difference between the current vehicle longitude position (from BSM Part I) and the longitude at which the path history position was originally collected.

- **elevationOffset:** This is the difference between the current vehicle elevation (from BSM Part I) and the elevation at which the path history position was originally collected.

The VSC-A design currently uses latOffset and longOffset but research is ongoing to understand the advantages of using the elevationOffset described above.

F.3.10.2.3 Vehicle Path Prediction Object

This object corresponds to the VehiclePathPrediction (called 'DF_PathPrediction' in SAE J2735 v2) data frame. The vehicle path prediction object allows a vehicle to share its predicted path trajectory, by estimating its future vehicle path of travel, with remote vehicles. This trajectory estimation provides an indication of the future positions of the transmitting vehicle and can be used by remote vehicles to significantly enhance in-lane and out-of-lane threat classification. The estimation is carried out by the Host Vehicle Path Prediction Module shown in Figure F2. In this representation, trajectories in the path prediction object are represented, at a first order of curvature approximation, as a circle with a radius R and an origin located at (0,R), where the x-axis is bore sight from the transmitting vehicle's perspective. The vehicle's (x,y) coordinate frame follows the SAE convention. R is positive for curvatures to the right when observed from the transmitting vehicle's perspective. The radii is capped at a maximum value supported by the path prediction radius data type. To help distinguish between steady state and non-steady state conditions, a confidence factor is included in the data element to provide an indication of signal accuracy due to rapid change in driver input. When driver input is in steady state (straight roadways or curves with a constant radius of curvature), a high confidence value is reported. During non-steady state conditions (curve transitions, lane changes, etc.), a lower confidence value is reported. In the VSC-A project,

this object when transmitted periodically at a nominal frequency of 10 Hz has provided the needed performance of safety applications developed. Research is currently underway to determine the optimal frequency of transmission for this object that takes into account the application performance.
In the VSC-A OTA message, this object is comprised of the following:

- **Radius of Curvature (R):** Radius of curvature of the predicted path, approximated to a circle between the current host vehicle position and the end of the predicted path. The radius is a signed calculation, where a default value is reserved for straight path.

- **Path Prediction Confidence:** This data field has (0 - 100)% range.

F.3.10.2.4 Vehicle Relative Positioning RTCM 1002 Data Object

This object corresponds to ‘msg1002’ of the VehicleLocationCorrection (called 'DF_RTCMPackage' in SAE J2735 v2) data frame. The vehicle relative positioning data object allows a vehicle to share its raw GPS information which enables accurate relative positioning between vehicles using moving base Real-Time Kinematic (RTK) solutions available with relative positioning modules. The transmission frequency of this relative positioning object is driven by safety application requirements.

In the VSC-A OTA message, this object is comprised of the following:

- **GPS antenna offset:** This is a set of signed data fields used to indicate the positive or negative offset of the GPS antenna from the center of the vehicle in the X and Y directions that follows the SAE convention. The range is defined to support roughly one half of the vehicle width and length range defined in the Part I data element.

- **Radio Technical Commission for Maritime Services (RTCM) data:** Version 3.0 of the RTCM1002 binary message data for observed satellites.

F.3.10.3 Core Modules of Interest for this Appendix

A detailed discussion of the VSC-A system modules shown in Figure F2 will take us too far afield in this appendix. However, in this section we briefly discuss a set of core modules necessary to support the safety applications. These core modules set the foundation for not only the safety applications developed as part of the VSC-A project but also for other safety applications to be developed.

F.3.10.3.1 Path History Module

The Path History (PH) module for the VSC-A system maintains a history of the past locations traversed by the host vehicle. It provides an adaptable concise representation of recent vehicle movement over a certain distance. The PH module in the host vehicle carries out these basic operations:

- Maintains a buffer of its recent vehicle position and sensor data points over a certain distance.

- Computes concise representation(s) of the actual path history of the vehicle based on allowable position error tolerance between the actual vehicle path and its concise representation (See Figure F3).

- Updates the path history concise representation periodically for use by the other VSC-A modules and for transmission over-the-air.

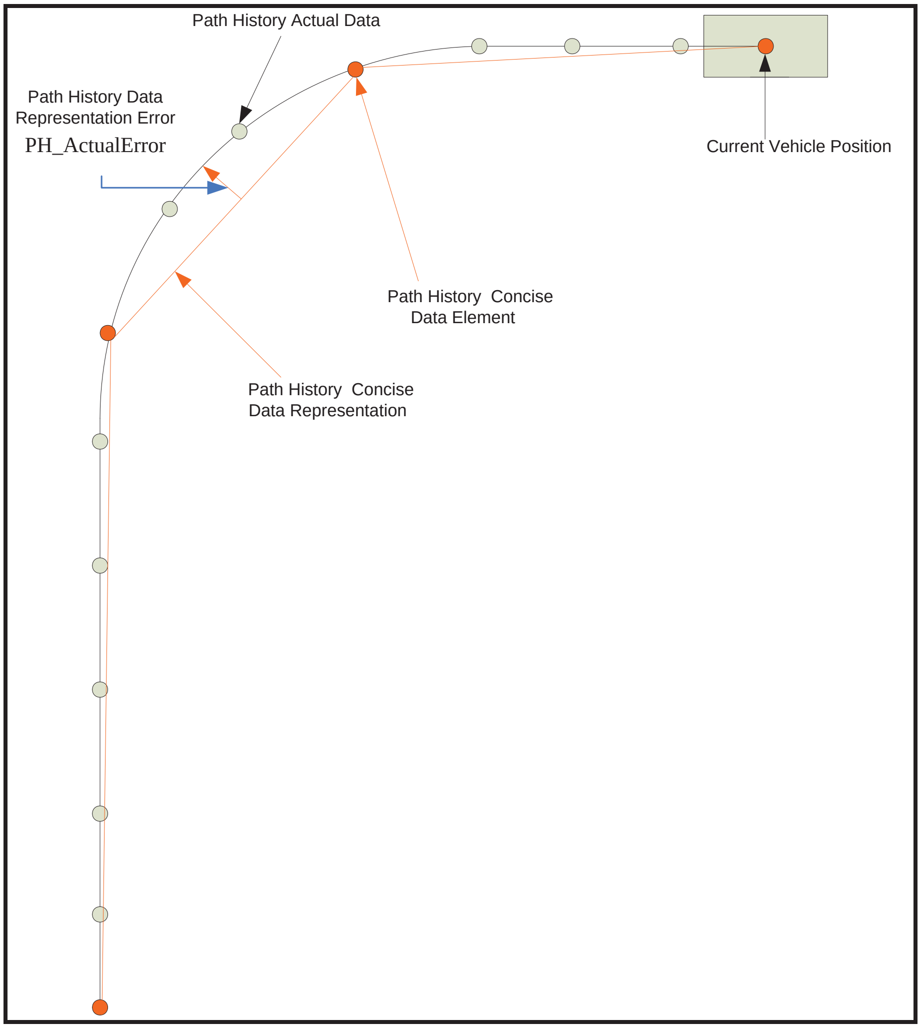


FIGURE F3 - ACTUAL AND CONCISE PATH HISTORY REPRESENTATIONS

Three methods of generating vehicle path history for the VSC-A system have been implemented and evaluated successfully. Using an allowable error tolerance PH_ActualError of one meter has been found to be adequate for good performance of all the safety applications developed in VSC-A.

Figure F4 below shows a typical concise path history representation for a vehicle traversing an oval track consisting of straight paths, tight curves (with estimated radius of 278m), and wide curves. With an allowable error PH_ActualError of one meter to represent a path history for a distance of at least 300m, the number of concise path history points that was required varied from two points to nine points.

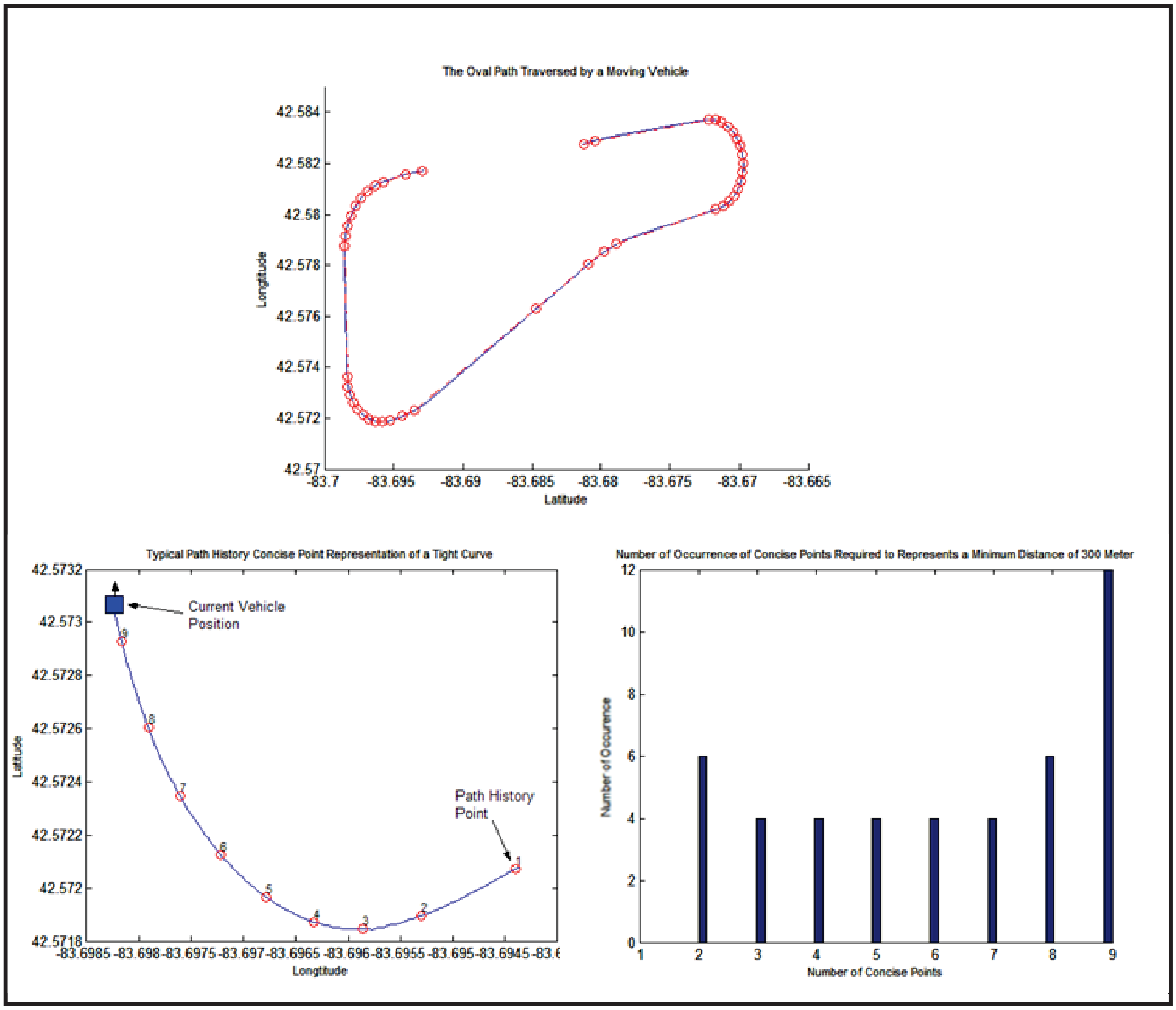


FIGURE F4 - TYPICAL CONCISE PATH HISTORY REPRESENTATION

F.3.10.3.2 Path Prediction

The Path Prediction (PP) module for the VSC-A system utilizes positioning and dynamics information provided by the host vehicle to calculate a radius of curvature representing the vehicle’s estimated future path. This is accomplished by using simple physics equations to compute curvature based on the host vehicle speed and the rate of change of heading (yaw rate). This curvature can be extrapolated forward to provide an estimate of the likely future path of the vehicle. In the VSC-A implementation, the estimate is provided without dependence on future road geometry information obtained from outside sources (ex. map databases, vision system). However other information could be used to improve the overall prediction of the future path. The PP module carries out the following basic operations:

- Gathers host dynamics and positioning information from the Sensor Data Handler.
- Computes path radius using dynamics information to represent the driver's intended future path:

$$\text{Radius} = 1/\text{curvature } (\rho)$$

- Computes path radius center point GPS Lat/Long coordinate.

- Computes confidence of the predicted path based upon the rate of change of the host vehicle dynamics to infer transient conditions.

- Updates path prediction output periodically for use by other VSC-A subsystems and for transmission over-the-air.

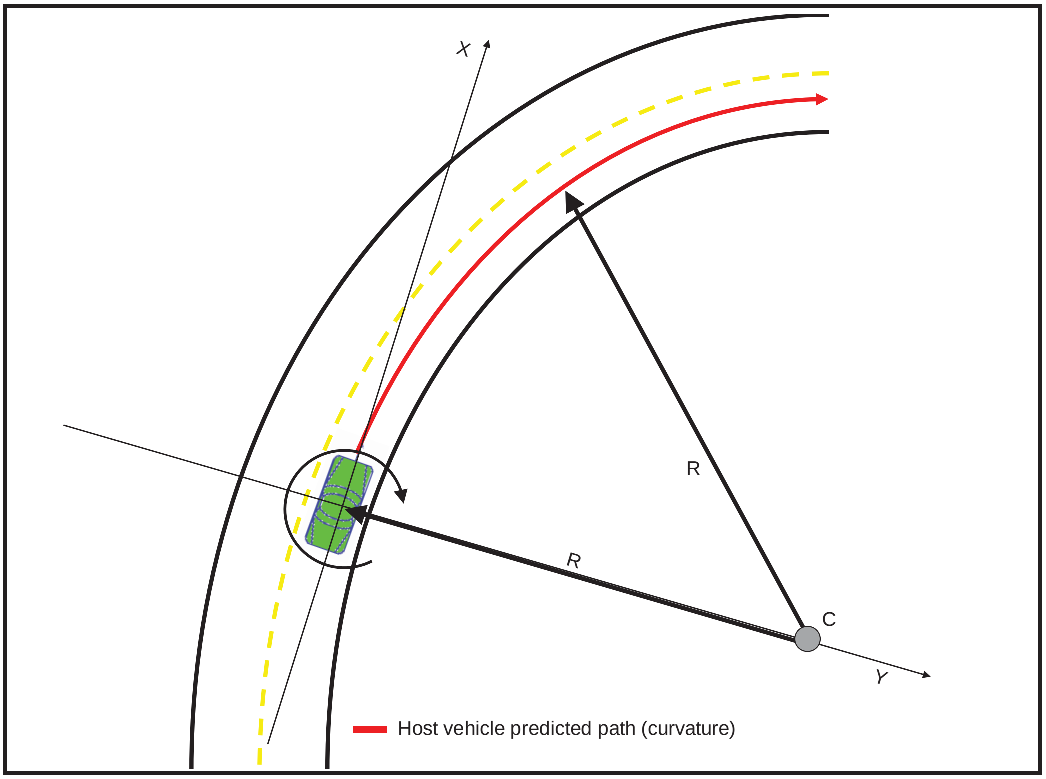


FIGURE F5 - HOST VEHICLE PATH PREDICTION

In the host vehicle's local coordinate plane, the center point of the path radius is merely an offset along the Y axis (See Figure F5). The sign of the radius calculation determines if the Y offset is positive or negative. The proposed method of generating vehicle path prediction for VSC-A system has been implemented and evaluated successfully.

F.3.10.3.3 Target Classification

The Target Classification (TC) module for the VSC-A system provides a 360 degree relative classification of the locations of communicating remote vehicles relative to the host vehicle. Based on the selection of VSC-A applications, possible classifications of remote vehicles that would meet the classification requirements for the applications are shown below in Figure F6. For each of the remote communicating vehicles, TC also provides the Lateral Offset, Longitudinal Offset, Relative Speed, Range, Range Rate, Azimuth, etc. of communicating remote vehicles relative to the host vehicle. The flow from TC to various VSC-A system applications is shown in Figure F6.

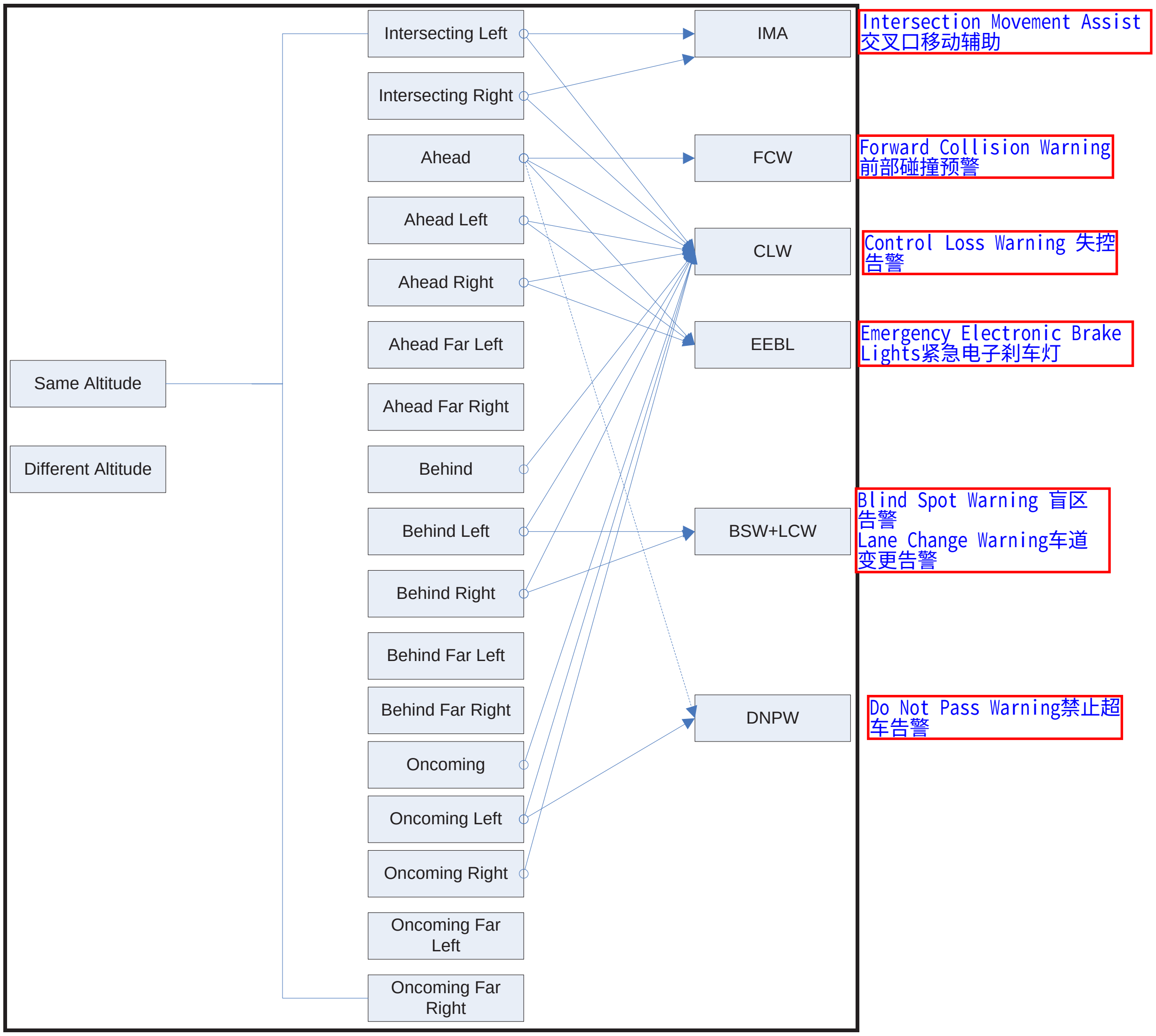


FIGURE F6 - TARGET CLASSIFICATIONS USED BY VSC-A APPLICATIONS

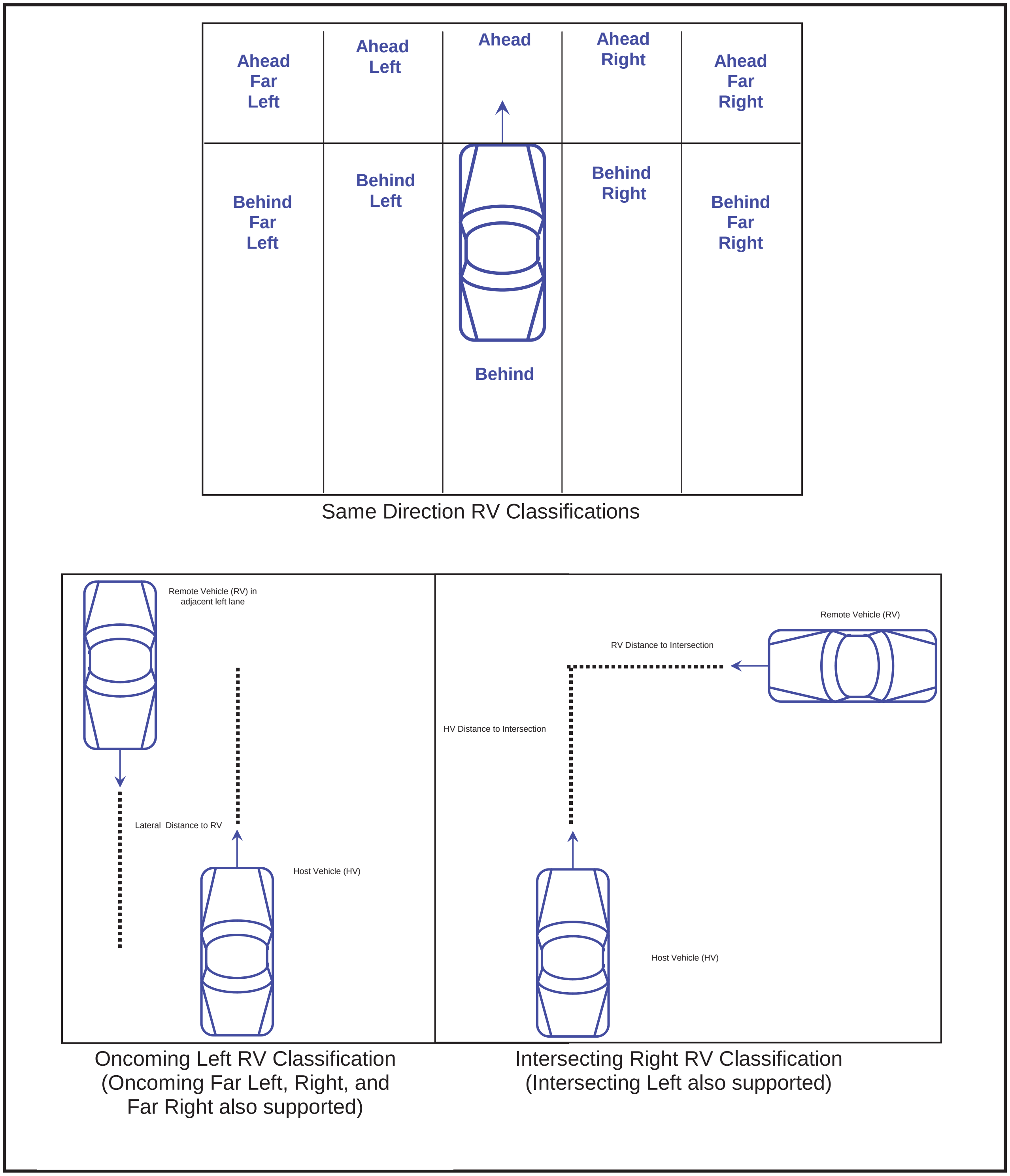


FIGURE F7 - REMOTE VEHICLE TARGET CLASSIFICATIONS

Figure F7 shows remote vehicle classifications that are typical in the VSC-A system. Note that proper classification of remote vehicles requires data elements from the message set described in Table F6. This includes latitude, longitude, and elevation from Part I, and path history and path prediction objects from Part II. In addition the accuracy of the classifications is improved when we use the relative positioning data object from Part II along with a moving base RTK algorithm for accurate relative positioning solutions.

F.3.10.3.4 Vehicle Positioning Subsystem

In the VSC-A system, vehicles share two data types for relative positioning data via over-the-air messages:

- Latitude, Longitude, Elevation (LatLon)
- Raw GPS Data

The primary focus is to establish the relative position vector (i.e., distance and orientation) between communicating vehicles. The VSC-A positioning system is capable of using two relative positioning methods:

- Using LatLon reported by two vehicles
- Using GPS raw data and RTK positioning

Figure F8 provides an illustration of the two data types for position exchange in VSC-A. GPS raw data exchange in OTA messages are based on RTCM v3.0 standard. Details of this implementation are beyond the scope of this appendix.

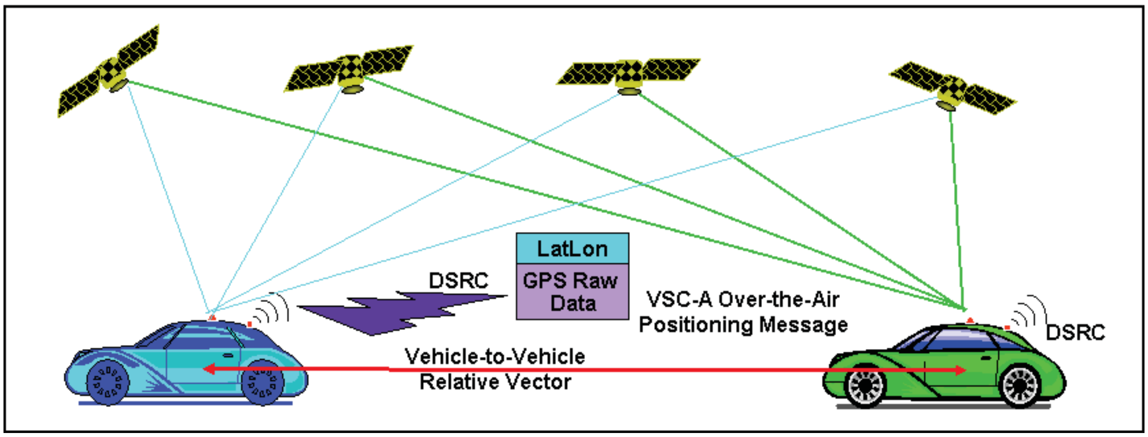


FIGURE F8 - VEHICLE POSITION DATA EXCHANGE IN VSC-A

F.3.11 References

- VSC 2 Consortium, "*Vehicle Safety Communications - Applications VSC-A First Annual Report December 7, 2006 through December 31, 2007*," found at: http://www.nhtsa.gov/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/2008/811073.pdf
- VSC 2 Consortium, *2009 SAE International Government / Industry Meeting Presentation*, found at: http://www.sae.org/events/gim/presentations/2009/ under 'Inter Vehicle Comm for Crash Av'

F.4 TRAVELER INFORMATION MESSAGE USE AND OPERATION

F.4.1 Traveler Information Introduction

Traveler Information is designed to enable delivery of broadcast advisory messages to the vehicle driver based upon location and situation relevant information. This appendix provides suggested implementations as well as descriptions of how the message set might be used. Messages are prioritized both for delivery and presentation based on the type of the advisory. Presentation to the driver may be in the form of text, graphics, or audio cues.

Examples include traveler advisories (traffic information, traffic incidents, major events, evacuations, etc.) and road signs. Traveler advisories are dynamic and temporary in nature. Conversely, road sign messages emulate their physical counterparts and are static in nature. Differences are discussed in this document.

The message, developed by the SAE-DSRC Traffic and Traveler Information Subcommittee discussed earlier in this Standard, describes the payload of the Traveler Information Message. This appendix describes how the On-Board Unit (OBU) will receive traveler information as well as how an OBU could utilize the data prior to presentation to the driver. The format and mode of the presentation to the driver is left to the developer.

F.4.2 Traveler Information Packet Structure

The following text describes the format of a packet containing multiple individual advisories or road signs (Refer to Figure F9).

F.4.2.1 Packet Structure

Multiple traveler advisories or road signs may be packaged into a single packet for transmission. However, it is recommended practice not to mix advisories and road signs within the same packet since road signs are essentially stable whereas advisories require frequent updates.

Each packet has a unique Packet ID. If a vehicle's OBU has processed a packet with a particular ID, it can then ignore subsequent packets with that same ID, updated packets will have a different ID. The recommended Packet ID structure is an octet string which is a combination of an agency identifier in the most significant byte and timestamp in the subsequent bytes. An example of this recommended Packet ID structure in shown below.

travelerInformation-identifier OCTET STRING (SIZE(4))

-- Recommended packetID structure

Byte 1	Bytes 2-4
Agency ID	*MinuteOfTheYear*

The recommended structure is an octet string which is a combination of an agency identifier is in the most significant byte that is unique within a region (e.g., state), and a timestamp in the subsequent bytes (minute of the year). The timestamp is the minute of the year when the contents of the traveler information packet was last changed. A change in any travel advisory or road sign in the traveler information packet results in a change in the timestamp.

F.4.2.2 Data Frame Header

All individual message (data frame) headers are of a common format. However, individual messages are either of type "advisory" or "road sign". If it is an advisory, the message ID consists of a 2-byte Advisory Number. This Advisory Number can be used to connect to additional message content transmitted in the ATIS message format over the IP stack, if available. Even if no additional information is available, an Advisory Number will be present and unique. Otherwise, an OBU could not determine if it is receiving repeated transmissions of the same advisory. If the message is a road sign, the message ID is a combination of 3D position, orientation of the sign and an MUTCD code. In addition to a message ID, the header contains a start time, duration time, and priority. This allows the advisory style of message to be similar to Dynamic Message Sign (DMS) content or to ATIS event message content (and therefore dynamic), whereas currently a road sign typically painted (and therefore static).

F.4.2.3 Data Frame Valid Regions

Up to 16 valid regions may be used to geographically define where each message is useful to the driver. Multiple regions are used to describe precise segments of roadway where the message applies, such as east and west bound lanes approaching an intersection or interchange.

F.4.2.4 Data Frame Content

All advisory and road sign content consists of multiple ITIS code/text fields with an optional URL to images or additional information.

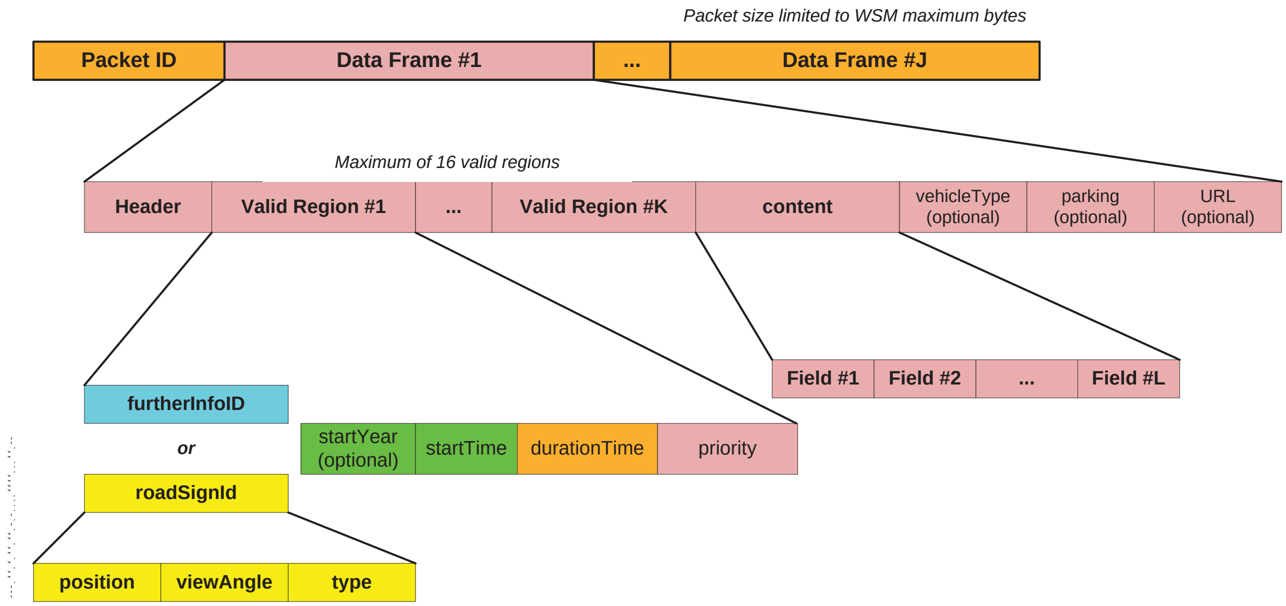


FIGURE F9 - PACKET FORMAT DIAGRAM

The ASN presentation of the message (travelerInformation) can be found in section 5.2.14.1 of this document.

F.4.3 Traveler Advisory Example

This sample packet contains two data frames, and they are both advisories. The first advisory has two circular activation regions, begins on January 10th 2008, lasts for 30 days, and warns drivers of work in the median and cautions them to drive carefully. The second advisory has one shape point set activation region, begins on January 10th 2008, lasts for 5 days, and warns drivers to use the left lane.

Both advisories also support the optional off-board URL for additional information. Some vehicles may be able to retrieve this image through an alternative mechanism - WiMax, WiFi, Cellular modem, etc. or by way of the IP stack over DSRC.

Encoding	Field	ASN.1 DC Name	Description
30 D1	DSRCMessage		TL; L = 209 bytes
	msgCount	DSRCMessage-sequence-number	always omitted for TravelerInfo
A1 CF	contents	DSRCMessageContents	TL; T = second field, constructed; L = 207 bytes
AC CD	travelerInfo	TravelerInformation	TL; T = 13th choice, constructed; L = 205 bytes
80 04 10 00 13 3D	packetID	TravelerInformation-identifier	TLV; V = Agency 16, Timestamp=Jan 4 @ 10:05 A
81 15 68 74 74 70 3A 2F 2F 77 77 77 2E 64 75 6D 6D 79 2E 63 6F 6D 2F	urlB	TravelerInformation-url-base	TLV; V = http://www.dummy.com/
A2 AE	dataFrames	TravelerInformationItems	TL; L = 174 bytes
A0 5D	dataFrame (1)	TravelerInformationItem	TL; L = 93 bytes
A0 04	msgId	TravelerInformationItemIdentifier	TL; L = 4 bytes
80 02 41 41	furtherInfoID	Advisory-identifier	TLV; V = "AA"
81 02 07 DD	startYear	TravelerInformationItem-start-year	TLV; V = 2013
82 02 34 80	startTime	TravelerInformationItem-start-time	TLV; V = Jan 10 @ 8:00 A
83 02 A8 C0	durationTime	TravelerInformationItem-duration	TLV; V = 43200 min = 30 days
84 01 03	priority	TravelerInformationItem-priority	TLV; V = prioity level 3
85 0B	commonAnchor	TravelerInformationItemAnchor	TL; L = 11 bytes
40	Preamble of SEQUENCE		no extension present; elevation present
14 DC 93 80	latitude	Location-latitude	V = 35.0000000 degrees N
B8 79 74 00	longitude	Location-longitude	V = 120.0000000 degrees W
27 10	elevation	Location-elevation	V = 1000.0 m
	commonWidth	TravelerInformationItem-default-width	omitted
87 01 00	commonDirectionality	TravelerInformationItem-default-direction	TLV; V = forward (0)
A8 1F	regions	TravelerInformationItemRegions	TL; L = 31 bytes
A0 07	region (1)	Region	TL; L = 7 bytes
	direction	Region-orientation	omitted
A1 05	area	Area	TL; L = 5 bytes
A1 03	circle	Circle	TL; L = 3 bytes
	anchor	CircleAnchor	omitted
81 01 14	radius	Circle-radius	TLV; V = 20 m
A1 14	region (2)	Region	TL; L = 20 bytes
	direction	Region-orientation	omitted
A1 12	area	Area	TL; L = 18 bytes
A1 10	circle	Circle	TL; L = 16 bytes
A0 0B	anchor	CircleAnchor	TL; L = 11 bytes
40	Preamble of SEQUENCE		no extension present; elevation present
14 DC 99 D7	latitude	Location-latitude	V = 35.0001623 degrees N (20 m N of anchor)
B8 79 74 00	longitude	Location-longitude	V = 120.0000000 degrees W
27 10	elevation	Location-elevation	V = 1000.0 m
81 01 14	radius	Circle-radius	TLV; V = 20 m

FIGURE F10 - TRAVEL ADVISORY EXAMPLE: PART 1 - START OF MESSAGE THROUGH FIRST ADVISORY

Encoding	Field	ASN.1 DC Name	Description
A9 0C	content	TravelerInformationItemContent	TL; L = 12 bytes
A0 04	content item (1)	ITIScodesAndText	TL; L = 4 bytes
80 02 04 06	itis		TLV; V = work-in-the-median (1030)
	text		omitted
A1 04	content item (2)	ITIScodesAndText	TL; L = 4 bytes
80 02 1C 01	itis		TLV; V = drive-carefully (7169)
	text		omitted
	vehicleType	TravelerInformationItem-applicable-vehicles	omitted
	parking-information	ParkingInformation	omitted
8C 07 73 61 6D 70 6C 65 31	url	TravelerInformationItem-url-short	TLV; V = sample1
A1 4D	dataFrame (2)	TravelerInformationItem	TL; L = 77 bytes
A0 04	msgId	TravelerInformationItemIdentifier	TL; L = 4 bytes
80 02 41 42	furtherInfoID	Advisory-identifier	TLV; V = "AB"
81 02 07 DD	startYear	TravelerInformationItem-start-year	TLV; V = 2013
82 02 34 80	startTime	TravelerInformationItem-start-time	TLV; V = Jan 10 @ 8:00 A
83 02 1C 20	durationTime	TravelerInformationItem-duration	TLV; V = 7200 min = 5 days
84 01 03	priority	TravelerInformationItem-priority	TLV; V = prioity level 3
85 0B	commonAnchor	TravelerInformationItemAnchor	TL; L = 11 bytes
40	Preamble of SEQUENCE		no extension present; elevation present
14 EB D5 C0	latitude	Location-latitude	V = 35.1000000 degrees N
B8 79 74 00	longitude	Location-longitude	V = 120.0000000 degrees W
27 10	elevation	Location-elevation	V = 1000.0 m
	commonWidth	TravelerInformationItem-default-width	omitted
87 01 00	commonDirectionality	TravelerInformationItem-default-direction	TLV; V = forward (0)
A8 15	regions	TravelerInformationItemRegions	TL; L = 21 bytes
A0 13	region (1)	Region	TL; L = 19 bytes
	direction	Region-orientation	omitted
A1 11	area	Area	TL; L = 17 bytes
A0 0F	shapePointSet	ShapePoint	TL; L = 15 bytes
	anchor	ShapePointAnchor	omitted
81 01 14	width	ShapePoint-width	TLV; V = 20 m
	directionality	ShapePoint-direction	omitted
A3 0A	nodes	ShapePointOffsetNodes	TL; L = 10 bytes
A0 08	node (1)	ShapePointOffsetNode	TL; L = 8 bytes
80 03 01 86 A0	xOffset	ShapePointOffsetNode-x-offset	TLV = 1000.00 m
81 01 00	yOffset		
	zOffset		omitted
	zTolerance		omitted
	width		omitted
A9 06	content	TravelerInformationItemContent	TL; L = 6
A0 04	content item (1)	ITIScodesAndText	TL; L = 4
80 02 1D 04	itis		TLV; V = use-left-lane (7428)
	text		omitted
	vehicleType	TravelerInformationItem-applicable-vehicles	omitted
	parking-information	ParkingInformation	omitted
8C 07 73 61 6D 70 6C 65 32	url	TravelerInformationItem-url-short	TLV; V = sample2
	localTravelerInformation	LOCAL.TravelerInformation	omitted
	…	extension for future versions of std	omitted
	crc	DSRCMessage-crc	always omitted for TravelerInfo
	…	extension for future versions of std	omitted

FIGURE F11 - TRAVEL ADVISORY EXAMPLE: PART 2 - SECOND ADVISORY TO END OF MESSAGE

F.4.4 Road Sign Example

This sample packet contains two generic road signs. Both road signs have a single valid region defined by a circle.

The basic content of the signs is the text string included in their “content" sections.

The signs also contain the optional off-board URLs for descriptive images. Some vehicles may be able to retrieve these images through an alternative mechanism - WiMax, WiFi, Cellular modem, etc., or by way of the IP stack over DSRC.

Encoding	Field	ASN.1 DC Name	Description
30 63	DSRCMessage		TL; L = 99 bytes
	msgCount	DSRCMessage-sequence-number	always omitted for TravelerInfo
A1 61	contents	DSRCMessageContents	TL; T = second field, constructed; L = 97 bytes
AC 5F	travelerInfo	TravelerInformation	TL; T = 13th choice, constructed; L = 95 bytes
80 04 10 00 00 00	packetID	TravelerInformation-identifier	TLV; V = Agency 16, Timestamp=Jan 1 @ midnight
81 15 68 74 74 70 3A 2F 2F 77 77 77 2E 64 75 6D 6D 79 2E 63 6F 6D 2F	urlB	TravelerInformation-url-base	TLV; V = http://www.dummy.com/
A2 40	dataFrames	TravelerInformationItems	TL; L = 64 bytes
A0 3E	dataFrame (1)	TravelerInformationItem	TL; L = 62 bytes
A0 16	msgId	TravelerInformationItemIdentifier	TL; L = 22 bytes
A1 14	roadSignID	RoadsignIdentifier	TL; L = 20 bytes
A0 0B	position	RoadsignLocation	TL; L = 11 bytes
40	Preamble of SEQUENCE		no extension present; elevation present
14 DC 93 80	latitude	Location-latitude	V = 35.0000000 degrees N
B8 79 74 00	longitude	Location-longitude	V = 120.0000000 degrees W
27 10	elevation	Location-elevation	V = 1000.0 m
81 02 80 01	viewAngle	Roadsign-orientation	TLV; V = due north
82 01 01	roadsign-ype	Roadsign-type	TLV; V = regulatory (1)
	startYear	TravelerInformationItem-start-year	omitted
	startTime	TravelerInformationItem-start-time	omitted
	durationTime	TravelerInformationItem-duration	omitted
	priority	TravelerInformationItem-priority	omitted
A5 0B	commonAnchor	TravelerInformationItemAnchor	TL; L = 11 bytes
40	Preamble of SEQUENCE		no extension present; elevation present
14 DC 8D 29	latitude	Location-latitude	V = 34.9998377 degrees N
B8 79 74 00	longitude	Location-longitude	V = 120.0000000 degrees W
27 10	elevation	Location-elevation	V = 1000.0 m
	commonWidth	TravelerInformationItem-default-width	omitted
	commonDirectionality	TravelerInformationItem-default-direction	omitted
A8 1F	regions	TravelerInformationItemRegions	TL; L = 31 bytes
A0 07	region (1)	Region	TL; L = 7 bytes
	direction	Region-orientation	omitted
A1 05	area	Area	TL; L = 5 bytes
A1 03	circle	Circle	TL; L = 3 bytes
	anchor	CircleAnchor	omitted
81 01 14	radius	Circle-radius	TLV; V = 20 m
A9 08	content	TravelerInformationItemContent	TL; L = 8 bytes
A0 06	content item (1)	ITIScodesAndText	TL; L = 6 bytes
	itis		omitted
81 04 53 54 4F 50	text		TLV; V = "STOP"
	vehicleType	TravelerInformationItem-applicable-vehicles	omitted
	parking-information	ParkingInformation	omitted
8C 02 52 31	url	TravelerInformationItem-url-short	TLV; V = R1
	localTravelerInformation	LOCAL.TravelerInformation	omitted
	…	extension for future versions of std	omitted
	crc	DSRCMessage-crc	always omitted for TravelerInfo
	…	extension for future versions of std	omitted

FIGURE F12 - ROAD SIGN EXAMPLE

F.4.5 Application and Use with DSRC

- **Network User:** Network Users generate individual advisory or road sign messages. Network users need to assign unique identifiers or "Advisory Numbers" to advisories. Road signs, however, are intrinsically identified by their location, direction and MUTCD code. The individual messages are then propagated into the backhaul network and eventually to the RSU. It is expected that this transmission will use the defined XML message formats of this Standard and TCP/IP for such transfers.

- **Network User -> RSU:** Individual advisories and road signs are combined together into packets, which must meet the maximum size limitation of Wave Short Messages (WSM). Unique Packet IDs are assigned to these combinations of specific messages. If any individual messages are altered or added to a packet, a new packet is formed with a new Packet ID.

- **RSU ->OBU Over-the-Air Traffic:** The flow of traveler advisory and road sign packets is one-way from the RSU to the vehicle (OBU). All traffic is transmitted via WSM. Very high priority packets can be transmitted over the Control Channel (CCH). However, most packets will typically be transmitted over a Service Channel (SCH). A packet is transmitted on the appropriate channel during the corresponding time slice. Depending on priority of the packet, it may be repeated multiple times per time slot to ensure delivery.

F.4.6 Handling Repeated Packets

The Packet ID is used to determine if any new traveler information messages have been received by the vehicle. If the data frames for a particular packet have already been stored locally, then subsequent receipts of the packet can be ignored. The general flow of receiving a packet is shown below.

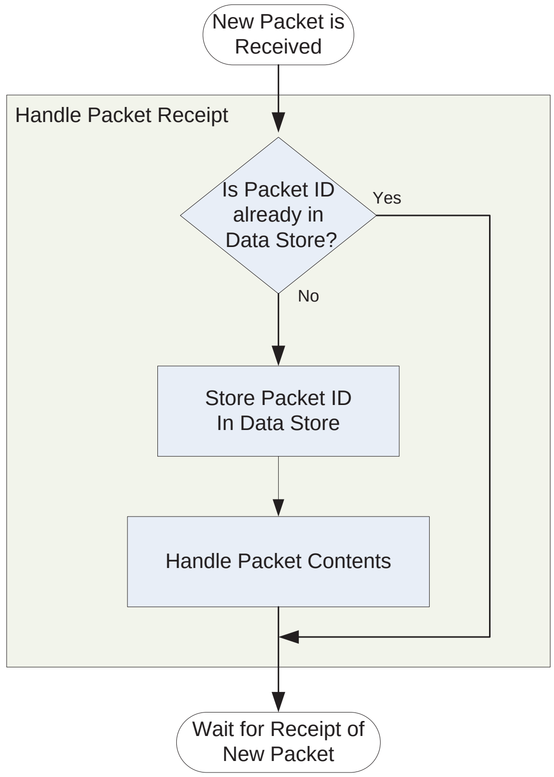


FIGURE F13 - HANDLE PACKET RECEIPT

F.4.7 Handling Newly Received Data Frames

Packets may contain geographically overlapping areas of advisories or road signs. As a result, a new packet can be received that contains advisories or road signs already stored on the vehicle. If a received road sign ID or advisory ID is not a match to anything on the vehicle, then it is new and should be stored if room is available. Note that OBU designers will have to manage their own storage policies depending on design constraints for their particular OBU. If sufficient space is not available, new data frames determined not to be in the current direction of travel may be viewed as being less pertinent and not stored. If there is a match for this ID, then the start time needs to be checked. If the stored start time is newer, then this received data frame is outdated. Likewise, if the stored start time is the same, then it is repeated. In both cases, the received data frame can be discarded. However, if the stored start time is older, then the received advisory or sign is updated. The old one is deleted, and the received one is stored in its place.

The following flowchart displays how each data frame can be parsed when receiving a new packet.

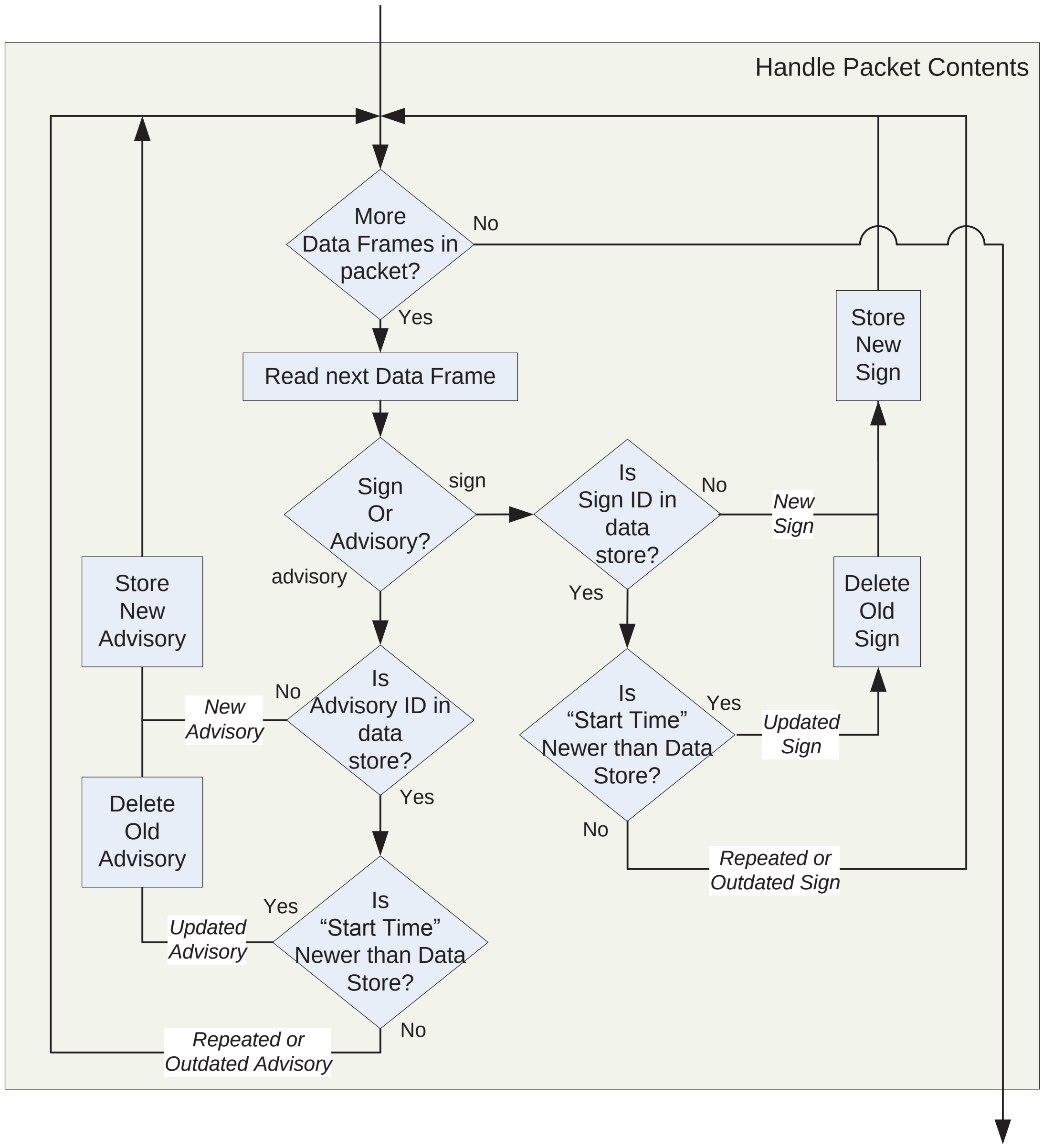


FIGURE F14 - HANDLE PACKET CONTENTS

F.4.8 Replacement Policy for Locally-Stored Messages

F.4.8.1 Pruning Messages by In-Vehicle Housekeeping

Housekeeping may need to be performed on the vehicle to delete locally-stored messages. The most obvious method is to delete stale messages with a duration time that has been exceeded. However, an OBU may have very limited physical memory and might need to employ some additional type of replacement policy when its memory limit is reached. This may be based on priority, heading, distance from vehicle, first-in first-out (FIFO), start time, etc.

F.4.8.2 Updated Messages from Network

If a network user needs to update a message, it issues it again with the same message ID but a more recent start time. Note that a message ID is either an advisory ID or road sign ID as shown previously in Figure F9. This allows for updated traveler information. A weather advisory issued in the morning may need to be updated later as conditions change.

F.4.8.3 Deleting Messages as Directed by Network User

There is also a mechanism for the Network User to delete, or recall, messages that have already made it to the vehicle. An updated message is sent where the duration time has already passed (or is set to zero). The updated message should replace the old one in the vehicle's data store, and it will now be considered stale because it has an expired valid time. A work zone warning issued early in the morning may need to be deleted if the construction schedule is delayed.

F.4.8.4 Vehicle Power-Up Events

It is advisable to store traveler information while the engine is stopped. If an OBU has the capability to store messages over a power cycle, it can utilize them immediately upon power up. Otherwise, no traveler information is available until the vehicle drives within range of roadside infrastructure (RSEs, etc.).

F.4.9 Presentation of Signs & Advisories in Vehicle

The specific presentation of road signs and traveler advisories is dependent upon vehicle manufacturer HMI guidelines, display capabilities, etc. Some vehicles may only be capable of presenting a subset of the message content. HMI design is out of scope for this document. However, three message attributes are universal - location, direction, and time. To ensure only pertinent information is presented to the driver, all messages have a physical region, direction of travel and timeframe in which they are valid.

F.4.10 Valid Time

All messages have a valid time which begins at the start time and ends after the duration time for that message. Advisories may exist for periods of time ranging from minutes to hours to many days, and even months of duration in the case of planned construction. Physical road signs exist twenty four hours a day and may be unchanged for years. Thus, during their valid time, most road signs will be valid twenty-four hours a day. This does not imply that they are valid indefinitely. When their expiration time is reached, they become invalid and should consequently be purged from the OBU. Exit service signs can contain a service provider with limited operating hours. The entire sign may be valid twenty-four hours a day, but individual services might only be presented to the driver during normal operating hours.

Valid time is transmitted in the message with a start time element. It is expressed in minute of the year format with an optional year attribute. The duration (expressed in a number of minutes from the start time), allows a span of multiple days with a resolution of 1 minute. OBU devices can easily combine these elements to determine is a specific message is still valid.

Traveler advisory are continually active during their valid time, and they should always be considered for presentation when they are active. The sign priority data element may be of value in determining this.

F.4.11 Valid Region

The validity of a sign or advisory can be evaluated spatially using its valid regions. There are three types of regions - circular, polygon and shape points. All are described below. Physically being within the area described by the region is not enough to make a message valid for display. If the region is not defined as omni-directional, then the vehicle must also be traveling in a designated direction. Each region type has its own directionality attribute.

```
Region ::= SEQUENCE {  direction          Region-orientation OPTIONAL,
        area     Area,    ... }
```

where

```
    Area ::= CHOICE {  shapePointSet          ShapePoint,
        circle    Circle,
        polygonPolygon}
```

The direction of travel is described by dividing a range of 360 degrees into 16 different segments (each of which are 22.5° wide) and can be combined to define the required heading of the vehicle within the region. An advisory is valid anytime a vehicle is within the circular region and traveling within the direction defined by *region-orientation*. In Figure F15, a circular region is used for a coastal flooding advisory. The region is centered on Zeeland, MI with a 30 mile radius. The *region-orientation* is ‘0111111000000000’B or ‘7E00’H. With this region definition, if the vehicle is within the circle and has a heading between 202° and 337°, the advisory is valid.

F.4.11.1 Circular Region

A circular region is the simplest region. It works well to cover a general area that is not restricted to one specific road segment. It can be quite effective for very large areas. A weather advisory for the entire Detroit Metropolitan area could utilize a large circular region that is valid for all directions of travel.

Circle ::= SEQUENCE { anchorCircleAnchor OPTIONAL,

radiusCircle-radius, ... }

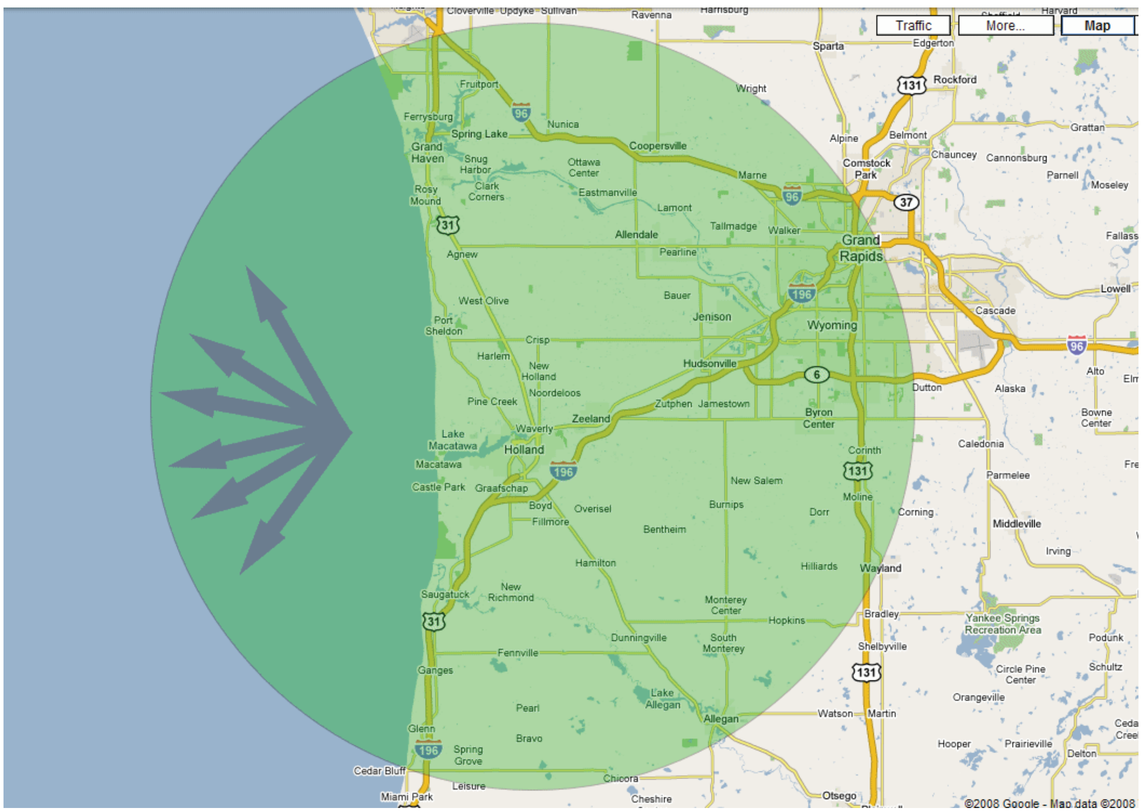


FIGURE F15 - CIRCULAR REGION

Circular regions should be used to designate extremely large areas. A circle can be set as large as an entire state or county. Setting the *region-orientation* to 0xFFFF ensures that any vehicle within the region will consider the corresponding traveler information to be active.

In the following example, a weather advisory needs to be issued that is relevant to the entire southeastern portion of Michigan. The following table represents a circular region centered around Green Oak, Michigan with a radius of 100 kilometers. The region is valid for any direction of travel. Figure F16 graphically demonstrates the region.

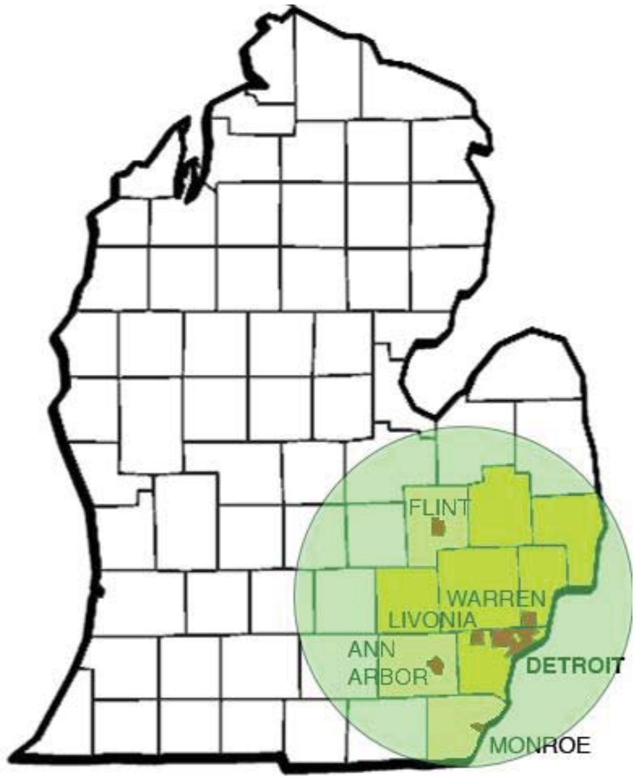


FIGURE F16 - LARGE WEATHER ADVISORY

F.4.11.2 Polygon Region

While the circular region is simple, its shortfall is that it is too inclusive. A polygon can describe complex regions such as an agency's jurisdictional coverage (See Figure F17).

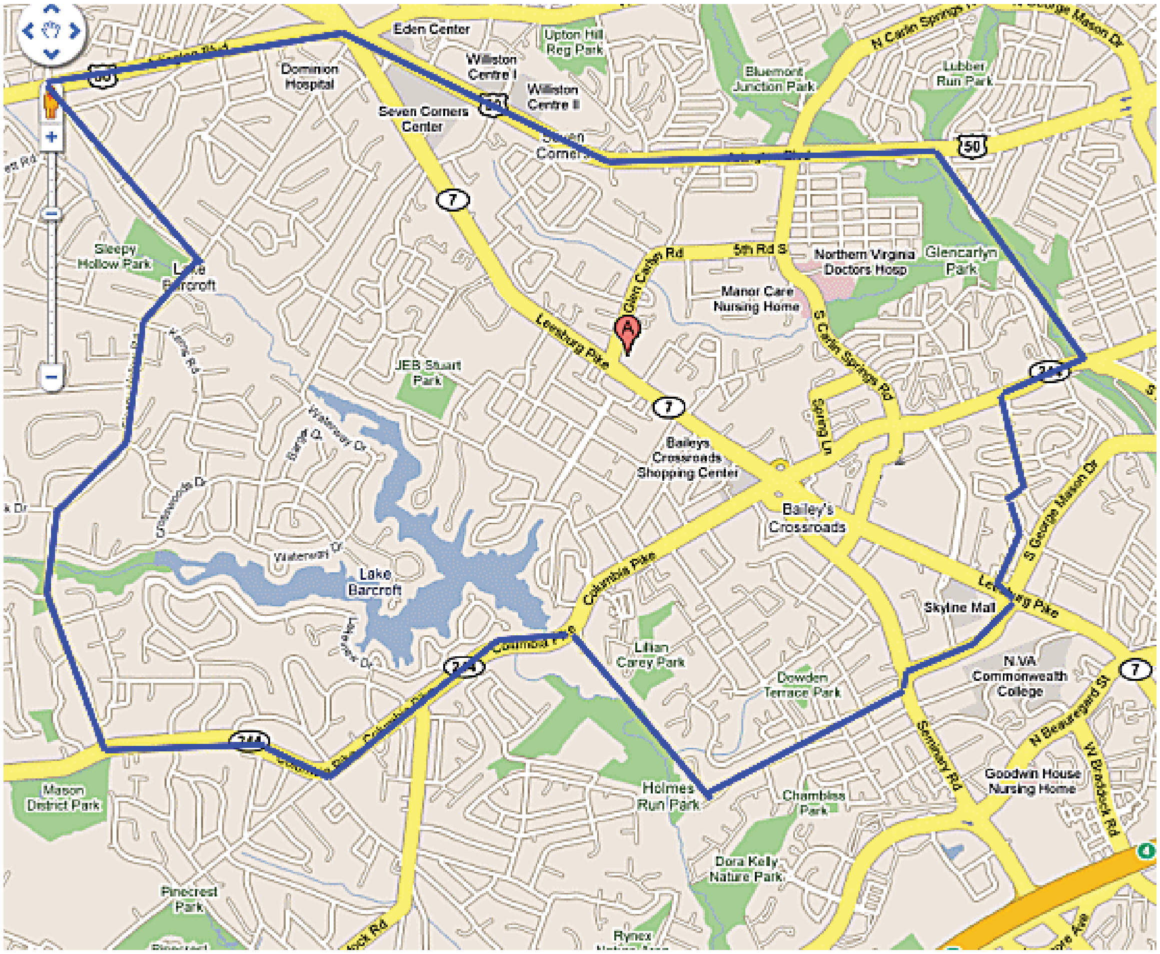


FIGURE F17 - JURISDICTIONAL COVERAGE OF A PARTICULAR AGENCY

A polygon area is defined by a series of offset points (x-axis, y-axis based on the WGS-84 coordinate system), measured in one meter units, from an anchor point which is defined by a geographic location (latitude, longitude, elevation).

F.4.11.3 Shape Point Set Region

An alternate form of valid region is the shape point set. It allows a spline-like representation of a road segment using the same concepts developed for DSRC map fragments and is intended to tightly bind the region to the contour of a particular road. The described segments use a node list to efficiently describe the contour of the roadway center line as well as any changes in width and elevation (optional elements used only when needed).

F.4.11.3.1 Simple Shape Point Set Region

A set of two shape points is the simplest form of this region. It defines a region that can be placed so that it overlays and includes a straight road segment. Using appropriate lane widths, two shape point sets can describe an intersection. In Figure F18, an intersection is defined by two valid regions. Both valid regions are simple shape point sets containing only two nodes each.

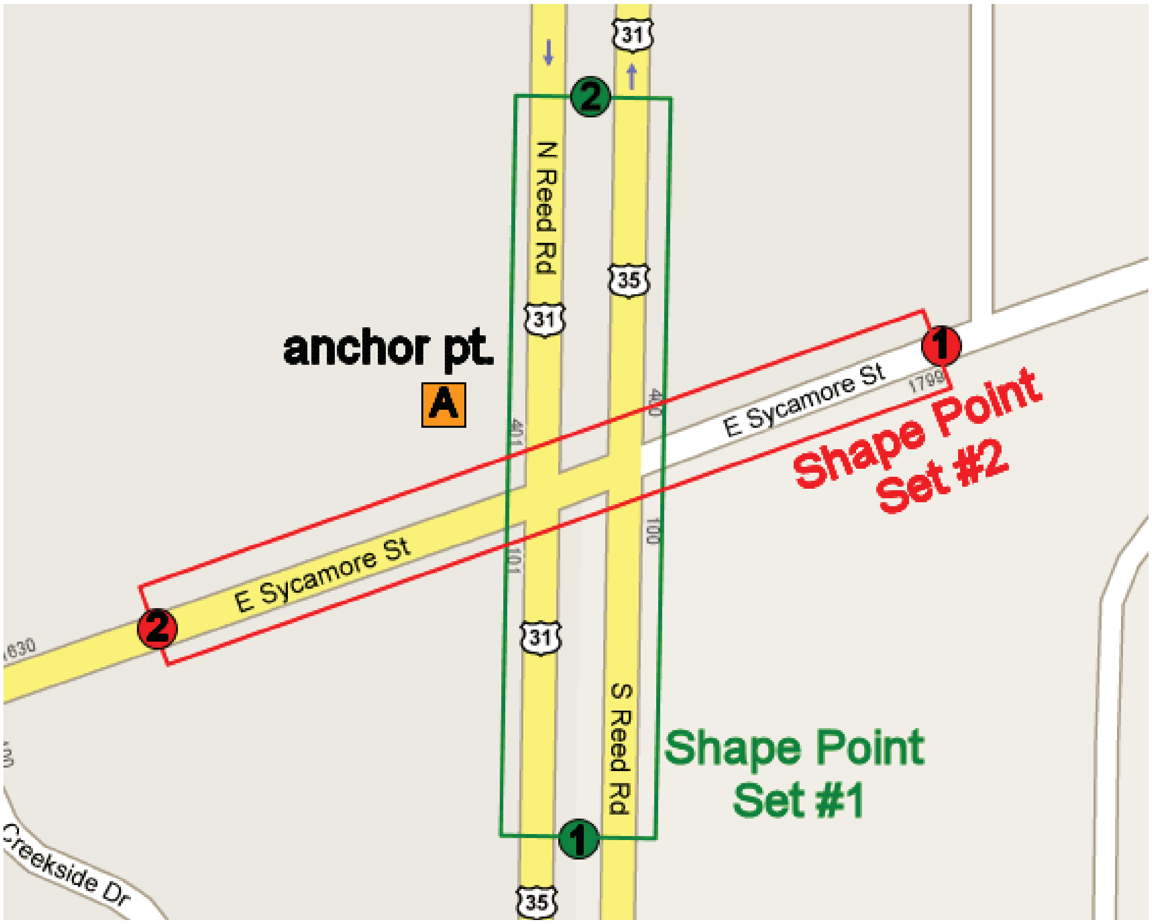


FIGURE F18 - SIMPLE INTERSECTION DEFINED BY TWO SHAPE POINT SETS

F.4.11.3.2 Multiple-Regions

Traveler Advisory data frames can contain up to sixteen valid regions. In Figure F19, four shape point set regions are used to describe the intersection in more detail. More complicated road structures can be described by using more regions, multi-node sets and directionality.

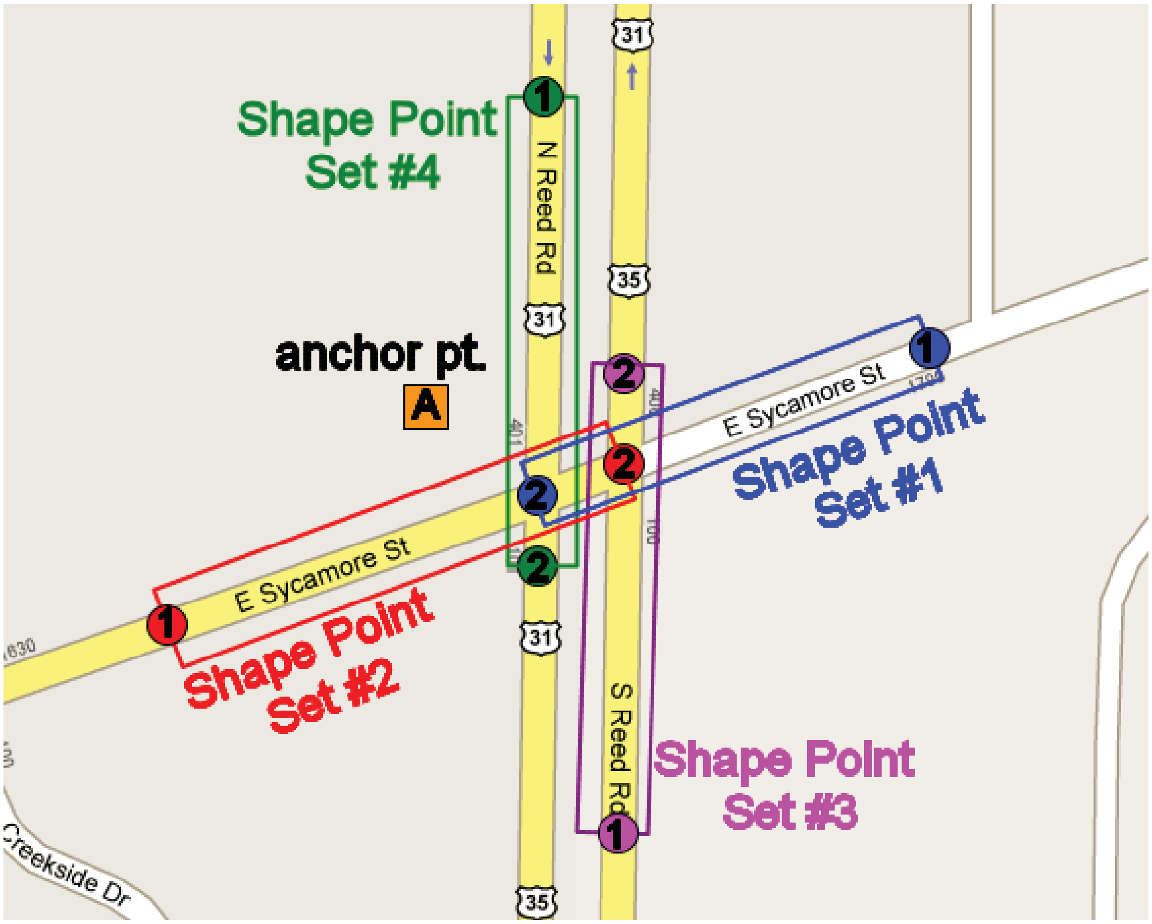


FIGURE F19 - INTERSECTION DEFINED BY 4 SHAPE POINT SETS

F.4.11.3.3 Multi-Node Sets

In previous examples, only two nodes were present in each set. Sets can contain up to 64 nodes. They can be constructed to closely follow the contour of the road segment they represent. The four node sets in Figure F20, show that even a modest number of nodes can represent a curved road well.

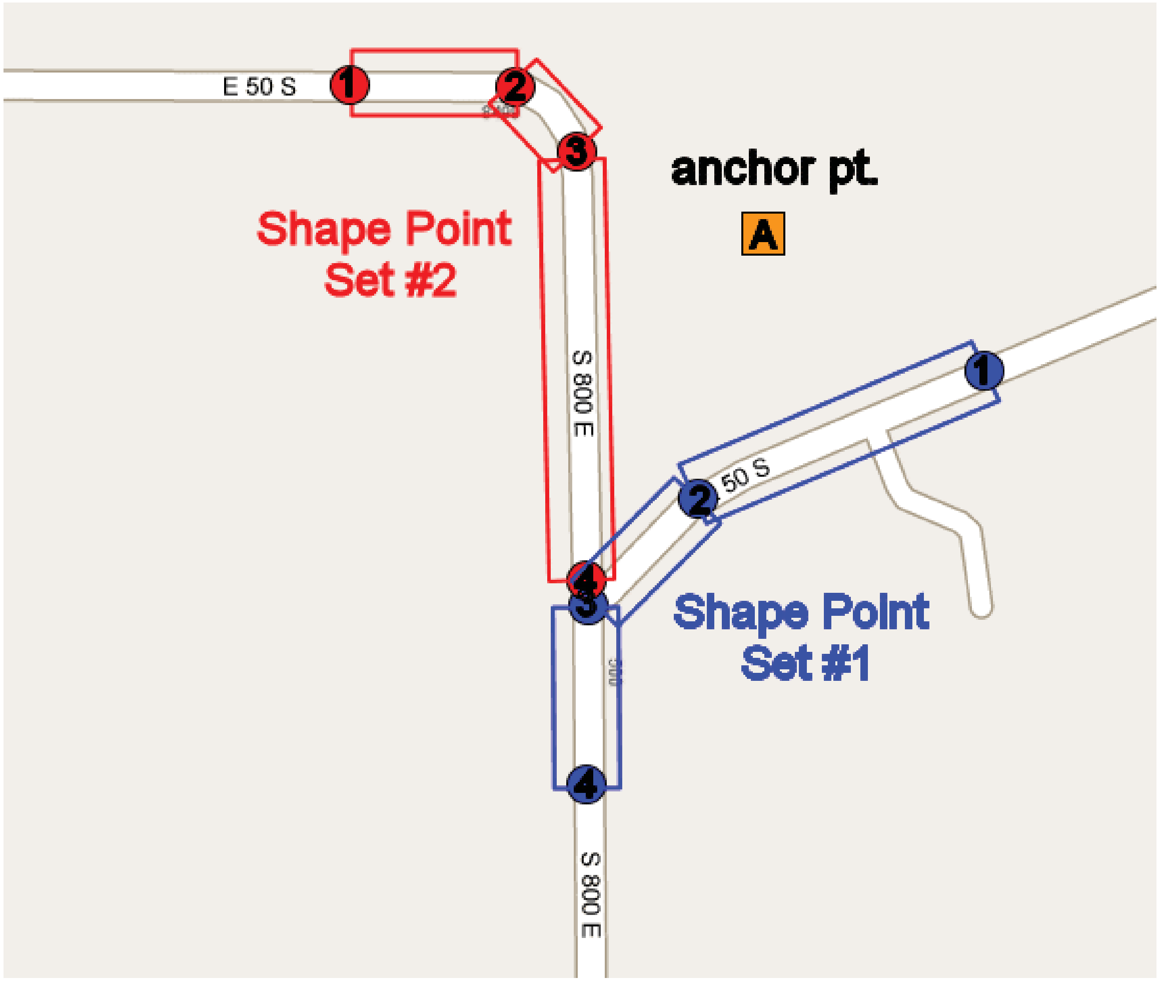


FIGURE F20 - MULTIPLE NODE SHAPE POINT SETS

F.4.11.3.4 Directionality

A set of shape points has three directionality characteristics.

- Forward Travel (originating from node 1)
- Reverse Travel (moving backwards towards node 1)
- Both (or All) Directions of Travel

Below, vehicles traveling forward will be cautioned about the lack of a road shoulder. Vehicles traveling in the reverse direction will not be advised.

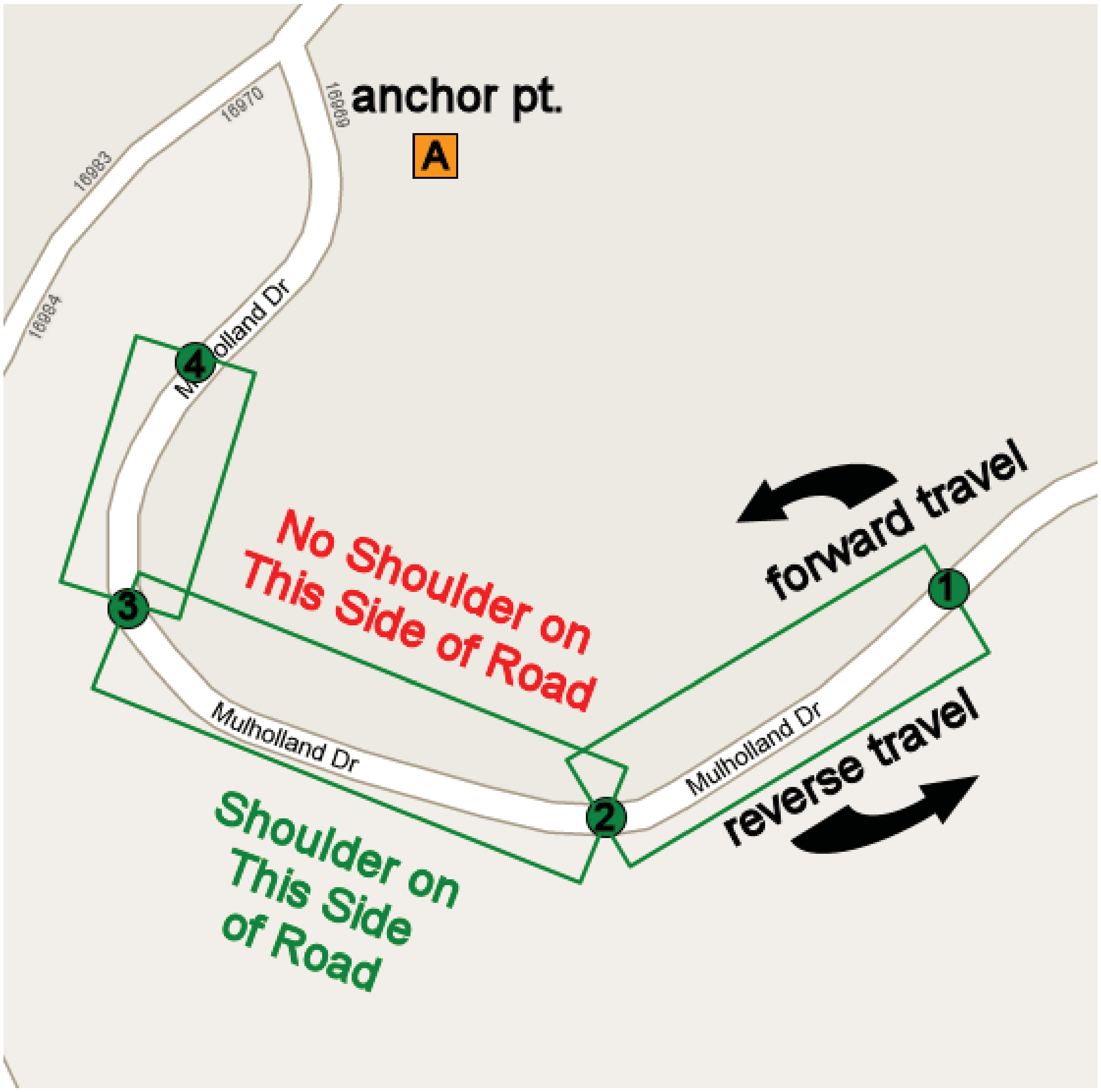


FIGURE F21 - SHAPE POINT SET UTILIZING HEADING ELEMENT

F.4.11.3.5 Optional Z-Axis Element

Each node in a shape point set is defined by an x-offset (longitude) and y-offset (latitude) from the anchor point. There is also an optional z-offset (elevation). In the example shown in Figure F22, the road segment crosses over itself. The message originator can utilize the z-offset elements to precisely define this region. The use of z-offsets is also beneficial in the case of multiple level highways such as the San Francisco-Oakland Bay Bridge.

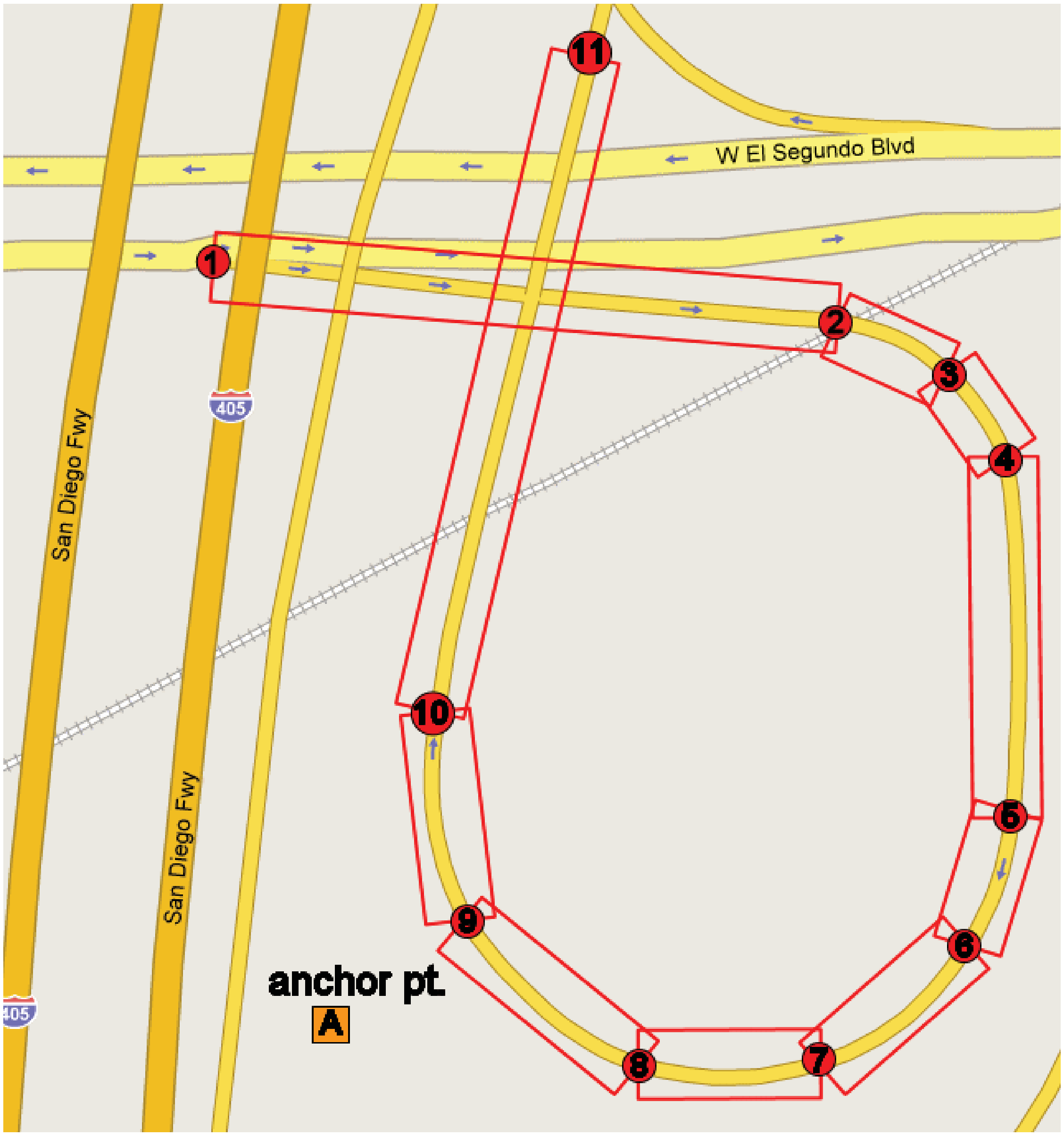


FIGURE F22 - OVERLAPPING REGION

F.5 TRAFFIC PROBE MESSAGE USE AND OPERATION

F.5.1 Probe Data Introduction

Probe Data is comprised of vehicle attribute and sensor data that is collected and sent from a vehicle OBU to a local RSU. The data may be sent by alternate mechanisms. This data may be used to ascertain real-time road, weather, and traffic conditions. The post-processed data will be used to advise vehicles approaching the area of current conditions and suggest appropriate action. This data is collected autonomously as vehicles are traveling along the roadway system and sent to an RSU when applicable. The probe message developed by the SAE-DSRC Traffic and Traveler Information Subcommittee discussed earlier in this Standard, describes the payload and format of the Probe Data Message. This Appendix describes when the OBU should collect Probe Data from the vehicle's internal modules/sensors as well as when and how an OBU could send the data.

F.5.2 Probe Message Structure

A Probe Message is transmitted from a vehicle to an RSU, which contains several snapshots, as well as the standard SAE J2735 message common header. The simplified structure of a probe message and snapshots is illustrated below.

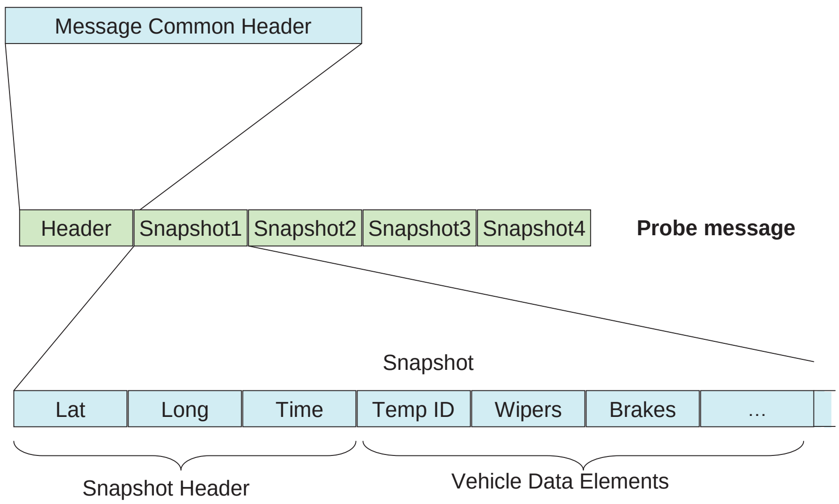


FIGURE F23 - PROBE MESSAGE AND SNAPSHOTS

The current allowed vehicle data elements that are included in the probe snapshot are listed below in Table F8. This table also lists what information is mandatory to be included in a snapshot, what information is mandatory to be included if available, and what information is optional. The message structure allows additional data elements as technology changes in vehicles and as the standard is revised.

TABLE F8 - SNAPSHOT DATA

Data	Data Concept	Conformance
Vehicle Position	location-oer	mandatory
Positional Accuracy	location-oer	mandatory
Transmission State	vehicle-movement-per	mandatory
Heading	vehicle-heading	mandatory
Device Acceleration	acceleration4Way	mandatory
Device Vertical Acceleration	acceleration4Way	mandatory
Yaw Rate	acceleration4Way	mandatory
Braking Activity	vehicle-brake-system-status-per	mandatory
Antilock Brake Status	vehicle-brake-system-status-per	mandatory
Traction Control State	vehicle-brake-system-status-per	mandatory
Stability Control Status	vehicle-brake-system-status-per	mandatory
Brake Boost	vehicle-brake-system-status-per	mandatory
Brake Applied Pressure	vehicle-brake-applied-pressure	mandatory (if available)
Wheel Vertical Acceleration	vehicleEnvironment-vertical-acceleration-flag	mandatory (if available)
Vehicle Lights Status	vehicle-lights	mandatory (if available)
Vehicle Front Wiper Status	wiperStatus	mandatory (if available)
Vehicle Front Wiper Sweeping Rate	wiperStatus	mandatory (if available)
Vehicle Rear Wiper Status	wiperStatus	mandatory (if available)
Coefficient Of Friction	vehicleEnvironment-roadway-friction	mandatory (if available)
Solar Radiation	vehicleEnvironment-sunlight	mandatory (if available)
Ambient Air Temperature	vehicleEnvironment-temperature-air	mandatory (if available)

Data	Data Concept	Conformance
Ambient Air Pressure	vehicleEnvironment-air-pressure	mandatory (if available)
Precipitation Rate	vehicleEnvironment-precipitation-rate	mandatory (if available)
Obstacle Information	obstacle	mandatory (if available)
Vehicle Status Change	vehicle-events	mandatory (if available)
Vehicle Type	vehicle-type	optional
Vehicle Identifier	vehicleIdentification	optional
Wind Direction	snapshotWeather-wind-direction	optional
Wind Speed	snapshotWeather-wind-speed	optional
Dewpoint Temperature	snapshotWeather-dewpoint	optional
Total Radiation	snapshotWeather-radiation	optional
Visibility	snapshotWeather-visibility	optional
Surface Temperature	snapshotWeather-surface-temperature	optional
Roadway Water/Ice Depth	snapshotWeather-precipitation-depth	optional
Roadway Snow Depth	snapshotWeather-snow-depth	optional
Adjacent Snow Depth	snapshotWeather-snow-depth-adjacent	optional
Fuel Type	vehicle-fuel-type	optional
Fuel Economy	vehicle-fuel-economy	optional
Fuel Remaining	vehicle-fuel-remaining	optional
Charge Remaining	vehicle-charge-remaining	optional
CO Emissions (Running)	emissions-carbonmonoxide-running	optional
CO Emissions (Idling)	emissions-carbonmonoxide-idling	optional
NOx Emissions (Running)	emissions-nox-running	optional
NOx Emissions (Idling)	emissions-nox-idling	optional
SO2 Emissions (Running)	emissions-so2-running	optional
SO2 Emissions (Idling)	emissions-so2-idling	optional
CO2 Emissions (Running)	emissions-co2-running	optional
CO2 Emissions (Idling)	emissions-co2-idling	optional
PM10 Emissions (Running)	emissions-pm10-running	optional
PM10 Emissions (Idling)	emissions-pm10-idling	optional
PM2.5 Emissions (Running)	emissions-pm25-running	optional
PM2.5 Emissions (Idling)	emissions-pm25-idling	optional
VOC Emissions (Running)	emissions-voc-running	optional
VOC Emissions (Idling)	emissions-voc-idling	optional

F.5.3 Application and Use with DSRC

The messages in this application are transmitted using the Wave Short Message protocol (WSM) stack in a single attempt unicast mode on a Service Channel (SCH) determined by the Roadside Unit (RSU) that has signaled its ability to receive this type of message (based on PSID value and running a suitable application). Upon reception of such messages they are examined for content and relevance regardless of the sender's ACM.

This is a provider application that employs a Wave Basic Service Set (WBSS) announced by the RSU as per IEEE 1609.4 Clause 5.3. A confirm-before-join operation is not required by the application in order to join and/or send Probe Data snapshots. When the application receives a Wave Management Entity (WME) notification (indicating a WBSS has been joined) from the (WME), it will request access to the WBSS to send all available snapshots.

This application shall transmit its messages using a PSID of 5, as defined by IEEE 1609.4 or its successors, and a PSC of 3. Probe Data is a one-way communication stream, vehicle-to-RSU, with no acknowledgements sent back to the vehicle by the RSU.

F.5.4 Probe Snapshot Generation

A Probe Data Message consists of a series of Probe Data Snapshots taken autonomously as the vehicle travels. In the absence of any overriding probe management messages (discussed later) snapshots are generated in three manners:

- Periodically - at intervals based on vehicle movement between RSUs
- Event Triggered - these occur when the state of certain vehicle status elements change
- Starts and Stops - these occur when a vehicle starts moving and stops moving

These snapshots consist of all probe data elements that are available on the vehicle, along with the time and location when each snapshot was taken. Not all vehicles will support all probe data elements when the DSRC system is first launched therefore, if a vehicle does not have the ability to send a certain element, it should not send any reference to that element.

The specific encoding of data elements sent in snapshots follows the ASN definitions provided. When more than one element is sent, i.e., a data frame (as in the case of selecting a specific wheel and then providing data about it) the normal tagging rules are still followed. The net effect of this over the air is typically a tag byte followed by a length byte, followed by the data itself.

F.5.4.1 Periodic Snapshots

In order to obtain ubiquitous coverage nationwide, periodic snapshots are intended to distribute snapshots between RSUs. To do this, the default method for the periodic snapshots is designed to space the snapshots at regular intervals between RSUs.

The default method for generating periodic snapshots is to use time and the vehicle's current speed to linearly space the intervals between snapshots. Although the method could use distance, the arguments for distance depend on uneven flow, such as when incidents occur however, most flow occurs when there are no incidents and thus using time as the default should provide a more uniform distribution of snapshots. As vehicle speed increases, the snapshot interval increases. This results in more widely spaced snapshots at higher speeds and closer spaced snapshots at lower speeds. This approach is used because in general RSUs will be further apart on higher speed roads.

The following assumptions were used to determine the default interval between snapshots:

- For the rural case at 60 mph (26.8 m/s), the RSU spacing is 10 minutes, or 600 seconds. When dividing this time by 30 snapshots it results in a snapshot interval of 20 seconds.
- For the urban case at 20 mph (8.9 m/s), the typical trip between RSUs would take 120 seconds or a snapshot interval of 4 seconds.

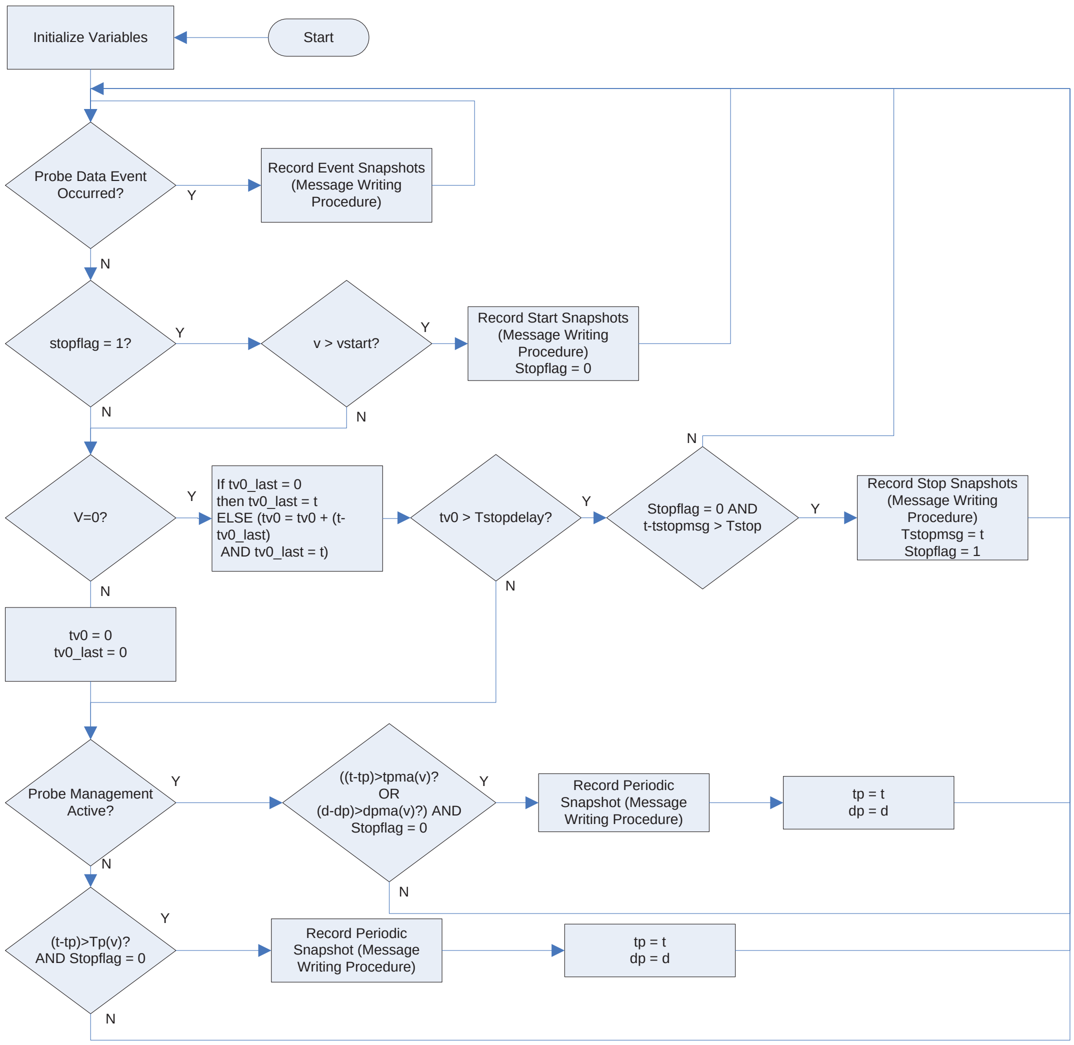
Thus the snapshot interval is:

- 4 seconds if speed is ≤ 20 mph and
- 20 seconds if speed is ≥ 60 mph

Between 20 mph and 60 mph a linear spread of snapshot intervals would be used, this is achieved by using the speed when a snapshot is taken to set a timer to count down to the next snapshot.

The exception to the above method is that periodic snapshots do not get collected after the vehicle is stopped (see below under starts and stops).

The implementation of the message recording loop is shown in the figure below.



Definition of Variables:
v = current velocity
t = current time
d = current distance
dp = distance at last periodic message recording
stopflag = bit indicating whether vehicle stopped (1 = stopped)
tp = time of last periodic message recording
tv0 = amount of time, in seconds, vehicle speed has been 0 mph?
tv0_last = time in ms since the last V=0 evaluation

Definition of Parameters:
Dpma(v) = vector of distances for periodic message recording from probe management
Tp(v) = vector of times for periodic message recording (function of velocity.
Tpma(v) = vector of times for periodic message recording from probe management
Tstop = length between stop messages when vehicle stopped (15s)
Tstopdelay = delay time at v=0 before observing vehicle stop (5s)
Vstart = minimum velocity to observe vehicle start

FIGURE F24 - MESSAGE RECORDING LOOP

While it is recognized that RSU spacing will vary from these assumptions, traffic engineers will have the ability to actively manage the collection of probe data by changing the snapshot interval parameters for RSUs in their purview. This management process is defined later.

F.5.4.2 Event Triggered Snapshots

Event triggered snapshots may be triggered by change in vehicle status elements, either a state change (e.g., from off to on) or when a value exceeds a specific threshold or undergoes a transition. The purpose of event triggered snapshots is to gather data on occurrences in the vehicle that are transitory by nature. An example of an event driven device is traction control switching from off to on. Multiple activations of traction control at adjacent locations could be used to indicate the location of a slippery road section.

F.5.4.3 Starts and Stops Snapshots

Snapshots may also be generated by stops and starts. Start and Stop events are defined as the following:

- A **Stop** is when there is no movement for a threshold stop time (default stop time threshold = 5 seconds) and no other stops have occurred within another threshold time (default last stop threshold time = 15 seconds). The latter being intended to prevent multiple counts when cars creep forward.

- A **Start** is when the vehicle speed exceeds a threshold (default start speed threshold = 10 mph (4.5 m/s)).

As noted previously, no snapshots are taken after a vehicle has experienced a stop event until the vehicle experiences a subsequent start event.

Starts and stops are useful indicators in a variety of traffic flow measures, including incident detection and clearance, and traffic signal operational measures such as cycle failures - where the queue does not dissipate in the first green phase.

F.5.5 Message Transmission Order

When a vehicle encounters an RSU that advertises the application using a PSID of 5 and a PSC value of 3, the OBU may send a single Probe Data Message Set, comprised of several individual snapshots, on the Service Channel indicated by the RSU. Snapshots are sent to the RSU as part of a probe message in the following order:

1. Event triggered snapshots are first in the transmission queue from the OBU to the RSU. Since these often relate to specific adverse conditions that are of interest to traffic operations, these are considered more critical than the other types of snapshots.

2. Stop or start triggered snapshots are second and are needed to provide finer information on incidents and the various dynamic parameters concerning the traffic flow.

3. Periodic snapshots are third, oldest first.

The snapshots are queued into groups of four per message, apart from when PSN (Probe Segment Number as defined below) changes cause a new message. Messages with start and stop snapshots and/or periodic snapshots should be composed of snapshots with the same PSN. Different PSNs should be in different messages. All of these messages are then sent as a set. Following transmission, all snapshots including non-transmitted snapshots in the buffer are purged. The implementation of the message transmit loop is shown in Figure 17.

F.5.6 Probe Segment Number (PSN)

The periodic snapshots are tagged with a short-lived Probe Segment Number (PSN). The PSN is regularly changed to ensure privacy. This change occurs following either 120 seconds or 1 km whichever comes last. To aid anonymity:

- Snapshots within the same probe message shall not contain different PSNs.
- The same PSN cannot be transmitted from the same vehicle to more than one RSU.
- PSNs are limited in duration to 120 seconds or 1 km whichever comes last.
- Separate messages can be transmitted to a single RSU with different PSNs.
- When a new PSN is generated there is a random changeover gap of 50 to 250 m or 3 to 13 seconds whichever comes first. Two random numbers should be used, one for distance one for time.
- When the vehicle identifies a "Leave RSU" state, all remaining snapshots containing a PSN that has already been sent to an RSU will be purged from the buffer. (A "Leave RSU" event/state is when the RSU communications link is not available for 6 minutes or 4 km, whichever comes first.)
- Event snapshots do not contain a PSN.

Figure 22 illustrates the reasons for changing a PSN.

F.5.7 Buffer Overflow - Snapshot Deletion

The OBU should store a minimum of 30 Probe Data Snapshots to ensure data relevancy for areas of sparsely deployed RSU. When the snapshot buffer is full the snapshots should be deleted in the following order: first periodic, second start/stop and third events. The deletion of the periodic snapshots should follow the following process.

The oldest periodic snapshot is deleted last. The first snapshot to be deleted is second oldest, then the fourth, sixth, etc. This is repeated until the snapshot in the position halfway between the oldest and the newest period snapshot is met and then the process is repeated starting again at the snapshot in the second position.

This process provides two features: the oldest periodic snapshot is kept to assist in the estimate of travel time and the deletion of snapshots is preferentially applied to the older data that is less relevant. The process is illustrated in Figure 20. The figure does not illustrate the effect of the deletion process if there are event snapshots; the effect of these is to reduce the point at which the deletion cycle is repeated.

Figure 21 illustrates the implementation of the snapshot deletion process.

F.5.8 Probe Data Message Sets Received By an RSU

When an RSU receives a Probe Data Message Set it can send the data to the RSU’s primary Network Access Point (NAP). The NAP then forwards the data to the Service Delivery Node (SDN) which maintains Subscriber Registration and Subscription information and publishes the data to all valid subscribers such as a local Traffic Operation Center or third party Content Service Providers.

Local systems, if authorized, can subscribe to probe data directly from the RSU. This will allow local systems and signal controllers to use probe data directly and significantly reduce bandwidth requirements.

F.5.9 Vehicle Anonymity

Probe snapshots when sent to the RSU and forwarded to an SDN publish/subscribe service will contain no record[12] of the originating vehicle nor will there be any information that directly links one PSN with another PSN. To aid anonymity:

- The collection of snapshots does not begin until 500 meters or 120 seconds (whichever occurs first) after the vehicle start up. All snapshots are purged from vehicle memory as they are sent to an RSU and also when the vehicle is turned off.

F.5.10 Probe Data Security

Probe data message Sets are sent, unicast, to the RSU. The RSU will NOT send an acknowledgement back to the OBU; therefore, if the message does not get through it is lost. All probe messages will be authenticated to ensure message validity and protect their contents. Key management is assumed to be handled by another layer, such as the IEEE 1609.2 Security Layer.

F.5.11 Probe Data Message Management

This message is broadcast from the RSU to all vehicles. Its purpose is to change the snapshot generation characteristics of the OBU. For example, the OBU can be instructed to take snapshots more frequently and transmit them more often. It does not change the snapshot message.

Probe management is temporary. By default a probe message management process ceases when a new RSU that supports probe messages is contacted. This case overrides the termination settings below.

Probe messages can be set to terminate as follows:

- A time-based duration expires,
- A distance-based length has been traversed, or
- A vehicle is out-of-range of the current RSU.

When a probe management message terminates the default conditions again operate in the OBU unless or until a new probe management message is received. Probe management messages may perform the following functions either singly or in combination:

- Control the production of snapshots by either distance or time
- Direct the management message to vehicles moving in specified directions
- Control how often snapshots are transmitted
- Be applied to only a random sample of vehicles
- Modify the thresholds of when event snapshots are triggered
- Modify the thresholds of start/stop snapshots

[12] Some public fleet vehicle types may provide additional identity information.

F.5.11.1 Probe Message Management: Time or Distance Periodic Snapshot Generation

The first component of the Time or Distance Snapshot Generation element is a switch indicating if snapshot generation can be based on a time interval or distance interval.

If time is to be used the message will have the capability of changing the default snapshot intervals as well as the speeds for these intervals:

T_1 = 4 seconds at S_1 = 20mph

T_2 = 20 seconds at S_2 = 60mph

TABLE F9 - SNAPSHOT GENERATION - TIME INTERVALS

Speed	Time Between Snapshots
≤ S_1	T_1
>S_1 & < S_2	linear extrapolation
>S_2	T_2

This will allow applications and users to fine tune the probe data being received. For example, if this is an urban freeway where the speeds are high but the RSUs are close together, then the 20 seconds at 60mph may be changed to 10 seconds to provide a finer geographic resolution of the data.

Additionally, an alternative method would be to enter a single time interval for T1 and T2, thus taking snapshots at constant intervals, independent of speed, such as one per second (T1 = 1 and T2 = 1).

If distance is to be used then a similar set of parameters can be sent, but instead the times (T1 and T2) would be replaced with distances (D1 and D2) in meters. In the same manner as the time calculation above, the distance used between speeds S1 and S2 will be linearly extrapolated. As before, two speeds (S1 and S2) can also be set, yielding the following:

TABLE F10 - SNAPSHOT GENERATION - DISTANCE INTERVALS

Speed	Distance Between Snapshots
≤ S_1	D_1
>S_1 & < S_2	Linear extrapolation
>S_2	D_2

This allows the operator to change the profile of the data collection policy to meet circumstances such as incidents. For example, an incident typically causes the traffic upstream of the incident to slow, but the downstream traffic flows rapidly. In this case D_1 can be made small to accommodate queue measurement and D_2 made large to space out the snapshots downstream of the incident.

An allowed alternative method would be to enter a single distance interval for D_1 and D_2, thus taking snapshots at constant distance intervals, independent of speed, such as once per 10 meters (D_1 = 10 and D_2 = 10). This would allow the user managing the probe data generation, given knowledge of the distance and direction to the next RSU, to evenly geographically space snapshots.

F.5.11.2 Probe Message Management: Interval between Probe Message Broadcasts

This parameter will control when the snapshots are transmitted back to the RSU as part of probe messages. This could allow the management message to request that probe messages be sent to the RSU at an interval other than the default (which is when a vehicle first enters range of an RSU). For example, this might allow an adaptive control system to request periodic snapshots be generated every two seconds and probe messages transmitted every four seconds (i.e., each probe message would contain only 2 periodic snapshots) while in range of the RSU.

For example, an RSU with a radius range of 1 kilometer along a roadway (and therefore spanning 2 km of any vehicle's path) would have an individual OBU in view for about 400 seconds if the vehicle were traveling at approximately 10 mph. For example, this may be used at a complex interstate intersection to determine the onset of congestion at merge areas.

F.5.11.3 Probe Message Management: Termination

This parameter is required to ensure that the OBU snapshot generation settings revert back from managed settings to the default settings. This parameter will contain data such that when the first of the following events occurs, probe snapshot generation returns to the default settings:

- A time-based duration expires
- A distance-based duration expires (i.e., a vehicle travels a certain distance)
- A vehicle is out-of-range of the current RSU for a threshold time (default: 5 seconds) - i.e., after 5 seconds of no RSU signal is received then management process is terminated

These values can be set independently, for example if time and out of range are not set then distance only applies. For example if distance were set at 1 kilometer for westbound vehicles then, if no new RSUs were encountered and no events or stops and starts occurred, the OBU would collect one snapshot per kilometer for the next 30 km.

F.5.11.4 Probe Message Management: Vehicle Status Element Triggers

This parameter may be used to adjust event triggered snapshot generation by adjusting the threshold of or transitions in various vehicle status elements which can be used as triggers.

For example, this parameter might include the vehicle status element for vertical acceleration, and a reduced threshold value. Thus, this would generate more snapshots that could be used as a roughness measurement. Another example would be to reduce the threshold of vertical g forces on each wheel to zero to calibrate road slope as a function of speed to determine adverse cambers.

F.5.11.5 Probe Message Management: Vehicle Sampling

The probe management message is a broadcast message. Therefore, all vehicles within range of an RSU receive this message and respond to it. However, it is possible to control the percentage sample of vehicles which respond to any message by including in the probe management message a vehicle sampling parameter. This parameter has two digits (range 0 to 255), which represent the range of the last digit of the OBUs MAC address for those vehicles to which the management message applies.

For example, by setting the first value to 0 and the second value to 63, all those OBUs with a current MAC address that ends in the range 0 to 63 would use this probe management message, thereby yielding a sample of one fourth of all vehicles (MAC addresses are hexadecimal, much like an IP address, and the last digit can vary from 0 to 255 and over large populations are distributed randomly). A vehicle OBU with a MAC address ending in 64 or higher would not respond to this probe management message. A statistically similar result could be achieved by using the values 64 and 127, also resulting in 1/4 of the local OBU population being affected. As a best practice, the issuer of the message should randomly vary the start and stop values selected to ensure that the burden of supporting the probe management message is evenly distributed among the entire OBU populations.

F.5.11.6 Probe Message Management: Managed Vehicle Heading

The probe management message may also include a parameter to indicate which direction-of-travel to which it applies. The *probe-orientation* parameter includes a heading value range, limiting its application to only vehicles which are currently traveling in that direction. Heading is described by dividing a range of 360 degrees into 16 different segments (each of which are 22.5° wide) and can be combined to define the required heading of the affected vehicles when entering the region.

For example, by setting the value to 0xFFFF all possible headings are selected and therefore any vehicle receiving the probe management message may be affected. If a value of 0x0018 were used only those vehicles traveling directly east-bound would be affected, while a value of 0x1800 would indicate only west-bound vehicles, and 0x1818 would include both directions.

F.5.11.7 Probe Message Management: Start and Stop Threshold Settings

The management message allows the start and stop thresholds to be modified. The default stop time threshold is 5 seconds, and the default last stop threshold time is 15 seconds. The default start speed threshold is 10 mph. These three values can be modified by the local RSU. The default values may be inappropriate for the case of ramp metering where the start stop thresholds are greater than the vehicle metering rate.

Figure 17 illustrates the implementation of the probe management process.

F.6 EMERGENCY VEHICLE MESSAGE USE AND OPERATION

F.6.1 Application Description

This is a vehicle to infrastructure message, typically sent from an emergency vehicle or transit vehicle. The Emergency Vehicle Message set consists of two distinct messages, as outlined below. Each will be discussed in turn in this appendix.

- **Signal Request Message (SRM).** Used to request a preemption or priority signal state (preferential treatment) from a signalized intersection.

- **Signal Status Message (SSM).** Used to relate the current preemption or priority signal state(s) a signalized intersection may be in.

These two messages are used in relation to the control of a signalized intersection during emergency response operations. The first message is transmitted by an emergency vehicle and is used by the controller of a signalized intersection. The second message is output by the local RSU (and originally created by the signal controller) if a preemption or priority request is granted, causing a change to the signal state status data of the *spat* message stream being sent, and allows emergency vehicles and priority transit to learn aspects of the internal state of the controller.

Restating the signal operations in greater detail: The first message, the Signal Request Message (SRM) is transmitted by the requesting vehicle (a PSOBU equipped vehicle) to the RSU for that intersection (and then on to the advanced signal controller (ASC) device). This message is sent after the vehicle has received and processed the “zones" present in the intersection map message which relates a specific preemption or priority id to a geographical area. The ASC, which is continuously emitting SPAT style messages to relate the current signal state to other vehicles in the area, will also issue a Signal Status Message (SSM) if there is one or more active or pending preemption or priority events to report. Note that this message is transmitted by the local intersection RSU in a broadcast style. There is a potential that multiple local vehicles will be simultaneously sending Signal Request Messages as they approach the intersection and receive the RSU/ASC generated Signal Status Message in this time interval. The required logic to decode the “winner" in such a conflict is outside the scope of this of document and resides in the ASC. The outcome of that process is reflected in the Signal Status Message. These two messages (along with the SPAT and MAP message discussed elsewhere) are also considered part of the intersection control message set.

When an emergency vehicle and other surrounding vehicles are equipped with PSOBUs and OBUs, the vehicles can establish communication when they are within range of each other and share information relative to their location and direction. A PSOBU is required in emergency vehicles as this is a special application that is not available to standard OBUs. This application should be implemented as a high powered application to extend range. It is expected that the surrounding OBUs will receive this message from the PSOBU well before they begin to receive the normal BSM transmission from the same vehicle. From calculations resulting from this information, the private vehicle can first notify its driver of the situation then may offer suggestions to avoid path interference. While difficult to make this function robust and precise, enough information can be made available to the driver that improvements over a non-equipped system can be significant.

F.6.2 Preconditions for Operations

The following general conditions are presumed to prevail in this application:

1. The private vehicles are equipped with active OBU.

2. The emergency vehicles are equipped with active PSOBU and can issue SRM messages.

3. The emergency vehicles has previously received a MAP message for the target intersection which contains “zone" data to relate specific priority or preemption values to specific service zones in the intersection.

4. The intersection is equipped with an RSU and ASC.

5. The intersection equipment can handle the intersection control messages (SPAT, MAP, SRM, SSM).

6. All systems are active and functional.

7. Emergency vehicles can provide location, speed, and direction of travel. This is optional for the SRM message. The messages can be used when the direction of travel is unknown (often the case when a vehicle is pulling out into traffic). ITIS codes and speed/heading denote when a vehicle is stopped (indicating at scene).

8. Private vehicles have available their location, speed, direction of travel.

F.6.3 Flow of Events

The two Emergency Vehicle Message Set messages are handled in the initial use case to control the intersection.

Flow of Events, Typical Intersection Use
1. Vehicle “A", a PSOBU equipped vehicle is operating in a non-emergency condition. It is acting similarly to any OBU equipped vehicle and it sends typical vehicle *basicSafetyMessage*s (BSM). It also receives MAP and SPAT messages about the local signalized intersections, from which it can extract the preemption or priority zones data when needed. The MAP and SPAT message are being sent out by the RSU for the target intersection on a periodic basis.
2. Vehicle "A" determines that activation of a *signalRequestMessage* (SRM) is needed. This could occur through various determinants.
3. This activates a PSOBU broadcast of the SRM, which contains the preemption or priority requested as well as the optional *vehicle-bsm-part1-oer* (BSM blob) data element with current location information, speed, and direction of travel in it. The SRM may also contain other information such as the lane number of the lane it wishes to exit the intersection on, and the time it anticipates reaching the intersection.
4. The intersection RSU receives the SRM and hands it to the ASC for further processing. The ASC looks that the data, its own current state, and any required validity credentials and makes a determination regarding how to respond to the request.
5. The ASC sends to the RSU (for broadcast) the *signalStatusMessage* (SSM) which contains a summary of the new state of the control with respect to preemptions and priority requests. The updated SPAT message (which may now reflect a transition to a preemption or priority condition) is also sent from the ASC to the RSU. The RSU broadcasts these in the normal way.
6. Vehicle "A" receiving the SSM and can determine if and when the request will become the current state of the signal. It also will be receiving the SPAT message where this can be further confirmed.
7. This process repeats (steps 4 to 7) until the vehicle has past the intersection and the intersection is then released to either resume normal operations or to process the next ranking preemption or priority request that it has received. A timeout event will occur in the ASC if the requesting SRM is missing for more than 3 seconds.
8. Vehicle "A" determines that it has past the intersection, and sends a new Signal Request message (SRM) with the cancel bit set in the signal request type field for a period of time.
9. The intersection RSU, receives the SRM with the cancel bit set and hands it to the ASC for further processing. The ASC looks that the data, its own current state, and any required validity credentials and makes a determination regarding how to respond to the request. It may allow another pending request to become the active one (in which case we again cycle over steps 4 to 7) or it may resume normal operations (returning to step one).
10. Vehicle "A" may note that the received SSM has removed its request from those active and pending, and therefore ceases sending the SRM with the cancel bit set, or after a duration of 3 seconds may simply cease sending.

F.6.4 Implementation Example

A PSOBU vehicle is put into emergency service. Upon being put into emergency service, the PSOBU vehicle will continue transmitting its BSM, but with the 'Emergency Response' bit set in the vehicle-events data frame. The PSOBU vehicle will also broadcast SRM messages to an intersection RSU as needed, containing the requested priority or preemption value, and optionally, some vehicle identification number (nominally a fleet number or VIN number). Any SSM received by the ASCs that are processing this and other requests will contain the current active request and data regarding which vehicle asked for it, as well as a sequence of other pending requests from other vehicles.

Private vehicles in the area may use the BSM message with the 'Emergency Response' bit on to analyze if they may encounter the responding vehicle. If this is possible, applicable information may be communicated to the operator. The warning can advise the driver to be prepared to take actions to stay out of the path of the responding vehicle. The warning could include information about:

- The location or proximity of the emergency vehicle
- Instructions on action that the driver may want to take

The warning presented to the driver may be different depending upon the proximity of the emergency vehicle to their vehicle. The closer the emergency vehicle is, the more severe the warning. If pre-determined emergency route information is available from a public safety vehicle, the information may be sent via other applications.

In general, private vehicles are expected to ignore SRM and SSM messages. When a preemption or priority event does occur in an intersection, they are informed of this by way of the SPAT message.

Other emergency vehicles that are responding, receiving the BSM message with the 'Emergency Response' bit on, may use the data to analyze if they may encounter the responding vehicle. The warning can advise the driver to be prepared to take actions to stay out of the path of the responding vehicle. The warning includes information about:

- The location or proximity of the emergency vehicle
- Instructions on action that the driver may want to take

The warning presented to the drivers may vary depending upon the proximity of other emergency vehicle to their vehicle and the use of sirens by one or more responding vehicles. The closer the emergency vehicle is, the more severe the warning that will be communicated to the operator.

In general, other emergency vehicles may also be sending SRM and receiving SSM messages at the same time (often in ad hoc convoys proceeding through the same intersection). The SSM may list their own signal requests as pending when another vehicle (ideally one ahead of them) has been granted the preemption or priority first. When a preemption or priority event is occurring in an intersection, they are also informed of this by way of the SPAT message, like private vehicles.

F.6.5 Application use with DSRC

The messages in this application are typically transmitted using the BER-DER encoding and the Wave Short Message protocol (WSM) stack in a periodic broadcast mode on a high power channel (CCH or SCH) to other devices (typically other mobile OBUs) who have determined to receive this type of message (based on PSID value and running a suitable application). Upon reception of such messages they are examined for message content and relevance regardless of any PSC provided by the sender.

If the message content is considered to be of a “low priority"[13] (such as standing static reports, permanent school zones, and other semi-permanent data such as construction warnings) then the message may be transmitted using an XML encoding as an IP datagram over a service channel in a periodic broadcast mode to other devices (typically other mobile OBUs) who have determined to receive this type of message (based on PSID value and running a suitable application). Upon reception of such messages they are examined for message content and relevance.

[13]The ultimate determination of this classification, and therefore the encoding and bandwidth allocated to either type of message is a local jurisdictional consideration.

Therefore, this is a provider application that does not employ a Wave Basic Service Set (WBSS) as per IEEE 1609.4 Clause 5.3 and there is no confirm and join operations. Receivers of these messages are expected to process all such message regardless of the PSC found (typically each device running a provider application will have its own PSC to further classify its transmissions).

This application shall transmit its messages using an PSID value of “19" [the “emergency-warning" service] as defined by IEEE 1609.4 or its successors. Multiple applications, each with their own PSC data, are expected to be found operating in overlapping local coverage areas but using the same PSID and this message set. Based on the data exchanged in this application, devices may determine the need to initiate other services or applications using other PSID values. The message priority of this application shall be set, as per Appendix F.1 of this document, to the value determined for devices sending this message. The expected repetition rate for the messages broadcast in this application is nominally to be one new message every half second for BER-DER WSM encodings. The expected repetition rate for the messages broadcast in this application is nominally to be one new message every two seconds for XML encodings. These values may vary based on other system allocation requirements.

F.7 MAP AND SPAT MESSAGE USE AND OPERATION

F.7.1 Introduction

There are four messages currently defined to support intersection mapping needs and relating signal phase and timing data to OBUs. These message support the intelligent intersection needs for this standard. All of these are the result of field experience involving several dozen intersections where similar prototype messages have been operating. The data content used in those messages was similar, but used a proprietary encoding, now replaced by the standard BER-DER encoding format specified here. These four messages (listed below) are mature but supporting documentation on how they are to be used remains to be developed. This appendix serves as a short introduction to the intended general use of the messages.

The four subject messages are:

- **Signal Phase and Timing Message (SPAT).** Relates the current intersection signal light phases.

- **Map Data (MAP).** Relates the Physical Geometry of the intersection.

- **Signal Request Message (SRM).** Requests preempt or priority services.

- **Signal Status Messages (SSM).** Relates the internal state of the signal controller.

F.7.1.1 Intended Audience

This appendix is written primarily for application and system programmers who write compliant software; system architects who drive the DSRC message creation, distribution and consumption processes; and content designers and managers such as city managers and their staff.

F.7.1.2 Philosophy of SPAT and MAPs

In normal use the OBU units are expected to receive the *mapData* message before entering the intersection. This message conveys all the physical geometry for one or more intersections and well as the regulatory information (allowed maneuvers) for the intersection and assigns specific lane numbers to both drivable vehicle lanes and other features of each intersection. When in the range of the intersection, the SPAT message is broadcast from an RSU with the current signal state at all times. OBU users can relate the (dynamic) SPAT message information to specific lanes of travel in the (static) MAP message and determine the phase state of the intersection and for how long that state will persist. Two additional messages (SRM and SSM) are used to request and the determine priority and preemption events. These two messages are typically used by public safety and public transport OBUs only.

At a high level, the MAP message contains all the static (unchanging) information relating to one or more intersections in the intersections data frame. This information (consisting of both required and optional informational content) is determined for the intersection and broadcast in such a way that a cache of local intersections can be maintained by the OBU. Besides describing the lane geometry paths and the allowed maneuvers for each lane, the intersection data frame can provide additional information regarding pedestrian walkways, shared roadways and rail lines that may affect vehicle movement.

By contrast the SPAT message contains the state of the intersection and got how long this state will persist for each lane that is active. The SPAT and MAP share a common lane numbering assignment between them to allow mapping.

F.7.2 The Overall Framework of the SPAT

The Signal Phase and Timing message (SPAT) uses a simple framework to provide a basic summary of the signal state at any given time (dynamic data). The many optional elements defined in this message allow for both simple and complex signalized intersections to be modeled without additional overhead in the message unless that overhead is needed (say to relate pedestrian lanes states, or other events that may not be present in every intersection). Consult the prior definitions for specific details, but here is a general overview of the structures defined in the SPAT message.

The overall use of the SPAT message is to reflect the current state of all lanes at a single intersection. Any preemption or priority then follows in a structure for the whole intersection. Lanes that are at the same state (with the same end time) are combined. Thus the simplest SPAT message consists of two such states, one for the then active lanes/approach, and another for all the other lanes that at that time share the state being stopped (a red state). The stopped (red) lanes are optionally not sent at other times (the presumption being that any lane not enumerated in the SPAT is in fact set red).

The SPAT message consists of a sequence of *trafficSignalMovement* at the intersection[14]. The SPAT status information is associated with the lanes found in the MAP message by the use of shared lane numbering values. The overall framework consists of the regionally unique *intersection-identifier* (required), the collation of current lane states, any signal preferential data, and some optional content (such as pedestrian information). Some additional information regarding the internal preemption or priority request status of the signal controller itself can be obtained in the SSM message.

Up to 255 unique states can be sent, although more commonly only active states are sent at any time (typically the active vehicular movements and any associated pedestrian movements) and all other lanes are interpreted to be in a red-phase by convention. Considering the *trafficSignalMovement* data frame further we see that it includes a great deal of timing information:

[14] In these messages all lanes are given a unique number regardless of what approach they may belong to. Therefore, an "approach" in a traffic engineering sense of the word always consists of one or more defined lanes in these messages. Lane numbering value assignment is arbitrary, but some conventions or *best practices* are expected to apply.

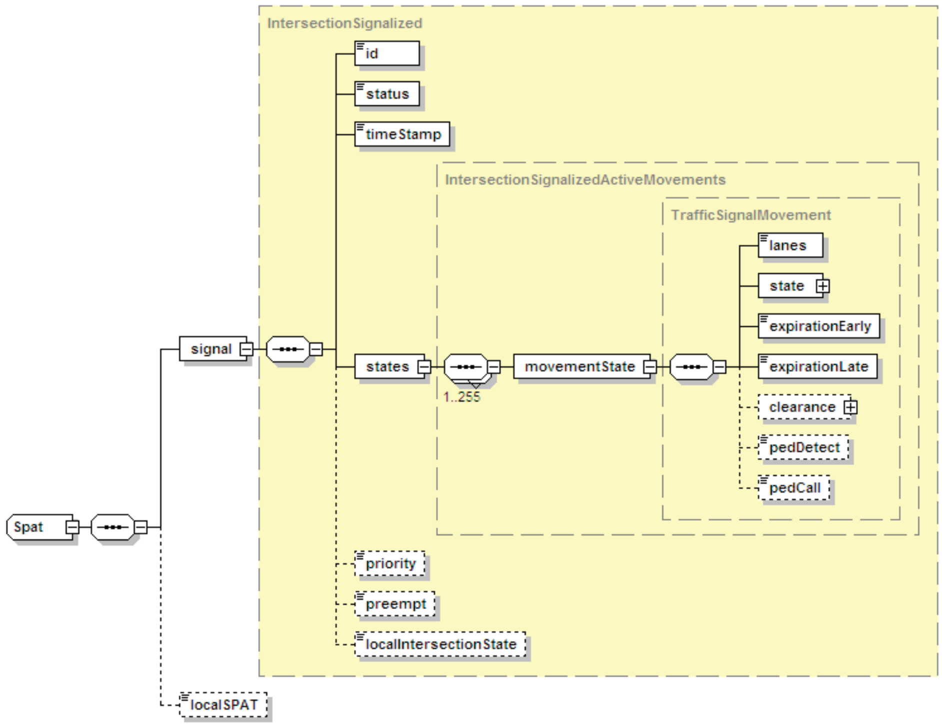


FIGURE F25 - SPAT DATA FRAME STRUCTURE

Note that the *lanes* (the list of lanes to which this applies), *expirationEarly*, *expirationLate* and *state* fields in the *movementState* data frame are required, the other elements are optional (indicated by the dotted lines). When presenting information about a vehicle lane, the *currState* element is used. When presenting other types of timing data other elements are used. For example, a pedestrian crosswalk timing uses the *pedState* element, while a train crossing an intersection uses the *specialState* element.

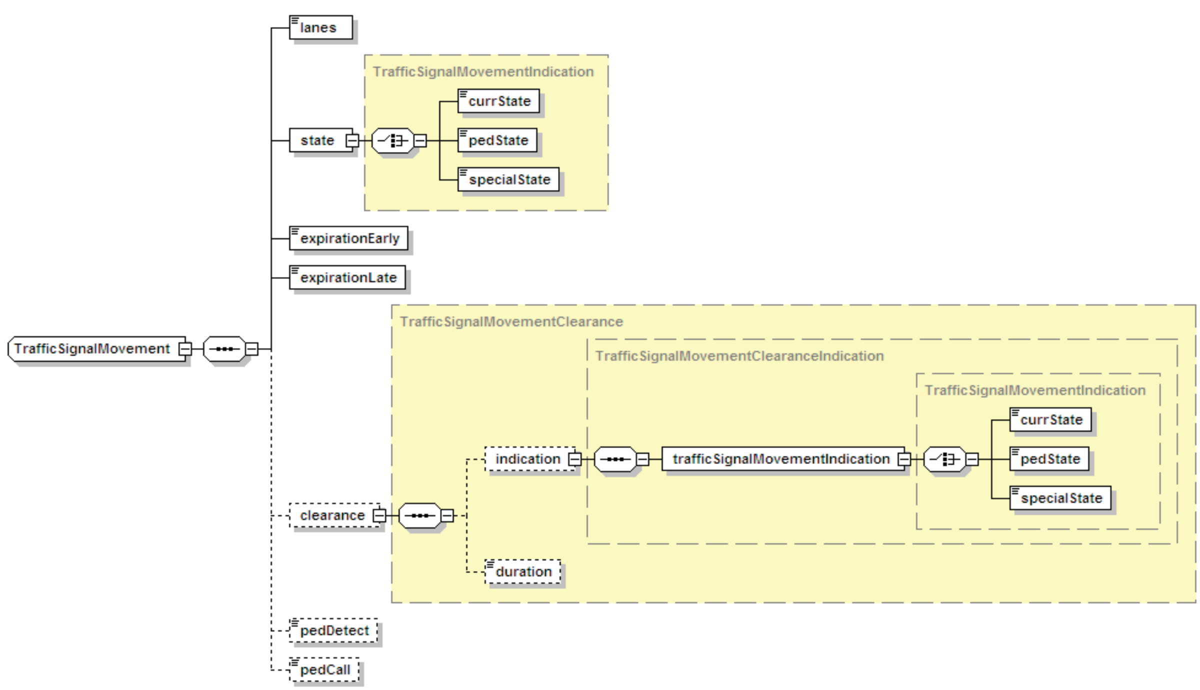


FIGURE F26 - TRAFFICSIGNALMOVEMENT DATA FRAME STRUCTURE

The *lanes* field lists all the lanes (by their assigned number defined in the MAP message) that share this common state and period. The *currState* element indicates the specific type of light (i.e., through arrow green, yellow flashing etc.) present. The *expirationEarly* and *expirationLate* indicates the earliest and latest time that this state will persist. The (optional) *clearance* field state defines the NEXT state of the movement and its duration. Its use will vary by local policies, but it is useful in relating yellow times as well as pedestrian walkway clearance times. Various other optional data elements can also be sent including if pedestrians or a pedestrian call have been detected.

F.7.3 The Overall Framework of the MAP

The MAP message is used to convey a number of different types of (static) maps in support of DSRC messages. The intersection is but one kind of such data, another is a roadway segment. Other forms of map data remain to be defined in future editions of the Standard. However, the intersection and the roadway segment of the map is defined; and the former is used along with the SPAT message to relate information about intersections.

F.7.3.1 Intersection Geometrics

The *intersection* data frame, shown below, is used to relate all the needed physical geometry of an intersection, assign the intersection a unique identifier, and to assign numbers to specific lanes. Up to 32 intersections can be contained in a single map message. Intersections, like traffic lanes, often follow repeating patterns, so a data compression scheme that allows “computed intersections" to replicate simple intersections is provided (*refInt*).

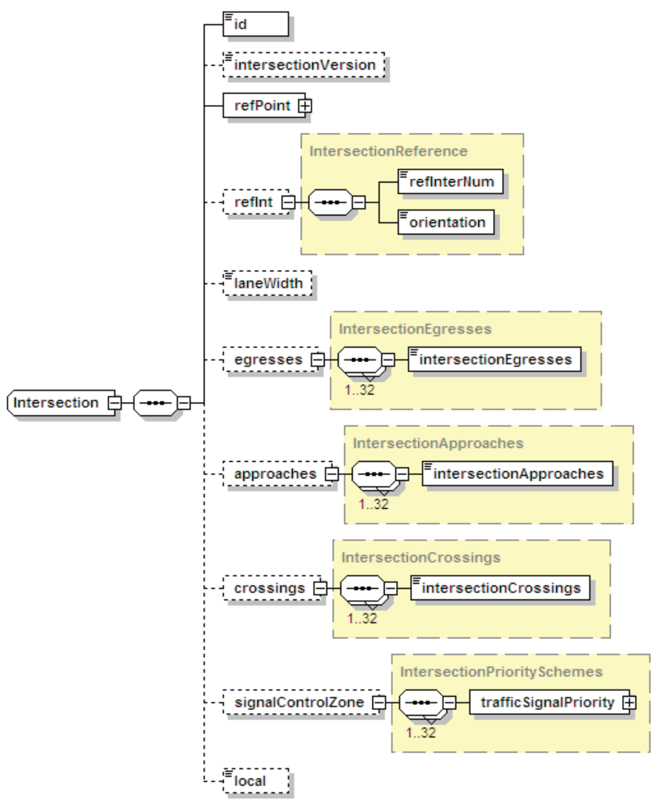


FIGURE F27 - MAPINTERSECTIONS DATA FRAME STRUCTURE

A reference point (*refPoint*) is used to define a precise position from which local offset values are used to describe the geometry of each lane. Lanes at an intersection can be defined as one of three types of lanes: driveable lanes leaving the intersection (*egresses*), driveable lanes approaching the intersection (*approaches*) and non-driveable lanes, such as pedestrian crosswalks or railroad tracks (*crossings*). Up to 32 of each type of lane is supported.

Each lane at an intersection is defined in the *lane* data frame, as shown below. Each intersection consists of a set of lanes, with each lane, along with the *intersection-identifier*, having a regionally unique identifier. A lane in this Standard refers to both driven vehicle use type lanes, as defined in the *vehicleAttributes* field for intersections, as well as several other lane types defined by the Standard. Lanes defined at this time include “pedestrian" lanes (*crosswalkAttributes*) and “special" lanes (*specialAttributes*) for shared lanes, rail track and other multi-modal uses.

The *vehicleAttributes* field contains is a bitstring which relates the allowed vehicle maneuvers such as noTurnOnRight, etc. In some complex cases (such as multiple soft left turns) the *connectsTo* field can be present (in approach lanes) to further clarify how this lane interacts with the egress lanes.

Each lane also can be related in terms of its path. A structure called *nodeList* is used to relate the path of the lane's centerline over the ground with whatever degree of precision and number of data points are required (including changes in width and elevation as needed). The *nodelist* itself is made up of either a series of *nodes* or is a parallel lane relative a referenced lane. The series of *nodes* is sequence of from one to 64 node points as shown below which relate the path in increments of 1 centimeter units. The width, when present, establish a new standing value for that item until a subsequent update, in a manner similar to the anchor points.

Adjacent or parallel lanes often follow repeating patterns, so a data compression scheme that allows "computed lanes" to replicate parallel lanes is provided (*parallel*).

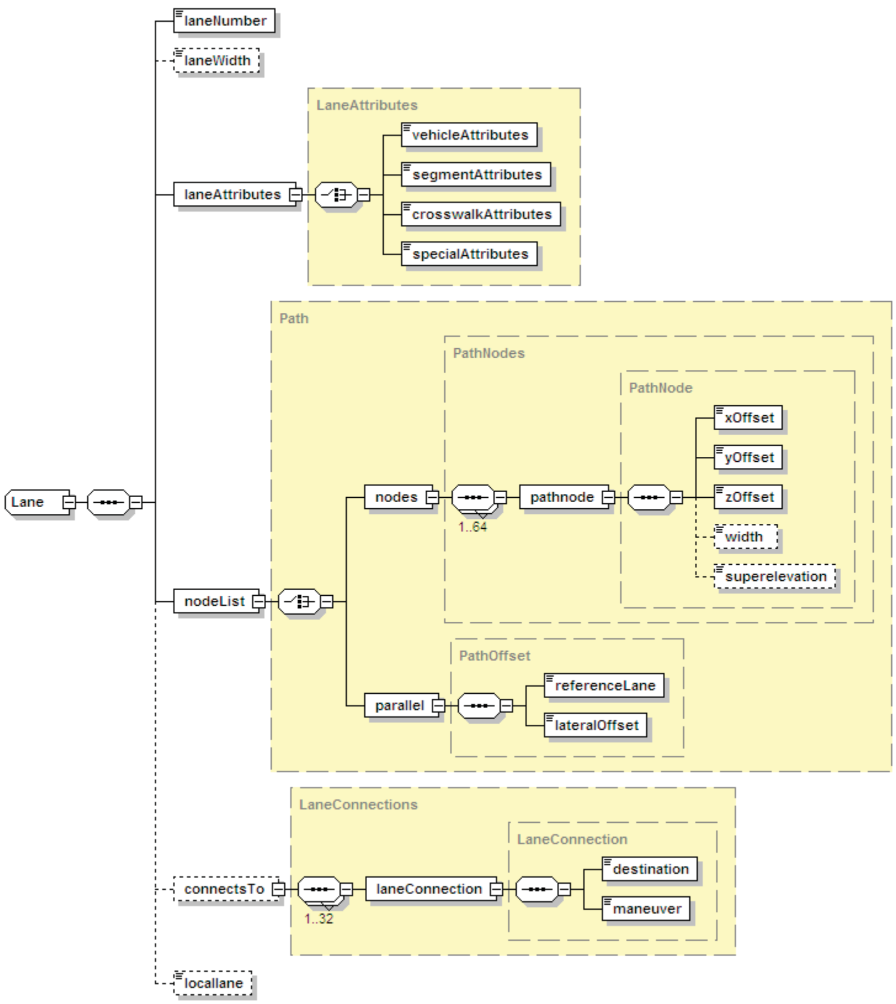


FIGURE F28 - LANE DATA FRAME STRUCTURE

In addition to the above, an optional structure (*signalControlZone*) is provided to support priority and preemption requests at the intersection. This structure allows mapping of the intersection geometry into specific request zones and values (0-7). The structure, called the *intersectionPrioritySchemes* data frame is shown below.

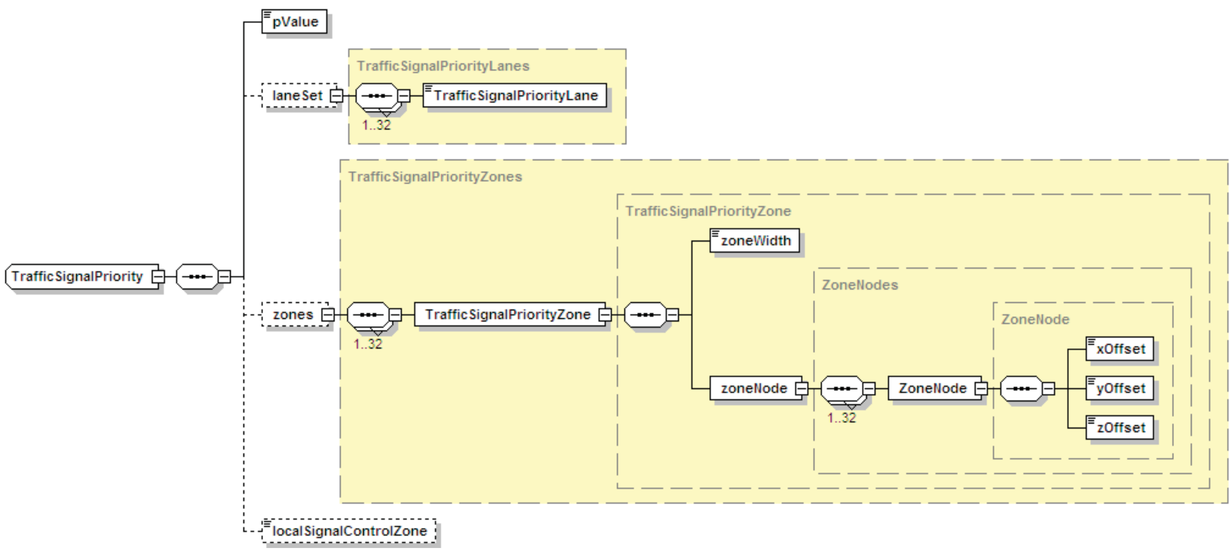


FIGURE F29 - INTERSECTIONPRIORITYSCHEMES DATA FRAME STRUCTURE

Each request value (*pValue*) is associated here with a set of data (data) that outlines either the lanes it covers (*laneSet*) or a set of zones (*zones*) made up of either enclosed lanes (*zoneWidth*) or a *zoneNode* list forming a polygon of coverage. Authorized vehicles use this data to determine which request to make, then use that value in the SRM message to request a preempt or priority from the intersection controller. The changed state of the controller (if any) is reflected in both the SPAT message and the SSM message.

F.7.3.2 Roadway Segment Geometrics

The *segment* data frame, shown below, is used to relate all the needed physical geometry of a roadway segment, assign a unique identifier to the roadway segment, and to assign numbers to specific lanes. Up to 32 roadway segments can be contained in a single map message.

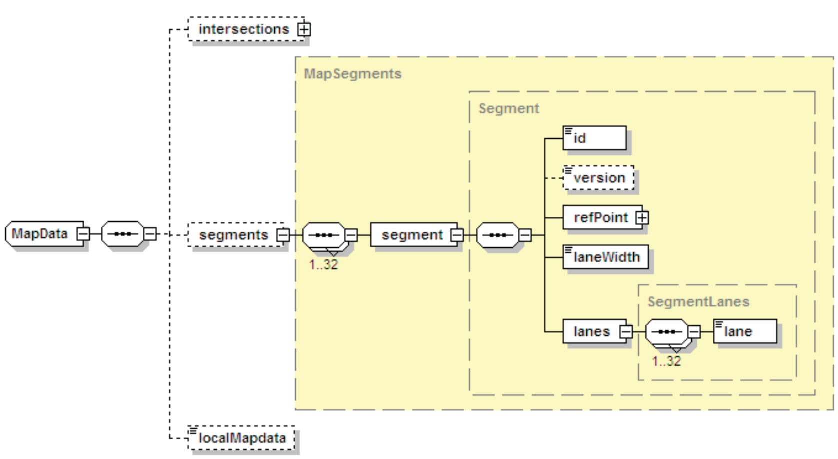


FIGURE F30 - MAPSEGMENTS DATA FRAME STRUCTURE

A reference point (*refPoint*) is used to define a precise position from which local offset values are used to describe the geometry of each lane. Up to 32 lanes are supported for each roadway segment.

Each lane at a roadway segment is defined in the *lane* data frame, as shown in Figure F28. Each roadway segment consists of a set of lanes, with each lane, along with the *segment-identifier*, having a regionally unique identifier. Each lane of the roadway segment is further defined by the *segmentAttributes* field, which consists of an ITIS:LaneRoadway description.

Each lane also can be related in terms of its path. A structure called *nodeList* is used to relate the path of the lane's centerline over the ground with whatever degree of precision and number of data points are required (including changes in width and elevation as needed). The *nodelist* itself is made up of either a series of *nodes* or is a parallel lane relative a referenced lane. The series of *nodes* is sequence of from one to 64 node points as shown below which relate the path in increments of 1 cm units. The width, when present, establish a new standing value for that item until a subsequent update, in a manner similar to the anchor points.

Adjacent or parallel lanes often follow repeating patterns, so a data compression scheme that allows "computed lanes" to replicate parallel lanes is provided (*parallel*).

F.7.4 Additional Details of Message Use

The use of this message set to correctly describe intersections and then model them with the SPAT will involve a considerable number of additional details. At the time the current Standard went to ballot, this detail had not been created, but is expected to be placed into a subsequent users guide document along with working examples.

F.7.5 Application Notes

F.7.5.1 How is Time Represented?

The representation of time in the DSRC Standard follows the methodology defined in the ISO 8601 standards for representing time. Unless specifically indicated in the definition of a data element, data frame, or message, the time reference shall be Coordinated Universal Time (UTC) with the time zone of Greenwich Mean Time (GMT). In this regard it follows the conventions of other ITS standards; however there are some minor unique points that should be pointed out. First, the resolution of time in DSRC is universally kept and expressed with a precision of one millisecond. The ms are often appended as an integer to the rest of the elements of time (minutes, hours, days, month years etc.), which are expressed in the normative definition provided by ISO 8601 including a local time zone, although the time zones is not used in most DSRC messages. Leap-seconds and other periodic approbations are handled in the normal ISO 8601 way.

In many DSRC messages there is only a need to send relative time (such as the current minute or second) and the full (absolute) moment of time is only sent once or periodically when actually needed. It should also be pointed out that component elements of the time in DSRC are defined as distinct integer values. This allows a more compact encoding of time information rather than the ASCII strings found in some representations.

Finally, some unknown values have been mapped to the last value in the range. This is at odds with some other standards that use zero for both a legal value of time and as an unknown value.

F.7.5.2 Why does the MAC ID Change?

The Media Access Control (MAC) address used by OBUs is randomly generated at various times according to a timer, vehicle start-up, or possibly other events. This random MAC address is called the Temporary ID in DSRC messages. The reason for having a non-permanent MAC address, and avoiding any other long-term identification that is publicly available, is to preserve privacy through anonymity. The MAC value for a mobile OBU device (unlike a typical wireless or wired 802 device) will therefore periodically change to a new random value to ensure the overall anonymity of the vehicle. Because this value is used as a means to identify the local vehicles that are interacting during an encounter, it is used in the message set.

F.7.5.3 How is Geo-Position Determined?

Global Navigation Satellite Systems (GNSS) provide geographical positioning information from a constellation of satellites in orbit to receivers at sea, on the ground, and in the air. The best known of these systems is the U.S. Global Positioning System (GPS), but the Russian GLONASS system provides a similar service, as will the European Galileo system. Together they are known as Global Navigation Satellite Systems, and they can provide position accuracies in the 10-meter to 15-meter range without augmentation. Although the satellites have the potential to provide more accurate positions, atmospheric and other effects degrade the quality of the satellite signals.

Much higher accuracies can be achieved by broadcasting data from reference stations at precisely known locations. This technique is known as Differential GNSS (DGNSS) service, and it has enabled precise navigation by ships, aircraft, and ground vehicles, as well as highly accurate surveying applications. RTCM's standards for DGNSS services are widely used protocols for communication between the reference stations, and mobile receivers at the location being determined. The use of RTCM standards allows interoperation between equipment from different manufacturers. Governments and service providers around the world are establishing networks of reference stations for precise positioning.

F.7.5.4 URLs Used in the Standard

The Standard makes use of URL strings in various places to link to other information. At times the data elements used to convey the full URL break the string up into component parts. This is done to save payload bytes in the transmitted message. For example, the data element *travelerInformationItem-url-short* must be combined with the contents of the data element *travelerInformationItem-url-base* to create a valid URL string in such cases.

F.7.5.5 Forward Compatibility in the Standard

The ASN defined by the standard is designed to allow the addition of new messages and content descriptions while preserving the backward compatibility with content described in this edition. Tagging values have been chosen such that both new standardized content as well as any locally developed and deployed content can be added. Locally defined content shall use the ITS convention of tag numbering ranges from 128 to 255 for any content which is added.

For further information and examples of how new message content is added to the ASN defined here, refer to the DSRC Implementation Guide for additional details and examples.

F.7.5.6 Requirements Placed on the ASN encoding used by this Standard

The general approach to compatibility used is that every compliant ASN parser must be able to handle well structured ASN messages, both those found in the standard today and those with several types of content that may be added to messages and found in the deployment environment in the future. By handle, it is meant that such a message can be parsed, and the currently defined content can be recovered. There are no requirements to use the resulting new content in any way, as it is not defined in this edition of the standard.

There are three types of additional tags (beyond those defined in the standard) that can be found in valid DSRC messages. These are:

- New application Tags
- New local application Tags
- Basic Universal Tags

New application tag content (numbered from zero and following after the last tag defined in the previous version of the standard). This is expected to be developed in the succeeding editions of the standard. New local application tag content (numbered from 128 to 255 to indicate that the content is locally defined). This type of tag is found when a deployment decides to add new (typically experimental) content to an existing message type in places where the symbol "..." is found. New tag content can also be composed of the basic universal tags used by ASN for basic types (integers, etc.). New messages may also come to exist, but as these will be encoded as different message types then those now defined, they should not be a problem to any compliant parser.

F.8 COMMERCIAL MOTOR VEHICLES

The commercial motor vehicle messages are intended to support roadside checks of commercial motor vehicles, such as credentialing, safety inspections, and security inspections. The intent of these messages are to improve the speed and efficiency of commercial vehicle operations - allowing agencies to focus inspections on vehicles that have not already been inspected or are of interest due to other factors. This could potentially decrease the number of inspections that carriers may be subjected to for each trip.

This appendix describes how commercial vehicle agencies could use these commercial vehicle messages to perform the roadside checks and how commercial motor vehicles may provide information to these agencies. The exact procedures and policies for how these messages are to be used by the commercial vehicle agencies are not addressed in this Appendix.

All commercial vehicle messages are based on the assumption that the commercial vehicle carrier and driver have opted in, that is, the carrier and driver have agreed to provide its commercial vehicle information and participate in the over-the-air (OTA) exchange of these commercial vehicle messages.

Also note that the roadside check stations that participate in the exchange of commercial vehicle messages may be a fixed station or a mobile unit, such as an enforcement vehicle.

F.8.1 Credentialing

One type of roadside check frequently performed is credentialing, where an agency can determine if a commercial vehicle's fees and permits are in order. The commercial vehicle messages are based on the assumption that a majority of the checks for the fees, permits and paperwork are processed in the back office. That is, the commercial motor vehicle that is being checked only needs to provide several key pieces of information to the agency. With those key pieces of information, an inspector can bring up all the other necessary information to complete the roadside check on his computer or mobile device.

For example, by providing the commercial vehicle's vehicle identification number and / or license plate, an inspector can look up, download and view the carrier's or owner's permits and fee history on a handheld device at a roadside check station.

F.8.1.1 Dialog Description

The dialog for the exchange of commercial vehicle messages to support credentialing consists primarily of two messages, the *commercialVehicleRequest* message and the *commercialVehicleData* message. A third message, *commercialVehicleClearance* is used to provide instructions to the commercial motor vehicle.

The exchanges are predicated on both the commercial vehicle and the RSU at the roadside check station (which may be a fixed station or a mobile station) being in transmission range of each other, and that the driver and owner of the commercial vehicle has opted in. While the roadside check station is in operation, the RSU shall continuously advertise its support for freight management messages. A commercial motor vehicle, upon receiving the *WSA* or *serviceAdvertisementMsg* shall respond with *commercialVehicleData* message. The *commercialVehicleData* transmitted shall minimally contain the commercial motor vehicle's unique vehicle identification number. An application may include other data elements in the initial *commercialVehicleData* message as well.

Upon receiving the *commercialVehicleData* message from the commercial vehicle, the roadside check station should process the information provided and determine if additional information is needed from the commercial vehicle.

For example, the roadside check station may transmit a *commercialVehicleRequest* message to the commercial vehicle, with the *target* field set to the commercial vehicle's vehicle identification number, requesting additional information. Information that may be requested include additional information about the vehicle, driver identification, cargo data, trailer data, the duty logs of the driver(s), or the results of a previous screening event. The *commercialVehicleRequest* message may also contain valid area information such that the request for information is only valid if the commercial vehicle is within the intended geographical area or traveling in the intended direction. If the commercial vehicle is not within the valid area or traveling in the designated direction, it may ignore the request for additional information. Otherwise, the commercial vehicle will transmit a new *commercialVehicleData* message with the information requested.

If the roadside check station determines that no additional information is needed, it can then transmit a *commercialVehicleClearance* message with instructions to the commercial vehicle (by including the commercial vehicle's vehicle identification number). Those instructions may contain the location and name of a roadside check station for the commercial vehicle to pull into, or it may instruct the commercial vehicle to bypass the roadside check station.

When the commercial vehicle receives the *commercialVehicleClearance* message, it should respond to the RSU with a *commercialVehicleAcknowledgement* message.

NOTE: A commercial vehicle should assume that if it does not receive a *commercialVehicleClearance* message from the RSU, the vehicle should pull into the roadside check station unless it receives some other indication that it does not have to.

F.8.1.2 Application Notes

The environment in which the OTA messages are being exchanged results in an occasional message not being completely and properly received by its intended recipient. As such, a connected device may have to retransmit its message periodically until it receives confirmation that the message has been properly received, usually by receiving the next message as defined in the standardized dialog.

However, the application needs to consider when to stop the retransmission of the message if a confirmation message is not received, otherwise the application may continue to transmit a message. When the application ceases to retransmit a message is up to the developer.

F.8.1.3 Message Format

A *commercialVehicleData* message can include several data elements to provide the necessary information to perform OTA credentialing of commercial vehicles. This information includes:

- Vehicle position and heading, using the same data elements that are included in the basicSafetyMessage
- Vehicle information, which may include the vehicle identification number, the license plate number (including the country and jurisdiction that issued the license plate), the name and registration numbers of the owner and the lessee
- Driver information, including the identification information of the driver(s)
- Information about each trailer, including its license plate number, its identification number, the number of axles and tires on the trailer and its weight
- Cargo information, which may include an identifier for the bill of lading, what hazardous materials the vehicle may be carrying and what placards are being displayed on the vehicle.

The registration information for a vehicle may include registrant's name, the country and jurisdiction that the vehicle is registered with, and the registration number. Multiple registration information (numbers) may be transmitted in the message.

For example, in the United States, all commercial carriers operating commercial vehicles transporting passengers or hauling cargo in interstate commerce must have a USDOT registration number, that is assigned by the Federal Motor Carrier Safety Administration (FMCSA). Thus, the registration information may include the *owner,* which would be the name or trade name of the motor carrier company appearing on Form MCS-150 (which is the application form for a USDOT number), the *identifier* (which would be the USDOT number), and the *country* would be US, which is the ISO 3166-1 alpha-2 code for the United States.

F.8.2 Screening

Another type of roadside check frequently performed is screening, when an agency performs safety inspections on the commercial vehicle to verify the sensors and equipment on the commercial vehicle are operating properly. The safety checks may also include a review of the commercial vehicle driver's duty logs.

These commercial vehicle messages are based on the assumption that the commercial vehicle is capable of receiving, and potentially storing the results of a screening event. By receiving the results of the screening event, a commercial vehicle might have the capability to compare the results of the screening events, as measured by the roadside check station's sensors, to its own vehicle sensors or the sensor readings as recorded from another check station (such as the vehicle owner's own equipment). This capability allows the commercial vehicle driver to undertake any actions to resolve the discrepancies as soon as possible.

The ability to store the results of the screening event on the commercial vehicle also has potential benefits to the fleet and vehicle owners. For example, the screening event results can be shared with other roadside check stations. These roadside check stations may then use the information to allow the vehicle to bypass the check station so the check station can focus on commercial vehicles who have not recently undergone a safety inspection.

F.8.2.1 Dialog Description

The dialog for a roadside check station to provide a commercial vehicle with the results of its screening event consists of two messages, the commercialScreeningData message and the commercialScreeningAcknowledgement message.

The exchange is predicated on both the commercial vehicle and the RSU at the roadside check station (which may be a fixed station or a mobile station) being in transmission range of each other, and that the driver and owner of the commercial vehicle has opted in. Once the roadside check station has completed the screening event, the RSU shall transmit a commercialScreeningData message to the commercial vehicle.

Upon receiving the commercialScreeningData message from the roadside check station, the commercial vehicle shall verify that the screening event result is for it, by confirming that the vehicle identification number matches. Each commercialScreeningData message contains a crc field at the end of the message. The commercial vehicle shall include this crc value when transmitting the commercialScreeningAcknowledgement message to the RSU to confirm its receipt of the screening event results.

F.8.3 Exchange Screening Results

One of the features supported by the candidate standard is to allow a connected device, such as a commercial vehicle, to share any screening event results in its records with another connected device, such as a roadside check station. This feature allows recipients to compare current sensor readings with previous screening event results. For a commercial vehicle, sharing this information may allow the commercial vehicle to bypass the roadside check station if the station confirms the results of the screening event.

F.8.3.1 Dialog Description

The dialog for a roadside check station to provide a commercial vehicle with the results of its screening event consists of four messages: the *commercialVehicleData* message, the *commercialVehicleRequest* message, *commercialScreeningResults* message.

The exchange is predicated on both the commercial vehicle and the RSU at the roadside check station (which may be a fixed station or a mobile station) being in transmission range of each other, and that the driver and owner of the commercial vehicle has opted in. While the roadside check station is in operation, the RSU shall continuously advertise its support for freight management messages. A commercial motor vehicle, upon receiving the *WSA* or *serviceAdvertisementMsg* shall respond with *commercialVehicleData* message. The *commercialVehicleData* transmitted shall minimally contain the commercial motor vehicle's unique vehicle identification number. An application may include other data elements in the initial *commercialVehicleData* message as well.

Upon receiving the *commercialVehicleData* message from the commercial vehicle, the roadside check station should process the information provided and transmit a *commercialVehicleRequest* message to the commercial vehicle, with the *target* field set to the commercial vehicle's vehicle identification number, requesting the results of a previous screening event. The *commercialVehicleRequest* message may also contain the identifier of the screening event that the roadside check station is requesting for. The commercial vehicle shall then transmit a *commercialScreeningResults* message with the specific screening event requested. If no screening event identifier is specified in the *commercialVehicleRequest* message, the commercial vehicle may transmit the most recent screening event results that it has stored. Up to four (4) screening event results may be transmitted by the commercial vehicle. If the commercial vehicle has no stored screening event results to transmit, it shall transmit a commercial screening results message with an screening event identifier equal to 0.

F.8.3.2 Application Notes

One of the safety inspections that may be performed at a roadside check station is a review of the commercial vehicle driver's duty logs. In the United States, FMCSA has developed a set of rules for CMV drivers regarding number of hours they can drive without a break and the minimum length of time for the break from driving. To facilitate the collection of this data, which allows an inspector to identify that the rules are being met, some CMVs are equipped with EOBRs. The contents of the EOBR duty status log and the types of events to be recorded can be found in Title 49 CFR 395.16 - Regulation for On Board Recorders, Appendix A.

Each screening event has a unique identifier assigned by the commercial vehicle agency. A roadside check station could check the results of a previous screening event of a commercial vehicle via the identifier. By reviewing the results of the previous screening event, the roadside check station can compare it with current sensor measurements for consistency, or to verify that the previous safety inspection was complete.

F.9 MAYDAY MESSAGES

The Mayday messages is designed to allow a connected vehicle to broadcast a need for assistance. This appendix describes how a connected vehicle could use the mayday message to request assistance. What constitutes a need to request assistance and when to stop broadcasting mayday messages is left to the developer. These messages are used by:

- The operators of a traffic management centers - for incident detection
- The dispatcher of emergency services - to aid emergency response
- Responders - to locate disabled vehicles

The *maydayMessage* consists of the time and position of the connected vehicle when the condition occurs that triggered the mayday. The *maydayMessage* also contains the type of event that triggered the mayday condition - supported types include if the vehicle's airbag was deployed, if the vehicle overturned, or that the vehicle is disabled. The vehicle sensor reading or event that triggers the *maydayMessage* indicating that the vehicle is disabled is application specific. The *maydayMessage* may also be manually activated by the vehicle's occupants, such as if there is a medical condition on board.

Other optional information that may be broadcasted with the *maydayMessage* includes the number of airbags deployed (if any), and the vehicle make, model, model year, and fuel type so responders can determine the type of response that may be needed, such as the number of ambulances that may need to respond, or if any special equipment is needed.

Because of the public safety concerns involving hazardous materials, the maydayMessage may also include the type of hazardous materials that the vehicle may be carrying and what placards are currently being displayed on the vehicle.

F.9.1 Application

If the vehicle broadcasting the *maydayMessage* is within range the message is broadcasted to an RSU. Passing connected devices within range of the Mayday vehicle can also store the message for forwarding to the next RSU.

Once a vehicle begins broadcasting a *maydayMessage*, it is up to the application to determine when to cease broadcasting the message. Ceasing the broadcast is important so that a communications channel is not congested with the *maydayMessage*, especially considering the capability to support forwarding messages (See Section F.10.1). It is suggested that:

1. Consideration should be given to using residual power

2. To cancel the message a BSM count (e.g., 1000 - that is 1000 passing vehicles) and/or a time out (e.g., 2 weeks) should be considered

3. If the car is driven for a certain distance (e.g., 200 meters) the message should be cancelled

4. The driver of the vehicle or a responder should be able to manually cease the broadcast

F.9.2 Privacy

To remove privacy concerns, drivers must opt-in to this service. If a driver opts-in then the message is generated either by an occupant through the HMI or by vehicle systems when an event occurs such as an airbag activation. The vehicle generates a random number that attaches to the message to ensure that responders associate the vehicle with the message and to account for accidents involving multiple vehicles.

If the owner enables the capability, a connected vehicle needs to be able to broadcast to other connected devices that it is involved in an incident or is disabled. An RSU or public safety vehicle receiving this transmission can then forward the transmission to the proper dispatch center so that the appropriate roadside assistance can be dispatched.

F.10 MAYDAY FORWARD MESSAGES

The *forwardedMessage* allows a connected device to re-transmit a message that it has previously received to a defined recipient. This message is intended to allow a connected device to forward a previously received *maydayMessage* to a public safety agency; however, it can be used to forward other messages also. This appendix describes how a connected device could forward mayday messages to assist vehicles in need of assistance. How an application stores and forwards the message is left to the developer.

The *forwardedMessage* effectively extends the range of a broadcasted *maydayMessage* by a connected vehicle that is disabled or in need of assistance. If there are no RSUs or public safety vehicles within the transmission range of the connected vehicle when it transmits the *maydayMessage*, it will be difficult for the connected vehicle to receive assistance, especially in remote areas. The *forwardedMessage* allows a connected device (the "Messenger") passing through the transmission range of the connected vehicle to receive the *maydayMessage* and then forward the message to either an RSU that supports a mayday service, or a public safety responder.

When forwarding the *maydayMessage* to the intended recipient, in this case a public safety agency, the Messenger connected device also shall include the date and time it first received the *maydayMessage*.

F.10.1 Application

Due to privacy considerations, there is no acknowledgement back to Mayday vehicle indicating that its *maydayMessage* has been forwarded by another connected device to a public safety agency. Thus, every connected device that receives the *maydayMessage* becomes a messenger. If the *maydayMessage* is broadcasted on a densely traveled freeway within coverage of an RSU, it is possible that a continual stream of over 1,000 vehicles may be transmitting forwardedMessages of the same *maydayMessage*. This condition is exacerbated if multiple vehicles are involved in an incident, e.g., a 100 vehicle pileup potentially results in 100,000 plus messages being continually broadcast.

This stream of messages will not stop until the broadcasting of the *maydayMessage* is turned off by the application, or manually turned off by the vehicle occupants or a responder.

The Messenger connected device, upon receiving the *maydayMessage*, can store the *maydayMessage* in a buffer. Once the Messenger is within transmission range of an RSU that supports mayday messages, or a public safety agency (e.g., vehicle), the messenger forwards the mayday message. While the messenger is still within the transmission range of the RSU, i.e., is receiving a *serviceAdvertisementMsg* or a WSA, the messenger may continue transmitting the forwarded message. Once the messenger is outside the transmission range, it may remove delete the mayday message from its buffer.

APPENDIX G
PERFORMANCE REQUIREMENTS
[NORMATIVE]

The contents of this Appendix serves as requirements for SAE J2735 SE. Eventually the contents of this information may be moved to another standard.

At this time, the SAE J2735 SE candidate needed to reference certain information that is proposed to be in a planned SAE (Tentative Title - DSRC Message Communication Minimum Performance Requirements) document. This appendix provides temporary references (requirements and proposed standards) until the planned SAE document is published as a recommended practice or standard. At that time, this Appendix will be deleted and the requirements in the planned SAE document will be directly referenced.

G.1 INTRODUCTION

The J2735 SE candidate is an informational level standard that can be used to develop a standard-based system interface for information exchange between applications that may be deployed in conjunction with wireless communications related to the next generation integrated transportation system, that is, the interface to Connected Vehicles and Infrastructure.

However, the SAE J2735 SE candidate does not address how the messages are used in various environments and use case scenarios. The purpose of the communication performance requirements in this appendix is to specify the minimum communication performance requirements of the messages, the associated data frames and data elements.

G.2 PERFORMANCE REQUIREMENTS - MESSAGE TRANSMISSION RATES

The J2735 SE design is predicated on a successful transmission of DSRC message(s). However it should be realized that the wireless communication link will not successfully transmit all messages. The implementer of systems should include factors in their design that takes into consideration the local wireless environment; the speed of vehicles; and occlusion by other vehicles. Other considerations include on the message being transmitted, the importance of the message, and environmental conditions, such as congestion on the communications network.

This section defines the range of allowable time intervals between consecutive transmissions of the same message between connected devices. Message transmission rate requirements include the minimum intervals and maximum intervals when data is transmitted by a connected device. The message transmission rate requirements will vary based on what user needs the information being exchanged is trying to satisfy, under reasonable packet success rate assumptions (i.e., percent confidence a single message packet will be received by intended connected devices). For example, higher message transmission rates may be needed for information exchanges that are used to satisfy user needs involving safety. Other information exchanges that are for driver convenience only, such as traveler information about services at upcoming exits, may require lower transmission rates.

In addition, each implementation may have different message transmission rate requirements for each information exchange. For example, because vehicles traveling at highway speeds tend to spend less time within the transmission range of the RSUs, RSUs along highways may broadcast traveler information messages more frequently than RSUs in urban areas to increase the likelihood that a vehicle will receive the message.

Potential message transmission rate requirements for an information exchange include:

- **Minimum message transmission rate.** The minimum rate that the connected device must transmit or broadcast the message - that is, the maximum interval, in ms or seconds, that may elapse between when a message is transmitted before the next message (of the same type) is transmitted. The minimum message transmission rate is generally selected based on how often a connected device must transmit a message to support the user needs it satisfies. Some minimum transmission rates are based on empirical data collected from field tests that have been performed.

- **Maximum message transmission rate.** The maximum rate that the connected device may transmit a message - that is, the minimum interval, in ms or seconds, that must elapse between when a message is transmitted before the next message (of the same type) is transmitted. A maximum message transmission rate is needed so that the communications medium is not overly congested with unnecessary transmissions.

- **Default transmission rate.** Each implementation may have a different default transmission rate, based on its particular needs. If a default transmission rate is desired for an implementation, it should be indicated in the PRL (See Section 3.3.3), otherwise it is recommended that the **suggested** default transmission rate be used. The actual transmission rate is allowed to vary from the default transmission rate.

- **Default Response time.** While some of the messages being transmitted are broadcasted, i.e., no confirmation is needed from the receiving connected device, some information exchanges require a response from the receiving connected device. The response time is measured as the time, in ms or seconds, between when a receiving connected device receives the last byte of a request and the transmission of the first byte of the response. During the response time, the connected device shall process all requests in accordance with all of the rules of the relevant standards (such as SAE J2735 SE), including updating any values in its database and initiating the transmission of the appropriate response. The default response time is a **suggested** response time. If a different maximum response time is desired for an implementation, it should be indicated in the PRL (See Section 3.3.3).

The following sections contain the detailed transmission rate requirements for information exchanges between connected devices.

G.2.1 Transmission Rates - Broadcast Vehicle Information

A connected vehicle will regularly broadcast its location, characteristics, status, and sensor readings to other connected devices. However, some of a vehicle's characteristics and readings are critical for vehicle-to-vehicle safety communications and applications, and thus must be sent at a more frequent rate than other vehicle characteristics and reading.

Thus, two different transmission rate requirements are provided for a connected vehicle to broadcast its vehicle information.

G.2.1.1 Requirements to Broadcast Vehicle Information

A connected vehicle shall broadcast its vehicle information to other connected devices only if all of the following conditions are met:

1. The vehicle ignition is ON.
2. The vehicle's reported time is valid (See 3.5.1.1.3.3);
3. The vehicle's reported position (latitude, longitude, elevation) is valid (See 3.5.1.1.3.4);
4. The vehicle's reported positional accuracy is valid (See 3.5.1.1.3.5);
5. The vehicle's reported point speed is valid (See 3.5.1.1.3.7);
6. The vehicle's reported heading (direction of motion) is valid (See 3.5.1.1.3.8);
7. The vehicle's reported acceleration along its longitudinal axis is valid (See 3.5.1.1.3.10); and
8. The vehicle's reported yaw rate is valid (See 3.5.1.1.3.12).

A reported value is valid when a value is available and satisfies the accuracy requirements for that value.

G.2.1.2 Transmission Rate Requirements - Broadcast Vehicle Information (Critical)

These transmission rate requirements are for those safety critical information (critical) that are needed for safety applications, such as pre-crash applications (e.g., to prepare a vehicle for crashes, such as tightening seat belts or pre-arming air bags). The critical vehicle state information are the mandatory requirements for broadcasting vehicle information and are listed in Section 3.5.1.1.3.

In addition, certain vehicle status change information also are critical to safety applications and should have the same message transmission rates as the safety critical information of a connected vehicle to other connected devices. These critical vehicle status change information are:

- if a vehicle's hazard lights are on (See Section 3.5.1.1.4.6.1);
- if the vehicle anticipates passing through a stopline without coming to a full stop before reaching it, or if the vehicle anticipates passing through a signalized intersection and its intended movement is not permitted (See Section 3.5.1.1.4.6.2);
- if the vehicle's anti-lock brake system is engaged (See Section 3.5.1.1.4.6.3);
- if the vehicle's traction control system is engaged (See Section 3.5.1.1.4.6.4);
- if the vehicle's stability control system is engaged (See Section 3.5.1.1.4.6.5);
- if the vehicle is braking hard (See Section 3.5.1.1.4.6.7);
- if the vehicle determines at least one of its tires has run flat (See Section 3.5.1.1.4.6.16);
- if the vehicle considers itself disabled (See Section 3.5.1.1.4.6.17); or
- if the vehicle indicates one or more of its air bags has deployed (See Section 3.5.1.1.4.6.18).

If any of the above occurs, the connected vehicle shall transmit that status change at the same transmission rate along with the mandatory elements of a connected vehicle's safety critical information to other connected devices.

The following are the detailed transmission rate requirements for a connected vehicle to broadcast its safety critical information to other connected devices.

G.2.1.2.1 Minimum Transmission Rate - Broadcast Vehicle Information (Critical)

A connected vehicle shall broadcast its safety critical information to other connected devices at least once every 500 ms.

G.2.1.2.2 Maximum Transmission Rate - Broadcast Vehicle Information (Critical)

A connected vehicle shall broadcast its safety critical information to other connected devices no more than once every 50 ms.

G.2.1.2.3 Default Transmission Rate - Broadcast Vehicle Information (Critical)

If the specification does not indicate a default transmission rate, the suggested default transmission rate for a connected vehicle to broadcast its safety critical information to other connected devices shall be once every 100 ms.

G.2.1.3 Transmission Rate Requirements - Broadcast Vehicle Information

The second transmission rate requirements are for all other vehicle characteristics, status and sensor readings, which are not considered safety critical information, but is useful to extend the capabilities of some safety applications or are needed for mobility or environmental applications. These non-critical vehicle state information can be broadcasted by the connected vehicle to other connected devices at a lower transmission rate.

The following are the detailed transmission rate requirements for a connected vehicle to broadcast its vehicle information to connected devices.

G.2.1.3.1 Minimum Transmission Rate - Broadcast Vehicle Information

A connected vehicle shall broadcast to other connected devices, the non-mandatory elements of its vehicle information, in addition to the safety critical information defined in G.2.1.2, at least once every five seconds.

G.2.1.3.2 Maximum Transmission Rate - Broadcast Vehicle Information

A connected vehicle shall broadcast to other connected devices, the non-mandatory elements of its vehicle information, in addition to the safety critical information defined in G.2.1.2, no more than once every 500 ms.

G.2.1.3.3 Default Transmission Rate - Broadcast Vehicle Information

If the specification does not indicate a default transmission rate, the suggested default transmission rate for a connected vehicle to broadcast the non-mandatory elements of its vehicle information to other connected devices, in addition to the safety critical information defined in G.2.1.2, shall be 1000 ms.

G.2.2 Transmission Rate Requirements - Request Vehicle Information

The detailed transmission rate requirements for a connected device to request additional vehicle information from a connected vehicle are as follows.

G.2.2.1 Maximum Transmission Rate - Request Vehicle Information

A connected device shall transmit requests for vehicle information from a connected vehicle no more than once every 50 ms.

G.2.2.2 Maximum Response Time - Request Vehicle Information

A connected vehicle shall process all requests, from a connected device, for its vehicle information, within the maximum response time. If the connected vehicle will respond to the request, the response time is measured as the time between the receiving of the last byte of the request and the transmission of the first byte of the response. If the specification does not indicate the response time, the maximum response time shall be 200 ms.

G.2.3 Transmission Rate Requirements - Broadcast Intersection Infringement

The detailed message transmission rate requirements for a connected vehicle, which anticipates that it will have an intersection infringement, to broadcast a message to other connected devices containing its path information are below. These intersection collision messages should be broadcasted at a high rate because of the safety consequences.

G.2.3.1 Minimum Transmission Rate - Broadcast Intersection Infringement

A connected vehicle, which anticipates that it will have an intersection infringement, shall broadcast a message to other connected devices containing its path information at least once every 200 ms.

G.2.3.2 Maximum Transmission Rate - Broadcast Intersection Infringement

A connected vehicle, which anticipates that it will have an intersection infringement, shall broadcast a message to other connected devices containing its path information to other connected vehicles no more than once every 50 ms.
Default Transmission Rate - Broadcast Intersection Infringement

If the specification does not indicate a default transmission rate, the suggested default transmission rate for a connected vehicle, which anticipates that it will have an intersection infringement, shall broadcast a message to other connected vehicles containing its path information shall be once per 100 ms.

G.2.4 Transmission Rates - Signal Preferential Treatment

The detailed transmission rate requirements for an authorized connected vehicle to transmit a preferential treatment request to an RSU are as follows.

G.2.4.1 Maximum Transmission Rate - Request Signal Preferential Treatment

An authorized connected vehicle shall transmit requests to an RSU for preferential treatment at a signalized intersection no more than once every 500 ms.

G.2.4.2 Maximum Response Time - Request Signal Preferential Treatment

An RSU shall process all signal preferential treatment requests from authorized connected vehicles within the maximum response time. The response time is measured as the time between the receiving of the last byte of the request and the transmission of the first byte of the response. If the specification does not indicate the response time, the default maximum response time shall be 2 seconds.

G.2.5 Transmission Rate Requirements - Commercial Vehicle Information

The detailed transmission rate requirements for an RSU to exchange commercial vehicle information with connected commercial motor vehicles (CMVs) are as follows.

G.2.5.1 Maximum Broadcast Rate - Commercial Vehicle Information

An RSU shall broadcast the same commercial vehicle message to connected commercial motor vehicles no more than once per 100 ms.

G.2.5.2 Default Broadcast Rate - Commercial Vehicle Information

If the specification does not indicate a default transmission rate, the suggested default transmission rate for an RSU to broadcast the same commercial vehicle message to connected commercial motor vehicles shall be once per second.

G.2.5.3 Maximum Response Time - Commercial Vehicle Information Requests

A commercial connected vehicle shall process all commercial vehicle messages from an RSU within the maximum response time. If the commercial vehicle responds to the message, the response time is measured as the time between the receiving of the last byte of the request and the transmission of the first byte of the response. If the specification does not indicate the response time, the suggested default maximum response time shall be 2 seconds.

G.2.5.4 Default Re-Transmission Rate - Commercial Vehicle Information (RSU)

The dialogs for sharing commercial vehicle information consists of a sequence of requests and responses between a specific CMV and an RSU. If an RSU transmits a message to a specific CMV, and does not receive an expected response or acknowledgement from the CMV, the RSU shall re-transmit the same message to the CMV at a fixed time interval until it receives a valid response or acknowledgement; or an amount of time has elapsed since the RSU first transmitted the message to the CMV.

The re-transmission is needed in case the initial transmission of the message by the RSU is not properly received by connected CMV, or the response from the connected CMV is not properly received by the RSU. Improper reception can be due to channel noise or bandwidth issues. Without this re-transmission, the dialog for the sharing of commercial vehicle information between the RSU and the connected CMV cannot be completed. If the specification does not indicate the time interval between re-transmission, the suggested re-transmission time shall be 3 seconds. A 3 second interval between transmissions provides the CMV with sufficient time to respond to the RSU's message and for the RSU to receive the response.

G.2.5.5 Default Re-Transmission Rate - Commercial Vehicle Information (CMV)

The dialogs for sharing commercial vehicle information consists of a sequence of requests and responses between a specific CMV and an RSU. If the CMV transmits a message to the RSU, and does not receive an expected response or acknowledgement from the RSU, the CMV shall transmit the same message to the CMV at a fixed time interval until it receives a valid response or acknowledgement; or an amount of time has elapsed since the CMV first transmitted the message to the RSU.

The re-transmission is needed in case the initial transmission of the message by the connected CMV is not properly received by RSU, or the response from the RSU is not properly received by the connected CMV. Improper reception can be due to channel noise or bandwidth issues. Without this re-transmission, the dialog for the sharing of commercial vehicle information between the RSU and the connected CMV cannot be completed. If the specification does not indicate the time interval between re-transmission, the suggested re-transmission time shall be 3 seconds. A 3 second interval between transmissions provides the RSU with sufficient time to respond to the connected CMV's message and for the CMV to receive the response.

G.2.5.6 Maximum Re-Transmission Time - Commercial Vehicle Information

The dialogs for sharing commercial vehicle information consists of a sequence of requests and responses between a specific CMV and an RSU. If one of the connected devices transmits a message to the other connected device, and does not receive an expected response or acknowledgement from the receiving connected device, the transmitting connected device shall re-transmit the same message to that specific receiving connected device until it receives a valid response or acknowledgement; or an amount of time has elapsed since the RSU first transmitted the message to the CMV. If the specification does not specify a maximum transmission time, the connected device shall re-transmit a message to another connected device for no more than 15 seconds.

This maximum time interval is needed so that a CMV or an RSU does not continuously re-transmit a message indefinitely, adding to any congestion on the communications channel. The 15 seconds provide sufficient time for a connected CMV traveling at the expected 95^{th} percentile speed would be within the transmission zone for at least three or four transmissions.

G.2.6 Transmission Rate Requirements - Sharing Probe Data

The detailed transmission rate requirements for an RSU to broadcast a service advertisement message, indicating its support for receiving probe data, to connected vehicles are as follows.

G.2.6.1 Maximum Transmission Rate - Broadcast Probe Data Service

An RSU shall broadcast a message to connected vehicles indicating its support for receiving probe data messages no more than once per second.

G.2.6.2 Default Transmission Rate - Broadcast Probe Data Service

If the specification does not indicate a default transmission rate, the suggested default transmission rate for an RSU to broadcast a message to connected vehicles indicating its support for receiving probe data messages shall be once per second.

If there is no need for an RSU to broadcast a message, then it recommended that no messages be transmitted from the RSU to minimize traffic, i.e., congestion.

G.2.7 Transmission Rate Requirements - Probe Data Management

The detailed transmission rate requirements for an RSU to broadcast a message to connected vehicles changing its data collection policy are as follows.

G.2.7.1 Maximum Transmission Rate - Broadcast Probe Data Management

An RSU shall broadcast a message to connected vehicles changing its data collection policy no more than once per second.

G.2.7.2 Default Transmission Rate - Broadcast Probe Data Management

If the specification does not indicate a default transmission rate, the suggested default transmission rate for an RSU to broadcast a message to connected vehicles changing its data collection policy shall be once per second.

If there is no need for an RSU to broadcast a message, then it recommended that no messages be transmitted from the RSU to minimize traffic, i.e., congestion.

G.2.8 Transmission Rate Requirements - Broadcast Roadway Geometrics Information

RSUs broadcasting roadway geometrics information has different transmission requirements than a generic RSU because of its safety aspects. For example, connected vehicles approaching or within an intersection needs to be aware of the roadway geometrics. Wireless communications is not 100% reliable, thus if a vehicle only has the opportunity to receive one transmission, there is a reasonable potential it will miss it. Thus, for RSUs broadcasting roadway geometric information, which may be considered safety critical, the transmission rates should be different to increase the opportunities for a connected device to receive the messages.

G.2.8.1 Minimum Transmission Rate - Broadcast Roadway Geometrics Information

An RSU shall broadcast roadway geometrics information to connected devices no less than once per 2 seconds.

G.2.8.2 Maximum Transmission Rate - Broadcast Roadway Geometrics Information

An RSU shall broadcast roadway geometrics information to connected devices no more than once per 500 ms.

G.2.8.3 Default Transmission Rate - Broadcast Roadway Geometrics Information

If the specification does not indicate a default transmission rate, the suggested default transmission rate for an RSU to broadcast roadway geometrics information to a connected device shall be once per second.

G.2.9 Transmission Rate Requirements - Location Corrections Detail Broadcasts

The detailed transmission rate requirements for an RSU to broadcast location correction details information to connected vehicles are as follows.

G.2.9.1 Minimum Transmission Rate - Location Corrections Detail Broadcasts

An RSU shall broadcast the location correction details message to connected devices at least once per second (1 hertz) for various corrections messages. Broadcasting location correction detail messages any slower than once per second has a significant effect on the integrity of the location correction information.

G.2.9.2 Default Transmission Rate - Location Corrections Detail Broadcasts

If the specification does not indicate a default transmission rate, an RSU shall broadcast the location correction details message to connected devices at a constant 1 hertz.

G.2.10 Transmission Rate Requirements - Broadcast Signal Phase and Timing Information

Broadcasting signal phase and timing information has different requirements because of its safety aspects - connected vehicles approaching a signalized intersection needs to be aware of the signal timing information. Wireless communications is not 100% reliable, thus if a vehicle only has the opportunity to receive one transmission, there is a reasonable potential it will miss it. Thus, for RSUs broadcasting signal phase and timing information, which may be considered safety critical, the transmission rates should be different to increase the opportunities for a connected vehicle to receive the messages.

G.2.10.1 Minimum Transmission Rate - Broadcast Signal Phase and Timing Information

An RSU shall broadcast signal phase and timing information to connected vehicles no less than once every 2 seconds.

G.2.10.2 Maximum Transmission Rate - Broadcast Signal Phase and Timing Information

An RSU shall broadcast signal phase and timing information to connected vehicles no more than once every 100 ms.

G.2.10.3 Default Transmission Rate - Broadcast Signal Phase and Timing Information

If the specification does not indicate a default transmission rate, the default transmission rate for an RSU to broadcast signal phase and timing information to a connected vehicle shall be once per 150 ms.

G.2.11 Transmission Rate Requirements - Broadcast Traveler Information

The detailed transmission rate requirements for an RSU to broadcast traveler information to connected devices are as follows.

G.2.11.1 Maximum Transmission Rate - Broadcast Traveler Information

An RSU shall broadcast a traveler information message to connected devices no more than once per second.

G.2.11.2 Default Transmission Rate - Broadcast Traveler Information

If the specification does not indicate a default transmission rate, the suggested default transmission rate for an RSU to broadcast a traveler information message to connected devices once per second.

If there is no need for an RSU to broadcast a message, then it recommended that no messages be transmitted from the RSU to minimize traffic, i.e., congestion. Otherwise, it is recommended that an RSU transmit a broadcast message frequently enough to ensure that the connected device for which the message is intended, traveling at the an expected percentile speed would be within the transmission zone for at least three or four broadcasts.

G.2.12 Transmission Rate Requirements - Broadcast Mayday

The following sections contain the detailed message transmission rate requirements for a connected vehicle to broadcast mayday messages to other connected devices.

G.2.12.1 Minimum Transmission Rate - Broadcast Mayday

A connected vehicle shall broadcast a mayday message with other connected devices at least once every 5 seconds.

G.2.12.2 Maximum Transmission Rate - Broadcast Mayday

A connected vehicle shall broadcast a mayday message to other connected devices no more than once per 500 ms.

G.2.12.3 Default Transmission Rate - Broadcast Mayday

If the specification does not indicate a default transmission rate, the default transmission rate for a connected vehicle shall broadcast a mayday message to other connected devices once per 1000 ms.

G.2.13 Maximum Response Time - Ad Hoc Messages

A connected vehicle shall process all ad hoc information and requests from an RSU within the maximum response time. The response time is measured as the time between the receiving of the last byte of the request and the transmission of the first byte of the response. If the specification does not indicate the response time, the default maximum response time shall be 2 seconds.

END OF INFORMATION REPORT