SAE International

SURFACE VEHICLE STANDARD

SAE J2735®

Issued 2006-12
Revised 2009-11

Superseding J2735 DEC2006

(R) Dedicated Short Range Communications (DSRC) Message Set Dictionary

Rationale

This 2nd edition of the standard provides additional DSRC messages developed beyond those defined in the first edition and incorporating feedback from early deployment experience. A uniform method of message encoding, using ASN.1 DER encoding, replaces the implicit binary encoding developed in the first edition, although some binary encoding remains in selected messages for efficiency. The messages defined in this edition have been designed to support deployment in such a way as to remain compatible with additional further planned message content, still in development at this time.

Foreword

Prepared for use by the DSRC committee of the SAE by SubCarrier Systems Corp (SCSC).

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Create_time:      12:00:00 PM Wednesday, October 28, 2009
Extracted from:   Dsrc_rev036.ITS      [Mod: 10/28/2009]
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1. Scope

This SAE Standard specifies a message set, and its 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"), communications systems. Although the scope of this Standard is focused on DSRC, this message set, and its data frames and data elements have been designed, to the extent possible, to also be of potential 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.

1.1 Purpose

The purpose of this SAE Standard is to support interoperability among DSRC applications through the use of a standardized message set, and its data frames and data elements. This Standard provides information that is useful in understanding how to apply the various DSRC Standards, along with the message set specified herein, to produce interoperable DSRC applications.

This second published version of J2735 is designated a 'Standard' rather than a 'Recommended Practice.' This implies that the data set dictionary in this version is deployable. It also creates a requirement that future revisions of J2735 be backward compatible with this revision. This revision adds content to and corrects errors in the previous published Standard.

2. References

2.1 Applicable Documents

The following documents shall be used, when applicable, in the process of populating and developing the message set of this Standard. The specific revision and issued date stated below shall be used for each document. When the following documents are superseded by an approved revision, the revised version shall be reviewed for applicability.

The references cited below shall be included in the references of the other companion volumes of this Standard unless specifically excluded.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J2540 – Messages for Handling Strings and Look-Up Tables in ATIS Standards, July 2002 and its successors.

SAE J2540-2 – ITIS Phrase Lists (International Traveler Information Systems), 4th edition. November 2009 and its successors.

SAE J2630 –Converting ATIS Message Standards From ASN.1 To XML (XML Translation rules), Publication date: December 2003

SAE J670, - Vehicle Dynamics Terminology, Issued 1976-07 and its successors

2.1.2 IEEE Publications

Available from Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE Std 1488-2000, IEEE Trial-Use Standard for Message Set Template for Intelligent Transportation Systems.

IEEE Std 1489-1999, IEEE Standard for Data Dictionaries for Intelligent Transportation Systems.

2.1.3 ISO Publications

Available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse, www.iso.ch. ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, New York, NY 10036, USA, www.ansi.org.

ISO/IEC 8824-1:1998, Information technology—Abstract Syntax Notation One (ASN.1): Specification of basic notation.

ISO/IEC 8824-2:1998, Information technology—Abstract Syntax Notation One (ASN.1): Information object specification.

ISO/IEC 8824-3:1998, Information technology—Abstract Syntax Notation One (ASN.1): Constraint specification.

ISO/IEC 8824-4:1998, Information technology—Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications.

2.1.4 RTCM Publications

Available from the Radio Technical Commission For Maritime Services, 1800 N Kent St., Suite 1060, Arlington, VA 22209, www.rtcm.org.

RTCM 10402.3 Recommended Standards For Differential GNSS (Global Navigation Satellite Systems) Service -Version 2.3 Revision 2.3 adopted on August 20, 2001and its successors.

RTCM Standard 10410.0 for Networked Transport of RTCM via Internet Protocol (Ntrip) Revision 1.0 adopted on September 30, 2004 and its successors.

RTCM Standard 10403.1 for Differential GNSS (Global Navigation Satellite Systems) Services -Version 3 adopted on October 27, 2006 and its successors, including amendment #2 adopted August 31, 2007.

2.1.5 NMEA Publication

Available from National Marine Electronics Association, 7 Riggs Ave., Severna Park, MD 21146, www nmea.org.

NMEA 183 Interface Standard V 3.01, published by the National Marine Electronics Association (NMEA) released January 2002.

2.2 It should be noted that this standard is intended to be independent of the underlying protocols used. However, it is also noted that early deployments are expected to use the "DSRC-WAVE" technology hosted at 5.9 GHz. For such applications the following standards are also of value.

2.2.1 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E2158-01 Standard Specification for Dedicated Short Range Communication (DSRC) Physical Layer Using Microwave in the 902 to 928 MHz Band

ASTM E2213 -03 Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems - 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications

2.2.2 IEEE Publications

Available from Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE Std 1609.2™-2006, IEEE Trial-Use Standard for Wireless Access in Vehicular Environments—Security Services for Applications and Management Messages, approved by SASB 8 June 2006, cover date 6 July 2006. And its adopted successors.

IEEE Std 1609.3™-2007, IEEE Trial-Use Standard for Wireless Access in Vehicular Environments (WAVE)—Networking Services, approved by SASB 23 march 2007, cover date 20 April 2007. And its adopted successors.

IEEE Std 1609.4™-2006, IEEE Trial-Use Standard for Wireless Access in Vehicular Environments (WAVE)—Multi-channel Operation, approved 30 October 2006, cover date 29 November 2006. And its adopted successors.

IEEE Std 802.11™-2007, Standard for LAN/MAN - Specific requirements Part 11: Wireless LAN Medium Access Control (MAC)and Physical Layer (PHY) Specifications, Institute of Electrical and Electronics Engineers / 12-Jun-2007 (date on the cover) / 1232 pages ISBN: 9780738156552

3. Terms and definitions

For the purposes of this standard, the following definitions, abbreviations and acronyms apply.

3.1 Definitions

For the purposes of this standard, the following definitions shall apply.

3.1.1 actuated operation: A type of traffic control signal operation in which some or all signal phases are operated on the basis of actuation, e.g. detector inputs. A signal without any actuation runs on either fixed time or time of day operation. A signal may be semi-actuated as well.

3.1.2 application-specific data dictionary: A data dictionary specific to a particular implementation of an ITS application. Local deployments which use DSRC (or other message sets) may often select a subset of the defined messages meeting their specific needs and create an application-specific data dictionary for that deployment.

3.1.3 approach: All lanes of traffic moving towards an intersection or a midblock location from one direction, including any adjacent parking lane(s). In the context of this standard an approach is a arbitrary collection of lanes used in the flow of traffic proceeding to an intersection or a midblock location. An approach is typically identified by its general flow, i.e. “the east-bound approach”. In this standard an approach consists of one or more motor vehicle lanes of travel as well as possible pedestrian lanes, parking lanes, barriers, and other types of lane objects some of which cross the path of the motor vehicle travel.

3.1.4 basic encoding rules: Rules laid out by the ASN.1 standard for encoding abstract information into a concrete data stream. The DSRC message set standard uses DER, a variant of BER for its encoding.

3.1.5 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.

3.1.6 byte type encoding: A type of information encoding where units of information are handled in modular increments of 8 bits.

3.1.7 computed lane: A computed lane is a lane drivable by motorized vehicle traffic which shares its path definition with another nearby lane at the same intersection. It is one of several types of basic lanes defined in the message set. The computed lane allows saving of message bytes used to express the geometric path of multiple lanes approaching an intersection from the same direction.

3.1.8 conflict monitor: A device used to detect and respond to improper or conflicting signal indications and improper operating voltages in a traffic controller assembly.

3.1.9 control channel (CCH): The radio channel of those defined in IEEE 802.11 used for exchange of management data and WAVE Short Messages.

3.1.10 controller assembly: A complete electrical device mounted in a cabinet for controlling the operation of a highway traffic signal.

3.1.11 controller unit: That part of a controller assembly that is devoted to the selection and timing of the display of signal indications.

3.1.12 cycle: One complete sequence of signal indications.

3.1.13 cycle length: The duration of one complete sequence of signal indications. The cycle length is not generally fixed at actuated controllers.

3.1.14 dark mode: The lack of all signal indications at a signalized location. (The dark mode is most commonly associated with power failures, ramp meters, beacons, and some movable bridge signals.) Note that when the SPAT message is used to convey the status of a non-signalized 4-way stop type of intersection, if an approach is modeled as being in the dark mode, it would indicate that the signage is missing (normally a flashing red stop would be indicated).

3.1.15 data: Representations of static or dynamic entities in a formalized manner suitable for communication, interpretation, or processing by humans or by machines.

3.1.16 data concept: Any of a group of data dictionary structures defined in this standard (e.g., data element, data element concept, entity type, property, value domain, data frame, or message) referring to abstractions or things in the natural world that can be identified with explicit boundaries and meaning and whose properties and behavior all follow the same rules.

3.1.17 data consumer: Any entity in the ITS environment which consumes data from others.

3.1.18 data dictionary: An information technology for documenting, storing and retrieving the syntactical form (i.e., representational form) and some usage semantics of data elements and other data concepts. The major message sets of ITS, of which DSRC is but one, are kept and represented in a data dictionary.

3.1.19 data element: A syntactically formal representation of some single unit of information of interest (such as a fact, proposition, observation, etc.) with a singular instance value at any point in time, about some entity of interest (e.g., a person, place, process, property, object, concept, association, state, event). A data element is considered indivisible.

3.1.20 data frame: (formerly: Data Structure, which appears in the early ITS efforts, is now more commonly called a Data Frame. The definition and meaning, which follows, remains the same.): One of the constructs used to represent the contents of a Data Dictionary. From a computer science perspective, data frames are viewed as logical groupings of other data frames and of data elements to describe "structures" or parts of messages used in this and other standards. A data frame is a collection of two or more other data concepts in a known ordering. These data concepts may be simple (data elements) or complex (data frames). A construct composed entirely of an octet string is considered a data frame if the octet string represents two or more distinct data concepts.

3.1.21 data plane: The communication protocols defined to carry application and management data across the communications medium.

3.1.22 data structure: Any construct (including data elements, data frames, and other data concepts) used to represent the contents of a data dictionary.

3.1.23 data type: A classification of the collection of letters, digits, and/or symbols used to encode values of a data element based upon the operations that can be performed on the data element. For example, real, integer, character string, Boolean, bitstring, etc.

3.1.24 dialog: A sequence of two or more messages which are exchanged in a known sequence and format (typically of a request followed by one or more replies), which are considered a bound transactional exchange between the parties.

3.1.25 distinguished encoding rules: A variant of ASN BER encoding used by this standard.

3.1.26 dual-arrow signal section: A type of signal section designed to include both a yellow arrow and a green arrow.

3.1.27 egress: In the context of this standard an egress is a flow of vehicular or other types of traffic leaving an intersection on one or more of the defined lanes of travel.

3.1.28 encounter: In the context of this standard an encounter is an exchange of messages between two or more DSRC equipped devices (OBUs or RSUs) lasting for a brief period of time.

3.1.29 entity: Anything of interest (such as a person, place, process, property, object, concept, association, state, event, etc.) within a given domain of discourse (in this case within the ITS domain of discourse).

3.1.30 entity type: An abstract type of structure defined in the ITS data register but no longer used. There are no entity types defined in this standard.

3.1.31 flashing mode: A mode of operation in which at least one traffic signal indication (but more typically all signal indication of the entire signalized intersection) in each vehicular signal face of a highway traffic signal is turned on and off repetitively. Expressed in the terminology of the SPAT message, this is reflected in the descriptions of signal states of the affected lanes (in that movement) being set to red flashing.

3.1.32 full-actuated operation: A type of traffic control signal operation in which all signal phases function on the basis of actuation.

3.1.33 functional-area data dictionary (FADD): A data dictionary that is intended to standardize data element syntax, and semantics, within and among application areas within the same functional area. This DSRC standard is a FADD.

3.1.34 ingress: In the context of this standard an egress is a flow of vehicular or other types of traffic approaching an intersection on one or more of the defined lanes of travel.

3.1.35 intelligent transportation systems (ITS): Systems that apply modern technology to transportation problems. 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.

3.1.36 interoperability: The ability to share information between heterogeneous applications and systems.

3.1.37 intersection: In the context of this standard an intersection is a nexus where two or more approaches 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 travel are reflected in the signal phases, the geometry of the intersection itself, and the local regulatory environment. The messages of this standard convey some of this information to the traveling public. Specifically, the MAP message conveys the relevant the road geometry, while the SPAT message conveys the current signal indication to allow and control movement in the intersection.

3.1.38 intersection control beacon: A beacon used only at an intersection to control two or more directions of travel.

3.1.39 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.

3.1.40 interval sequence: The order of appearance of signal indications during successive intervals of a signal cycle.

3.1.41 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.

3.1.42 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), and the current signal phase (and therefore the allowed movements) then applicable to that lane or its approach is provided in the SPAT message.

3.1.43 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.

3.1.44 link (RF): A communications channel being used in support of application data transfer needs.

3.1.45 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.

3.1.46 management plane: The collection of functions performed in support of the communication system operation, but not directly involved in passing application data.

3.1.47 message: A well structured set of data elements and data frames that can be sent as a unit between devices to convey some semantic meaning in the context of the applications about which this standard deals. Within Section 5 of this standard, each sub-section (e.g. 5.1) defines one message. The term "message type" has the same meaning as "message" in this standard.

3.1.48 message set: A collection of messages based on the ITS functional-area they pertain to. The collection of messages defined in Section 5 of this standard is a message set

3.1.49 networking services: The collection of management plane and data plane function at the network layer and transport layer, supporting WAVE communications.

3.1.50 notification: An indication of an event of interest, sent to an application. Also a term used by lower layers inform upper layers an event of interest in a protocol stack.

3.1.51 offset (phase): Offset is the time lag for the cycle start of a coordinated signal. Quoting from the FHWA Signal Timing Manual, Chapter 6, Section 6.1 Terminology. (Draft 3 version, development still underway): "The time relationship between coordinated phases defined reference point and a defined master reference (master clock or sync pulse)." In other words, a local signal controller setting that references the start of the green to a common clock so the beginning of green can be coordinated along a roadway to speed motorist along at a designed speed.

3.1.52 on-board unit: An On-Board Unit (OBU) is a vehicle mounted DSRC device used to transmit and receive a variety of message traffic to and from other DSRC devices (other OBUs and RSUs). Among the message types and applications supported by this process are vehicle safety messages, a primary subject of this standard, used to exchange information on each vehicle's dynamic movements for coordination and safety. An OBU contains a station (STA).

3.1.53 pedestrian change interval: An interval during which the flashing UPRAISED HAND (symbolizing DONT WALK) signal indication is displayed, often also called the pedestrian clearance time. During this interval the SPAT messages indicates a don't walk state for that pedestrian lane (along with an optional period of time remaining for this state).

3.1.54 pedestrian clearance time: The minimum time provided for a pedestrian crossing in a crosswalk, after leaving the curb or shoulder, to travel to the far side of the traveled way or to a median. During this interval the SPAT messages indicates a Flashing Don't Walk indication for that pedestrian lane (along with an optional period of time remaining for this state). The duration for such time intervals comes from MUTCD and is based on a rate of speed of 2 meters per second.

3.1.55 pedestrian phase: The time during which a walking figure or word "WALK" is presented and the DON'T WALK is presented. The pedestrian phase is also the time interval of the pedestrian walk interval and the pedestrian change interval combined.

3.1.56 pedestrian walk interval: An interval during which the WALKING PERSON (symbolizing WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "walk sign." During this interval the SPAT messages indicates a walk state

for that pedestrian lane (along with an optional period of time remaining for this state and the subsequent pedestrian clearance state).

3.1.57 permissive mode: A mode (left or right) of traffic control signal operation in which, when a CIRCULAR GREEN signal indication is displayed, left and/or right turns are permitted to be made after yielding to pedestrians and/or oncoming traffic.

3.1.58 preemption control: The transfer of normal operation of a traffic control signal to a special control mode of operation.

3.1.59 pretimed operation: A type of traffic control signal operation in which none of the signal phases function on the basis of actuation. When such a signal operation is reflected in the SPAT message, the time intervals given for various signal phases are fixed and do not vary based on any form of actuation. Pretimed operation may be fixed or based on time of day schedules.

3.1.60 protected mode: A mode (left or right) of traffic control signal operation in which left or right turns are permitted to be made when a left or right GREEN ARROW signal indication is displayed.

3.1.61 provider service context (PSC): A field associated with a PSID containing supplementary information related to the service. The format of the PSC is PSID dependent.

3.1.62 provider service identifier (PSID): A number that identifies a service provided by an application.

3.1.63 red clearance interval: An optional interval that follows a yellow change interval and precedes the next conflicting green interval.

3.1.64 reference lane: A reference lane is a lane drivable by motorized vehicle traffic which also contains a detailed path definition of the lane's geometry (a center line path and width) as well as basic attributes (such as the allowed maneuvers) about the lane. The provided path data may optionally be shared with another nearby lane (a "computed lane") in the same intersection. It is one of several basic types of lanes defined in the message set.

3.1.65 reference point: A reference point is a complete latitude – longitude – and vertical point on the reference surface which is used as an initial starting point for subsequent orthogonal offset X, Y, Z values from that point. All roadway geometry, maps of intersections, lane and curve descriptions, and other geometrical data that is encoded in this standard uses a systems of local reference points to index and offset the data that follows.

3.1.66 roadside unit: A RoadSide Unit (RSU) is a DSRC device used to transmit to, and receive from, DSRC 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). Some RSUs have the ability to transmit signals with greater power than OBUs and some may have connectivity to other nodes or the Internet. An RSU contains a station (STA).

3.1.67 semi-actuated operation: A type of traffic control signal operation in which at least one, but not all, signal phases function on the basis of actuation.

3.1.68 service channel: Secondary channels (logical channels) used for application-specific information exchanges.

3.1.69 signal head: An assembly of one or more signal lamps. One or more signal heads may be used to provide complementary indications to one of more approaches, which may cover multiple lanes. The definitive mapping to specific lanes can be determined by examining the SPAT and MAP fragment messages.

3.1.70 signal phase: The right-of-way, yellow change, and red clearance intervals in a cycle that are assigned to an independent traffic movement, or combination of movements. Each of these cycles are reflected in the SPAT message for the lanes that are part of the movement(s), along with its expected timing interval (which may be updated in signal systems that vary the time interval based on actuation or other methods).

3.1.71 signal section: Two or more traffic control signals operating in signal coordination. Also called a signal system.

3.1.72 signal timing: The amount of time allocated for the display of a signal indication, slang.

3.1.73 SPAT: In the context of this standard, Signal Phase And Timing (SPAT), is a message type which 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 control state.

3.1.74 split (phase): In split phase operations opposing turn lanes are coordinated at differing times. For example, the east and west left turn movements would get green arrows at different times.

3.1.75 split (signal): Signal split is a term having to do with coordinated signals. Signal split pertains to time allocated to the coordinated road vs. the cross streets.

3.1.76 stability control: A system which operates to prevent a car from sliding sideways under dynamic driving conditions.

3.1.77 station: Any device that contains an IEEE 802.11 conformant medium access control (MAC) and physical layer (PHY) interface to the wireless medium.. An RSU and OBU contain stations (STA).

3.1.78 stop line: The stop line is a defined location along the path of the lane type where users (vehicles) are presumed to stop and come to rest at the edge of the intersection. The stop line is used as the starting point to define the centerline path of a lane in the messages (with sets of offset points defining the path of the lane proceeding away from the stop line). While stop lines are normally considered for lanes describing motorized vehicle travel, they are also used on other forms of lanes (such as pedestrian walkway lanes) to describe the initial point of the path.

3.1.79 syntax: The structure of expressions in a language, and the rules governing the structure of a language.

3.1.80 transactions: Bi-directional data exchanges between devices (RSUs and OBUs).

3.1.81 Unavailable: In the context of this standard and in the context of a data concept definition, the term unavailable shall mean that the value of this data concept could not be obtained for use in the message.

3.1.82 value domain: A well known range of values, or terminology, or enumeration that many be referenced as an abstract type the ITS data register but no longer used. There are very many value domains used in ITS standards.

3.1.83 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 the ITS.

3.1.84 walk interval: An interval during which the WALKING PERSON (symbolizing WALK) signal indication is displayed. When a verbal message is provided at an accessible pedestrian signal, the verbal message is "walk sign."

3.1.85 warning beacon: A beacon used only to supplement an appropriate warning or regulatory sign or marker.

3.1.86 WAVE device: A device that contains a WAVE-conformant medium access control (MAC) and physical layer (PHY) interface to the wireless medium. (See IEEE 802.11 and IEEE 1609.4)

3.1.87 WAVE management entity (WME): The set of management functions, as defined in IEEE Std 1609 documents, required to provide WAVE Networking Services.

3.1.88 XML: A common method of exchanging messages made up of tags and values organized in a data structure and typically transported over common Internet formats such as HTTP. XML has a growing number of supporters due to its ability to be implemented in the types of heterogeneous systems often found in ITS deployments. It is possible to express and exchange the DSRC message set using this method; XML schema definitions are provided in the latter clauses of the standard.

3.1.89 yellow change interval: The first interval following the green interval during which the yellow signal indication is displayed. In the SPAT message the fixed duration of the yellow change interval is (optionally) provided for each active lane being described.

3.2 Abbreviations and acronyms

The terms, abbreviations and acronyms cited below shall be a part of the terms of this standard (and of the other companion volumes and guides) unless specifically cited otherwise.

AAMVA	American Association of Motor Vehicle Administrators
ABS	Anti-lock Braking System
ACM	A La Carte Message
ASC	Advanced Signal Controller

ASN	Abstract Syntax Notation revision One, Also: ASN.1
ASTM	American Society for Testing and Materials
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Transportation Management Systems
BER	Basic Encoding Rules
BLOB	Binary Large OBject
BSM	Basic Safety Message
BSW	Blind Spot Warning
CAN	Controller Area Network
CCC	Cooperative Cruise Control
CCH	Control Channel
CER	Canonical Encoding Rules
CICAS-V	Cooperative Intersection Collision Avoidance System – Violation
CLW	Control Loss Warning
CRC	Cyclic Redundancy Code
CSR	Common Safety Request Message
DE	Data Element
DER	Distinguished Encoding Rules
DF	Data Frame
DNPW	Do Not Pass Warning
DSRC	Dedicated Short Range Communications
DVIN	Driver-Vehicle Interface Notifier
EEBL	Emergency Electronic Brake Lights
EGUI	Engineering Graphical User Interface
ESS	Environmental Sensors Stations
EVA	Emergency Vehicle Alert Message
FCW	Forward Collision Warning
GES	General Estimated System
GID	Geographic Information Description
GMT	Greenwich Mean Time
HMI	Human Machine Interface
HVPP	Host Vehicle Path Prediction
ICA	Intersection Collision Alert Message
IEEE	Institute of Electrical and Electronics Engineers
IM	Incident Management or inter-modal
IMA	Intersection Movement Assist

IP	Internet Protocol
IPv6	Internet Protocol version 6
ISO	International Standards Organization
ITE	Institute of Transportation Engineers
ITIS	International Traveler Information Systems
LCW	Lane Change Warning
LLC	Logical Link Control
LRMS	Location Referencing Message System
LSB	Least Significant Bit
MAC	Medium Access Control
MAP	Map Data Message
MIB	Management Information Base
MIL	Malfunction Indicator Light (Check Engine Light)
MSB	Most Significant Bit
MSG	Message
NAP	Network Access Point
NEMA	National Electronics Manufacturers Association
NMEA	National Marine Electronics Association
NTCIP	National Transportation Communications for ITS Protocols
NTRIP	Networked Transport of RTCM via Internet Protocol
OBE	On-Board Equipment
OBU	On-Board Unit
OEM	Original Equipment Manufacturer
OTA	Over-The-Air
PDM	Probe Data Management Message
PDU	Protocol Data Unit
PER	Packed Encoding Rules
PH	Path History
PHY	Physical Layer
PP	Path Prediction
PSC	Provider Service Context
PSID	Provider Service Identifier
PSN	Probe Segment Number
PVD	Probe Vehicle Data Message
RSA	RoadSide Alert Message
RSU	RoadSide Unit

RTCM	Radio Technical Commission For Maritime Services or RTCM Corrections Message
RTK	Real Time Kinematics
SAE	SAE International
SAP	Service Access Point
SC-104	Sub-Committee 104 of the RTCM
SCH	Service Channel
SDH	Sensor Data Handler
SDN	Service Delivery Node
SDO	Standards Developing Organizations or Standards Development Organization
SPAT	Signal Phase And Timing Message
SRM	Signal Request Message
SRS	Safety Restraint System
SSM	Signal Status Message
STA	Station
TA	Threat Arbitration
TC	Traction Control or Target Classification
TCIP	Transit Communications Interface Profiles
TCP	Transmission Control Protocol
TCS	Traction Control System
TIM	Traveler Information Message
TMDD	Traffic Management Data Dictionary
UDP	User Datagram Protocol
USDOT	United States Department of Transportation
UTC	Universal Coordinated Time
VIN	Vehicle Ident Number
VSC	Vehicle Safety Communications
VSC-2	Vehicle Safety Communications 2
V-V	Vehicle-to-Vehicle (also V2V)
WAVE	Wireless Access in Vehicular Environments
WME	WAVE Management Entity
WMH	Wireless Message Handler
WSM	WAVE Short Message
WSMP	WSM Protocol
XML	eXtensible Markup Language

4 The use of DSRC messages in Applications

This section contains introductory material about this edition of J2735, background information on the rationale for the Standard, and an introduction to the messages and other data concepts, which follow in Sections 5-8.

4.1 Introduction to DSRC Goals and Objectives (Informative)

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, have 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:

1) Safety

2) Mobility

3) 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.

The message set specified in this SAE Standard depends upon the lower layers of the DSRC protocol stack (or potentially other wireless communications systems) to deliver the messages from applications at one end of the communication system (for example, in a vehicle) to the other end (for example, in another vehicle). These lower layers of the DSRC protocol stack are defined and specified in standards developed by other Standards Development Organizations (SDOs). In particular, the protocols at the lowest layers are addressed by IEEE 802.11, and the middle layer protocols are covered in the IEEE 1609 series of standards. The DSRC family of standards developed by the various SDOs are meant to operate together in a harmonious fashion. This standard defines the content and structure of messages exchanged between applications. A given J2735 message is the payload of the next lower layer protocol, e.g. the "WSM data" field defined in IEEE 1609.3. The aggregate content of an over-the-air packet is determined jointly by all the protocols in the stack.

The following subsection provides an overview of the DSRC architecture and protocol stack. Subsequent annexes describe examples of how the message and data concepts specified in this Standard might be used, which also strongly influenced the philosophy of the message design. These messages are presented in Section 5. The particular message design techniques described in this Standard have allowed for the construction of a dictionary of reusable, relevant data frames and data elements that support interoperability for currently envisioned applications and are also intended to expedite the development of future messages. The standard data frames are presented in Section 6 of this Standard, and the data elements are specified in Section 7. Data concepts reused from other areas of ITS work are presented in Section 8.

4.2 DSRC Overview (Informative)

The Wireless Access for Vehicular Environment (WAVE) communications system is designed to enable vehicle-to-vehicle and vehicle-to/from-infrastructure communications in order to provide a common platform to achieve the safety, mobility and commercial priorities described in Section 4.1. Interoperability is a fundamental requirement of this common platform, and WAVE is designed to provide the required interoperable wireless networking services for transportation. As well, the WAVE system uniquely supports the high-availability, low-latency communications requirements of vehicle safety applications, such as pre-crash collision mitigation, intersection collision avoidance and cooperative collision avoidance.

The physical layer (PHY) and the medium access control (MAC) layer of the WAVE system are specified in IEEE Standard 802.11™-2007, as amended (hereafter IEEE 802.11). The system generally supports a MAC and PHY for each channel on which it operates, i.e. the control channel (CCH) and/or one or more service channels (SCHs). The range of this system is generally considered to be line-of-sight distances of less than 1000 meters. The MAC and PHY protocols have been modified to support usage by vehicles traveling at highway speeds.

The IEEE Standard 1609™ family of standards (hereafter IEEE 1609) provides enhancements to the IEEE 802.11 medium access control (MAC) that support WAVE safety, mobility and private applications in a multi-channel system by specifying mechanisms for prioritized access, channel routing, channel coordination and data transmission.

The upper layers of the network stack, up to the application layer, are defined in IEEE 1609. There are two pathways through the WAVE upper layers above the LLC layer: the Wave Short Message Protocol (WSMP) stack and the IPv6 stack. IEEE 1609 describes networking services for applications running over either of these stacks, as well as describing the operation of the WSMP stack. Transmissions on the CCH are limited to WAVE Short Messages (WSM) and some management messages. Both the WSMP stack and the IPv6 stack may be used for communications on SCHs. The WSMP stack is generally used for broadcast applications. The IPv6 stack is typically used with UDP for the messages defined in this standard.

IEEE 1609 defines secure message formats, and specifies how these secure messages are processed within the WAVE system. These security services are designed to protect messages from attacks such as eavesdropping, spoofing, alteration and replay, while respecting end users' rights to privacy. The messages covered in IEEE 1609 security procedures include WAVE management messages and application messages, but do not yet include vehicle-originating safety messages. Security services for vehicle-originating safety messages have not yet been specified in any standard, but will be required before vehicle safety applications can be widely deployed.

4.3 Philosophy of Message Design (Informative)

The wireless DSRC channels over which J2735 messages are communicated are finite resources, which should be used conservatively in order to achieve good performance in realistic traffic environments. The WAVE Short Message Protocol (WSMP) is designed to operate efficiently over DSRC, using short packets that are frequently broadcast in an un-acknowledged delivery mode. Other protocols can be used over DSRC as well, for example to carry a variety of other ITS related information including such things as ATIS information encoded in XML forms. WSMs also support dialogs and transactions, and these can leave the control channel in order to use a service channel as needed, but the general design goal is to maximize support for short broadcast style messages. To that end, a dense encoding of information is used in defining the messages of this Standard. Several of the design aspects of this encoding are discussed below.

This dense encoding uses a three-way approach:

1) The smallest divisions of information content to be standardized are called Data Elements

2) Data Frames are the next, more complex data structures to be standardized in this dense encoding

3) The top level of complexity in the data structure standardization is called Messages

The above data concepts are all described in both Abstract Syntax Notation revision One (ASN.1, referred to as ASN hereafter) and in an XML schema syntax. This process follows the typical style used for message sets defined in ITS standards by SAE and the other SDOs engaged in ITS development. Complete ASN modules and XSD schema sets of the Standard are available for developers.

4.4 Message Encoding (Normative)

The ASN specified by this Standard is then 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 this Standard 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. Consult any textbook on ASN for further[1] details.

In the production of ASN and XML found in this standard there are OCTET STRING segments defined which are made up of inner content constructed as outlined in ASN comments which are part of the definition. In such cases the OTECT 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 MsgCount field in DF_ BSM_Blob shall conform to the definition of DE_MsgCount."

5. Message Set

This section defines the precise structure of the DSRC messages defined by this standard. The DSRC 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 unless expressly marked otherwise. Definitions for this message set are presented in the following subclauses. The ASN.1 is presented in a section titled ASN.1 Representation. The equivalent XML expression is presented in a section titled XML Representation

[1] The DSRC committee has developed a (freely available) users guide to illustrate the proper use the messages, and part of that guide provides additional data on the rules of encoding used in the message set.

which follows the translation rule set cited in Clause Two (SAE Standard J2630). Should the two sections conflict in some way, the ASN.1 expression 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. The XML productions follow directly from the ASN.1 specifications and the same rules shall be applied. Users of this standard seeking to be in conformance with it shall follow the normative text outlined here.

5.1 Message: MSG_A_la_Carte (ACM)

Use: An A_la_carte message always includes the DSRCMsgID, and optionally includes any data frames, data elements, or external content defined in Sections 6, 7 or 8 of this standard. If the MsgCRC 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.

ASN.1 Representation:

```
AlaCarte ::= SEQUENCE {
   msgID           DSRCmsgID,
                  -- the message type
   data            AllInclusive,
                  -- any possible set of data items here
   crc             MsgCRC OPTIONAL,
   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:element name="alaCarte" type=" AlaCarte"/>
<xs:complexType name=" AlaCarte" >
      <xs:sequence>
         <xs:element name="msgID" type=" DSRCmsgID" />
        <!-- the message type -->
         <xs:element name="data" type=" AllInclusive" />
        <!-- any possible set of data items here -->
         <xs:element name="crc" type=" MsgCRC"   minOccurs="0"/>
         <xs:element name="localAlaCarte"  type="local:AlaCarte"  minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

5.2 Message: MSG_BasicSafetyMessage (BSM)

Use: The basic safety message (BSM) is used in a variety of applications to exchange safety data regarding vehicle state. This message is broadcast frequently to surrounding vehicles with a variety of data content as required by safety and other applications. Transmission rates are beyond the scope of this standard, but a rate 10 times per second is typical. Part I data shall be included in every 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 Annex "Operation with the Basic Safety Message in Vehicles" for examples of how the Basic Safety Message can be used.

ASN.1 Representation:

```
BasicSafetyMessage ::= SEQUENCE {
   -- Part I
   msgID        DSRCmsgID,                 -- 1 byte

   -- Sent as a single octet blob
   blob1        BSMblob,

   --
   -- The blob consists of the following 38 packed bytes:
```

```
    --
    -- msgCnt       MsgCount,                -x- 1 byte
    -- id           TemporaryID,             -x- 4 bytes
    -- secMark      DSecond,                 -x- 2 bytes

    -- pos       PositionLocal3D,
      -- lat       Latitude,                -x- 4 bytes
      -- long      Longitude,               -x- 4 bytes
      -- elev      Elevation,               -x- 2 bytes
      -- accuracy  PositionalAccuracy,      -x- 4 bytes

    -- motion    Motion,
      -- speed      TransmissionAndSpeed,  -x- 2 bytes
      -- heading   Heading,                -x- 2 byte
      -- angle     SteeringWheelAngle      -x- 1 bytes
      -- accelSet  AccelerationSet4Way,    -x- 7 bytes

    -- control   Control,
    -- brakes       BrakeSystemStatus,    -x- 2 bytes

    -- basic     VehicleBasic,
    -- size         VehicleSize,          -x- 3 bytes

    -- Part II, sent as required
    -- Part II,
    safetyExt       VehicleSafetyExtension OPTIONAL,
    status          VehicleStatus          OPTIONAL,

    ... -- # LOCAL_CONTENT
    }
```

XML Representation:

```
<xs:element  name="basicSafetyMessage"  type=" BasicSafetyMessage"/>
<xs:complexType name=" BasicSafetyMessage" >
      <xs:sequence>
        <!-- Part I -->
         <xs:element name="msgID" type=" DSRCmsgID" />
        <!-- 1 byte
        Sent as a single octet blob -->
         <xs:element name="blob1" type=" BSMblob" />
        <!-- The blob consists of the following 38 packed bytes:
         -->
        <!-- msgCnt       MsgCount,              -x- 1 byte
        id           TemporaryID,           -x- 4 bytes
        secMark      DSecond,               -x- 2 bytes
        pos       PositionLocal3D,
        lat        Latitude,              -x- 4 bytes
        long       Longitude,             -x- 4 bytes
        elev       Elevation,             -x- 2 bytes
        accuracy   PositionalAccuracy,    -x- 4 bytes
        motion    Motion,
        speed      TransmissionAndSpeed,  -x- 2 bytes
        heading    Heading,               -x- 2 byte
        angle      SteeringWheelAngle    -x- 1 bytes
        accelSet   AccelerationSet4Way,   -x- 7 bytes
        control  Control,
        brakes       BrakeSystemStatus,     -x- 2 bytes
        basic    VehicleBasic,
        size         VehicleSize,           -x- 3 bytes
        Part II,  sent as required
        Part II, -->
         <xs:element name="safetyExt" type=" VehicleSafetyExtension"  minOccurs="0"/>
         <xs:element name="status" type=" VehicleStatus"   minOccurs="0"/>
        <xs:element name="localBasicSafetyMessage" type="local:BasicSafetyMessage"
minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Remarks: This message is divided into two parts and uses the same BER-DER encoding system in each.

In the Part I area (those data elements which are always sent in each BSM) some data elements have been encoded as a well-defined octet blob to enable concise encoding and conserve channel bandwidth. In the Part II area, BER-DER tags and lengths precede each defined data element in the normal way. Any locally defined content can be added to the part two content in the normal way. Developers of such local content should take steps to avoid creating content with tags which could conflict with future revisions of the standard (such tags should be in the local range of 128~255 to avoid conflict with the national standard).

5.3 Message: MSG_CommonSafetyRequest (CSR)

Use: The Common Safety Request message provides a means by which a vehicle participating in the exchange of the basic safety message can unicast requests to other vehicles for addition information which it requires for the safety applications it is actively running. Responding vehicles will (or may) add this information to the appropriate place in the basic safety message when they broadcast it. Additional operational concepts are explained further in other clauses of this standard.

Addition information (data elements and data frames) can be requested by this message to be placed into the Part II sections of the basic safety message (Part I contains selected information that is always present in every message without exception).

When a device receives a request for a data element it does not understand or support, or from a vehicle with a spatial position or heading that it may choose to ignore, then that request is simply ignored.

ASN.1 Representation:

```
CommonSafetyRequest ::= SEQUENCE {
   msgID          DSRCmsgID,
   msgCnt         MsgCount OPTIONAL,
   id             TemporaryID OPTIONAL,

   -- Note: Uses the same request as probe management
   requests       SEQUENCE (SIZE(1..32)) OF RequestedItem,

   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:element name="commonSafetyRequest" type=" CommonSafetyRequest"/>
<xs:complexType name=" CommonSafetyRequest" >
       <xs:sequence>
          <xs:element name="msgID" type=" DSRCmsgID" />
          <xs:element name="msgCnt" type=" MsgCount"   minOccurs="0"/>
          <xs:element name="id" type=" TemporaryID"   minOccurs="0"/>
         <!-- Note: Uses the same request as probe management -->
          <xs:element name="requests" >
             <xs:complexType>
                <xs:sequence minOccurs="1" maxOccurs="32">
                   <xs:element name="request" type=" RequestedItem" />
                </xs:sequence>
             </xs:complexType>
          </xs:element>
           <xs:element name="localCommonSafetyRequest" type="local:CommonSafetyRequest"
minOccurs="0"/>
       </xs:sequence>
</xs:complexType>
```

5.4 Message: MSG_EmergencyVehicleAlert (EVA)

Use: The Emergency Vehicle Alert message is used to broadcast warning messages to surrounding vehicles that an emergency vehicle (typically an incident responder of some type) is operating in the vicinity and that additional caution is required. The message itself is built on the original ATIS roadside alert message which in turn uses the common ITIS phrase list to both describe the event and provide advice and recommendation for travelers. The Emergency Vehicle Alert message appends to the message some additional data elements regarding the overall type of vehicle involved and other useful data. Note that this

message can be used by both private and public response vehicles, and that the relative priority of each (as well as security certificates) is determined in the application layer.

ASN.1 Representation:

```
EmergencyVehicleAlert ::= SEQUENCE {
   msgID              DSRCmsgID,
   id                 TemporaryID OPTIONAL,
   rsaMsg             RoadSideAlert,
                          -- the DSRCmsgID inside this
                              -- data frame is set as per the
                              -- RoadSideAlert.  The CRC is
                              -- set to a value of zero.
   responseType       ResponseType                    OPTIONAL,
   details            EmergencyDetails                OPTIONAL,
                     -- Combines these 3 items:
                     -- SirenInUse,
                     -- LightbarInUse,
                     -- MultiVehicleReponse,

   mass               VehicleMass                     OPTIONAL,
   basicType          VehicleType                     OPTIONAL,
                                -- gross size and axle cnt

   -- type of vehicle and agency when known
   vehicleType        ITIS.VehicleGroupAffected       OPTIONAL,
   responseEquip      ITIS.IncidentResponseEquipment OPTIONAL,
   responderType      ITIS.ResponderGroupAffected     OPTIONAL,
   crc                MsgCRC,
   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:element  name="emergencyVehicleAlert"  type=" EmergencyVehicleAlert"/>
<xs:complexType name=" EmergencyVehicleAlert" >
      <xs:sequence>
         <xs:element name="msgID" type=" DSRCmsgID" />
        <xs:element  name="id"  type=" TemporaryID"   minOccurs="0"/>
         <xs:element name="rsaMsg" type=" RoadSideAlert" />
        <!-- the  DSRCmsgID inside this
        data frame is set as per the
         RoadSideAlert.  The CRC is
        set to a value of zero. -->
         <xs:element name="responseType" type=" ResponseType"   minOccurs="0"/>
         <xs:element name="details" type=" EmergencyDetails"   minOccurs="0"/>
        <!-- Combines these 3 items:
         SirenInUse,
         LightbarInUse,
         MultiVehicleReponse, -->
         <xs:element name="mass" type=" VehicleMass"   minOccurs="0"/>
         <xs:element name="basicType" type=" VehicleType"   minOccurs="0"/>
        <!-- gross size and axle cnt
         type of vehicle and agency when known -->
        <xs:element  name="vehicleType"  type=" itis:VehicleGroupAffected"
minOccurs="0"/>
         <xs:element name="responseEquip" type=" itis:IncidentResponseEquipment"
minOccurs="0"/>
         <xs:element name="responderType" type=" itis:ResponderGroupAffected"
minOccurs="0"/>
         <xs:element name="crc" type=" MsgCRC" />
       <xs:element name="localEmergencyVehicleAlert" type="local:EmergencyVehicleAlert"
minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Remarks: The TemporaryID data element shall be sent only if the vehicle wishes to identify itself to others. If a data element value is not known or will not be sent (because its presence is marked OPTIONAL in the ASN) then that data item will not be part of the message. The CRC value found as part of the Road Side Alert message shall be properly set for the value for the bytes enclosed in that message.

and the CRC value found as part of the Emergency Vehicle message shall be properly set for the value for the bytes enclosed in that message. In other words, the Road Side Alert message shall be a valid message within the Emergency Vehicle message.

5.5 Message: MSG_IntersectionCollisionAvoidance (ICA)

Use: This message deals with providing data from the vehicle to build intersection collision avoidance systems with. It identifies the intersection being reported on and the recent path and accelerations of the vehicle.

ASN.1 Representation:

```
IntersectionCollision ::= SEQUENCE {
   msgID            DSRCmsgID,
   msgCnt           MsgCount,
   id               TemporaryID,
   secMark          DSecond OPTIONAL,
   path             PathHistory,
                   -- a set of recent path histories
   intersetionID    IntersectionID,
                   -- the applicable Intersection, from the MAP-GID
                   -- the best applicable movement, from the MAP-GID
   laneNumber       LaneNumber,
                   -- the best applicable Lane, from the MAP-SPAT-GID
                   -- zero sent if unknown
   eventFlag        EventFlags,
                   -- used to convey vehicle Panic Events,
                   -- Set to indicate "Intersection Violation"
   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:element  name="intersectionCollision"  type=" IntersectionCollision"/>
<xs:complexType name=" IntersectionCollision" >
      <xs:sequence>
         <xs:element name="msgID" type=" DSRCmsgID" />
         <xs:element name="msgCnt" type=" MsgCount" />
         <xs:element name="id" type=" TemporaryID" />
         <xs:element name="secMark" type=" DSecond"   minOccurs="0"/>
        <xs:element name="path" type=" PathHistory" />
       <!-- a set of recent path histories -->
        <xs:element name="intersetionID" type=" IntersectionID" />
       <!-- the applicable  Intersection,  from the MAP-GID
       the best applicable movement,  from the MAP-GID -->
        <xs:element name="laneNumber" type=" LaneNumber" />
       <!-- the best applicable Lane,  from the MAP-SPAT-GID
       zero sent if unknown -->
        <xs:element name="eventFlag" type=" EventFlags" />
       <!-- used to convey vehicle Panic Events,
        Set to indicate &quot;Intersection Violation&quot; -->
        <xs:element name="localIntersectionCollision" type="local:IntersectionCollision"
minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

5.6 Message: MSG_MapData (MAP)

Use: The MapData message is used as a wrapper object to relate all the types of maps defined in the standard. 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). The contents of this message are at times informally referred to as the *GID layer*.

ASN.1 Representation:

```
MapData ::= SEQUENCE {
   msgID            DSRCmsgID,
```

```
    msgCnt            MsgCount,
    name              DescriptiveName OPTIONAL,
    layerType         LayerType   OPTIONAL,
    layerID           LayerID   OPTIONAL,
    intersections     SEQUENCE (SIZE(1..32)) OF
                      Intersection OPTIONAL,

    -- other objects may be added at this layer, tbd,
    -- this might become a nested CHOICE statement
    -- roadSegments      SEQUENCE (SIZE(1..32)) OF
    --                   RoadSegments OPTIONAL,
    -- curveSegments     SEQUENCE (SIZE(1..32)) OF
    --                   curveSegments OPTIONAL,

    -- wanted: some type of data frame describing how
    -- the data was determined/processed to go here
    dataParameters     DataParameters OPTIONAL,
    crc                MsgCRC,
    ... -- # LOCAL_CONTENT
    }
```

XML Representation:

```
<xs:element  name="mapData"  type=" MapData"/>
<xs:complexType name=" MapData" >
      <xs:sequence>
         <xs:element name="msgID" type=" DSRCmsgID" />
         <xs:element name="msgCnt" type=" MsgCount" />
         <xs:element name="name" type=" DescriptiveName"   minOccurs="0"/>
         <xs:element name="layerType" type=" LayerType"   minOccurs="0"/>
         <xs:element name="layerID" type=" LayerID"   minOccurs="0"/>
         <xs:element name="intersections"  minOccurs="0">
            <xs:complexType>
               <xs:sequence minOccurs="1" maxOccurs="32">
                  <xs:element name="intersection" type=" Intersection" />
               </xs:sequence>
            </xs:complexType>
         </xs:element>
         <!-- other objects may be added at this layer,  tbd,
         this might become a nested CHOICE statement
         roadSegments     SEQUENCE  (SIZE (1..32) )  OF
         RoadSegments  OPTIONAL ,
         curveSegments    SEQUENCE  (SIZE (1..32) )  OF
         curveSegments  OPTIONAL ,
         wanted: some type of data frame describing how
         the data was determined/processed to go here -->
         <xs:element name="dataParameters" type=" DataParameters"   minOccurs="0"/>
         <xs:element name="crc" type=" MsgCRC" />
         <xs:element name="localMapData" type="local:MapData" minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

5.7 Message: MSG_NMEA_Corrections (NMEA)

Use: The NMEA_Corrections message is 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.

ASN.1 Representation:

```
NMEA-Corrections ::= SEQUENCE {
   msgID       DSRCmsgID,
   rev         NMEA-Revision,
               -- the specific edition of the standard
               -- that is being sent, normally 2.0
```

```
   msg          NMEA-MsgType,
                -- the message and sub-message type, as
                -- defined in the revision being used
   -- NOTE as the message type is also in the payload,
   wdCount      INTEGER (0..1023),
                -- a count of bytes to follow
   payload      NMEA-Payload,
   ...
   }
```

XML Representation:

```
<xs:element name="nMEA-Corrections" type=" NMEA-Corrections"/>
<xs:complexType name=" NMEA-Corrections" >
      <xs:sequence>
         <xs:element name="msgID" type=" DSRCmsgID" />
         <xs:element name="rev" type=" NMEA-Revision" />
        <!-- the specific edition of the standard
        that is being sent,  normally 2.0 -->
         <xs:element name="msg" type=" NMEA-MsgType" />
        <!-- the message and sub-message type,  as
        defined in the revision being used
        NOTE as the message type is also in the payload, -->
         <xs:element name="wdCount" >
            <xs:simpleType>
               <xs:restriction base="xs:unsignedShort">
                  <xs:maxInclusive value="1023"/>
              </xs:restriction>
            </xs:simpleType>
         </xs:element>
        <!-- a count of bytes to follow -->
         <xs:element name="payload" type=" NMEA-Payload" />
      </xs:sequence>
</xs:complexType>
```

5.8 Message: MSG_ProbeDataManagement (PDM)

Use: The ProbeDataManagement message is used to control the type of data collected and sent by OBUs to the local RSU (also called a STA in some documents) . Taken at a defined snapshot event to define RSU coverage patterns such as the moment an OBU joins or becomes associated with an RSU and can send probe data.

ASN.1 Representation:

```
ProbeDataManagement  ::= SEQUENCE {
   msgID                DSRCmsgID,          -- This is a unique message
                                            -- identifier, NOT related to
                                            -- the PSID\PSC
   sample               Sample,              -- identifies vehicle
                                            -- population affected
   directions           HeadingSlice,
                                            -- Applicable headings/directions
   term CHOICE {
      termtime          TermTime,            -- Terminate management process
                                            -- based on Time-to-Live
      termDistance      TermDistance         -- Terminate management process
                                            -- based on Distance-to-Live
      },
   snapshot CHOICE {
      snapshotTime      SnapshotTime,        -- Collect snapshots based on time
      snapshotDistance  SnapshotDistance     -- Collect snapshots based on Distance
      },
   txInterval           TxTime,              -- Time Interval at which to send snapshots
   cntTthreshold        Count,               -- number of thresholds that will be changed
    dataElements SEQUENCE (SIZE(1..32)) OF
                        VehicleStatusRequest,
                                            -- a data frame and its assoc thresholds

   ...
```

```
}
```

XML Representation:

```
<xs:element  name="probeDataManagement"  type=" ProbeDataManagement"/>
<xs:complexType name=" ProbeDataManagement" >
      <xs:sequence>
         <xs:element name="msgID" type=" DSRCmsgID" />
        <!-- This is a unique message
        identifier,  NOT related to
        the PSID\PSC -->
         <xs:element name="sample" type=" Sample" />
        <!-- identifies vehicle
        population affected -->
         <xs:element name="directions" type=" HeadingSlice" />
        <!-- Applicable headings/directions -->
         <xs:element name="term" >
            <xs:complexType>
               <xs:choice>
                  <xs:element name="termtime" type=" TermTime" />
                 <!-- Terminate management process
                 based on Time-to-Live -->
                  <xs:element name="termDistance" type=" TermDistance" />
                 <!-- Terminate management process
                  based on Distance-to-Live -->
               </xs:choice>
            </xs:complexType>
         </xs:element>
         <xs:element name="snapshot" >
            <xs:complexType>
               <xs:choice>
                  <xs:element name="snapshotTime" type=" SnapshotTime" />
                 <!-- Collect snapshots based on time -->
                  <xs:element name="snapshotDistance" type=" SnapshotDistance" />
                 <!-- Collect snapshots based on Distance -->
               </xs:choice>
            </xs:complexType>
         </xs:element>
         <xs:element name="txInterval" type=" TxTime" />
        <!-- Time Interval at which to send snapshots -->
         <xs:element name="cntTthreshold" type=" Count" />
        <!-- number of thresholds that will be changed -->
         <xs:element name="dataElements" >
            <xs:complexType>
               <xs:sequence minOccurs="1" maxOccurs="32">
                  <xs:element name="dataElement" type=" VehicleStatusRequest" />
                 <!-- a data frame and its assoc thresholds -->
               </xs:sequence>
            </xs:complexType>
         </xs:element>
      </xs:sequence>
</xs:complexType>
```

Remarks: The ProbeDataManagement message originates from the ATMS and its associated infrastructure and is used to control the types of information reported back to meet the needs of the ATMS and private users of the data.

5.9 Message: MSG_ProbeVehicleData (PVD)

Use: The probe vehicle message frame is defined below. The probe vehicle message is used to exchange status about a vehicle with other (typically RSU) DSRC readers to allow the collection of information about typically vehicle traveling behaviors along a segment of road. The exchanges of this message as well as the event which caused the collection of various elements defined in the messages are defined in Annex B of this standard. 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 event 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.

ASN.1 Representation:

```
ProbeVehicleData ::= SEQUENCE {
   msgID            DSRCmsgID,            -- App ID value, 1 byte
   segNum           ProbeSegmentNumber OPTIONAL,
                                          -- a short term Ident value
                                          -- not used when ident is used
   probeID          VehicleIdent OPTIONAL,
                                          -- ident data for selected
                                          -- types of vehicles
   startVector      FullPositionVector,    -- the space and time of
                                          -- transmission to the RSU
   vehicleType      VehicleType,           -- type of vehicle, 1 byte
   cntSnapshots     Count OPTIONAL,
                                          -- a count of how many snaphots
                                          -- type entries will follow
   snapshots        SEQUENCE (SIZE(1..32)) OF  Snapshot,
                                          -- a seq of name-value pairs
                                          -- along with the space and time
                                          -- of the first measurement set
   ... -- # LOCAL_CONTENT
   } -- Est size about 64 bytes plus snapshot sizes (about 12 per)
```

XML Representation:

```
<xs:element  name="probeVehicleData"  type=" ProbeVehicleData"/>
<xs:complexType name=" ProbeVehicleData" >
      <xs:annotation>
         <xs:documentation>
            Est size about 64 bytes plus snapshot sizes  (about 12 per)
          </xs:documentation>
      </xs:annotation>
      <xs:sequence>
         <xs:element name="msgID" type=" DSRCmsgID" />
        <!-- App ID value,  1 byte -->
         <xs:element name="segNum" type=" ProbeSegmentNumber"   minOccurs="0"/>
        <!-- a short term Ident value
        not used when ident is used -->
         <xs:element name="probeID" type=" VehicleIdent"   minOccurs="0"/>
        <!-- ident data for selected
        types of vehicles -->
         <xs:element name="startVector" type=" FullPositionVector" />
        <!-- the space and time of
        transmission to the RSU -->
        <xs:element  name="vehicleType"  type=" VehicleType" />
        <!-- type of vehicle,  1 byte -->
         <xs:element name="cntSnapshots" type=" Count"   minOccurs="0"/>
        <!-- a count of how many snaphots
        type entries will follow -->
         <xs:element name="snapshots" >
            <xs:complexType>
               <xs:sequence minOccurs="1" maxOccurs="32">
                  <xs:element name="snapshot" type=" Snapshot" />
                 <!-- a seq of name-value pairs along with the space and time of the
first measurement set -->
               </xs:sequence>
            </xs:complexType>
         </xs:element>
         <xs:element name="localProbeVehicleData" type="local:ProbeVehicleData"
minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Remarks: At the time of writing additional probe vehicle messages are being developed that will allow control over what information is gathered and reported in a probe vehicle message. Builders are urged to consider these messages in their development of products using this message.

5.10 Message: MSG_RoadSideAlert (RSA)

Use: This message is used to send alerts for nearby hazards to travelers. Unlike many other messages which use the LRMS profiles to describe the areas affected, this message likely applies to the receiver by the very fact that it is received. In other words, it does not use LRMS. Typically transmitted over the Dedicated Short Range Communications (DSRC) media in both WSM and XML forms, this message provides simple alerts to travelers (both in vehicle and with portable devices). Typical example messages would be "bridge icing ahead" or "train coming" or "ambulances operating in the area." The full range of ITIS phrases are supported here, but those dealing with mobile hazards, construction zones, and roadside events are the ones most frequently expected to be found in use.

This message is for the alerting of roadway hazards; not for vehicle cooperative communications, mayday, or other safety applications. It is generally presumed that each receiving device is aware of its own position and heading, but this is not a requirement to receive and understand these messages. Nor is having a local base map.

The position section of the message gives a simple (and optional) vector for where the hazard is located (fixed or moving) and can be used to filter some messages as being not applicable. Consider a "train approaching" message which indicates the train is in fact traveling away from the receiver. The basic messages types themselves are represented in the standard ITIS codes sent only in their integer representation formats. This ITIS list is national in scope, never outdated (items can only be added), and in this use does not allow local additions. Refer to SAE J2540.1 for the complete code list. A priority level for the message is also sent, which may be matched to various other priorities in the cockpit to determine the order and type of message presentation to minimize driver distraction. Message transmission priority is typically handled in the IEEE 1609 standard layer in the application stack and is a function of the application type. A duration field provides a gross level for the range (distance) of applicability for the message over distance. For example, some messages are no longer meaningful to the traveler once the vehicle has moved a distance down the roadway link.

In many cases a complex event will also be explained in the other supporting ATIS messages (available on DSRC service channels), and a linkage value is given in those cases when such data is available.

ASN.1 Representation:

```
RoadSideAlert ::= SEQUENCE {
   msgID           DSRCmsgID,
                  -- the message type.
   msgCnt          MsgCount,
   typeEvent       ITIS.ITIScodes,
                  -- a category and an item from that category
                  -- all ITS stds use the same types here
                  -- to explain the type of  the
                  -- alert / danger / hazard involved
                  -- two bytes in length
   description    SEQUENCE (SIZE(1..8)) OF  ITIS.ITIScodes OPTIONAL,
                  -- up to eight ITIS code entries to further
                  -- describe the event, give advice, or any
                  -- other ITIS codes
                  -- up to 16 bytes in length
   priority        Priority OPTIONAL,
                  -- the urgency of this message, a relative
                  -- degree of merit compared with other
                  -- similar messages for this type (not other
                  -- message being sent by the device), nor a
                  -- priority of display urgency
                  -- one byte in length
   heading         HeadingSlice  OPTIONAL,
                  --  Applicable  headings/direction
   extent          Extent OPTIONAL,
                  -- the spatial distance over which this
                  -- message applies and should be presented
                  -- to the driver
                  -- one byte in length
   positon         FullPositionVector OPTIONAL,
```

```
                -- a compact summary of the position,
                -- heading, rate of speed, etc of the
                -- event in question. Including stationary
                -- and wide area events.
    furtherInfoID  FurtherInfoID OPTIONAL,
                -- a link to any other incident
                -- information data that may be available
                -- in the normal ATIS incident description
                -- or other messages
                -- 1~2 bytes in length
    crc            MsgCRC
    }
```

XML Representation:

```
<xs:element  name="roadSideAlert"  type=" RoadSideAlert"/>
<xs:complexType name=" RoadSideAlert" >
      <xs:sequence>
         <xs:element name="msgID" type=" DSRCmsgID" />
        <!-- the message type. -->
         <xs:element name="msgCnt" type=" MsgCount" />
         <xs:element name="typeEvent" >
            <xs:simpleType>
               <xs:restriction base ="itis:ITIScodes"/>
            </xs:simpleType>
         </xs:element>
        <!-- a category and an item from that category
         all ITS stds use the same types here
         to explain the type of  the
         alert / danger / hazard involved
         two bytes in length -->
          <xs:element name="description"  minOccurs="0">
            <xs:complexType>
               <xs:sequence minOccurs="1" maxOccurs="8">
                  <xs:element name="description-item" >
                     <xs:simpleType>
                        <xs:restriction base ="itis:ITIScodes"/>
                     </xs:simpleType>
                  </xs:element>
                 <!-- up to eight ITIS code entries to further describe the event,  give
advice,   or any other ITIS codes up to 16 bytes in length -->
               </xs:sequence>
            </xs:complexType>
         </xs:element>
          <xs:element name="priority" type=" Priority"   minOccurs="0"/>
        <!-- the urgency of this message,  a relative
         degree of merit compared with other
         similar messages for this type  (not other
         message being sent by the device) ,  nor a
         priority of display urgency
         one byte in length -->
          <xs:element name="heading" type=" HeadingSlice"   minOccurs="0"/>
        <!--  Applicable  headings/direction -->
          <xs:element name="extent" type=" Extent"   minOccurs="0"/>
        <!-- the spatial distance over which this
        message applies and should be presented
         to the driver
         one byte in length -->
          <xs:element name="positon" type=" FullPositionVector"   minOccurs="0"/>
        <!-- a compact summary of the position,
         heading,  rate of speed,  etc of the
          event in question. Including stationary
         and wide area events. -->
          <xs:element name="furtherInfoID" type=" FurtherInfoID"   minOccurs="0"/>
        <!-- a link to any other incident
         information data that may be available
         in the normal ATIS incident description
         or other messages
         1~2 bytes in length -->
          <xs:element name="crc" type=" MsgCRC" />
```

```
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is used directly by one other data structure in this standard, a MSG called MSG_EmergencyVehicleAlert(EVA) <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: This message is also used a building block for other DSRC messages. When used in other public safety messages, additional elements may be appended to form new message types.

5.11 Message: MSG_RTCM_Corrections (RTCM)

Use: The RTCM_Corrections message is used to encapsulate 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. 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 RTCM standard and used directly by various positioning systems to increase the absolute and relative accuracy estimates produced.

ASN.1 Representation:

```
RTCM-Corrections ::= SEQUENCE {
   msgID       DSRCmsgID,
   msgCnt      MsgCount,
   rev         RTCM-Revision,
               -- the specific edition of the standard
               -- that is being sent

    anchorPoint  FullPositionVector OPTIONAL,
   -- precise observer position, if needed

   -- precise ant position and noise data
    rtcmHeader   RTCMHeader,
   -- octets of:
   -- status       GPSstatus
   -- antOffsets   AntennaOffsetSet(x,y,z)

   -- one or more RTCM messages
    rtcmSets     SEQUENCE (SIZE(1..5)) OF  RTCMmsg,
   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:element name="rTCM-Corrections" type=" RTCM-Corrections"/>
<xs:complexType name=" RTCM-Corrections" >
      <xs:sequence>
         <xs:element name="msgID" type=" DSRCmsgID" />
         <xs:element name="msgCnt" type=" MsgCount" />
         <xs:element name="rev" type=" RTCM-Revision" />
        <!-- the specific edition of the standard
        that is being sent -->
         <xs:element name="anchorPoint" type=" FullPositionVector"  minOccurs="0"/>
        <!-- precise observer position,  if needed
        precise ant position and noise data -->
         <xs:element name="rtcmHeader" type=" RTCMHeader" />
        <!-- octets of:
        status       GPSstatus
        antOffsets   AntennaOffsetSet (x, y, z)
        one or more RTCM messages -->
         <xs:element name="rtcmSets" >
            <xs:complexType>
               <xs:sequence minOccurs="1" maxOccurs="5">
                  <xs:element name="rtcmSet" type=" RTCMmsg" />
               </xs:sequence>
            </xs:complexType>
         </xs:element>
```

```
          <xs:element name="localRTCM-Corrections" type="local:RTCM-Corrections"
minOccurs="0"/>
       </xs:sequence>
</xs:complexType>
```

In addition, this item may be used by data structures in other ITS standards.

Remarks: Observe that the transport layer details (preamble, CRC, etc.) as outlined in RTCM standard 10403.1 version 3.0 clause four are not sent in this message. In a similar fashion, the same framing information found in clause 4.2 of the RTCM standard 10402.3 (version 2.3) is not sent. These would be reconstituted after reception by a mobile device and before sending the resultant message to any positioning device expecting messages in such a format, as outlined in the RTCM recommendations found in clause four of each document. Also observe that the specific bit ordering of the transport message level used in the final message varies between RTCM version 3.x and that of version 2.3.

5.12 Message: MSG_SignalPhaseAndTiming Message (SPAT)

Use: The Signal Phase and Timing (SPAT) message is used to convey the current status of one or more signalized intersections. Along with the MSG_MapData message (which conveys a full geometric layout of the intersection in question) the receiver of this message can determine the state of the signal phasing and when the expected next phase will occur.

The SPAT message sends the current movement state of each active phase in the system as needed (values of what lights are active and values of for what durations the light is expected to continue). The state of un-active movements (typically all red) is not normally transmitted. Movements are mapped to specific lanes and approaches by use of the lane numbers present in the message. These lane numbers correspond to the specific lanes described in the MAP message for that intersection.

The current signal preemption and priority status values (when present or active) are also sent. A more complete summary of any pending priority or preemption events can be found in the Signal Status message.

ASN.1 Representation:

```
SPAT ::= SEQUENCE {
   msgID           DSRCmsgID,
   name            DescriptiveName OPTIONAL,
                   -- human readable name for this collection
                   -- to be used only in debug mode

    intersections SEQUENCE (SIZE(1..32)) OF  IntersectionState,
                   -- sets of SPAT data (one per intersection)

   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:element name="sPAT" type=" SPAT"/>
<xs:complexType name=" SPAT" >
       <xs:sequence>
          <xs:element name="msgID" type=" DSRCmsgID" />
          <xs:element name="name" type=" DescriptiveName"  minOccurs="0"/>
         <!-- human readable name for this collection
          to be used only in debug mode -->
          <xs:element name="intersections" >
             <xs:complexType>
                 <xs:sequence minOccurs="1" maxOccurs="32">
                   <xs:element name="intersection" type=" IntersectionState" />
                   <!-- sets of SPAT data (one per intersection) -->
                 </xs:sequence>
             </xs:complexType>
          </xs:element>
          <xs:element name="localSPAT" type="local:SPAT" minOccurs="0"/>
       </xs:sequence>
</xs:complexType>
```

In addition, this item may be used by data structures in other ITS standards.

5.13 Message: MSG_SignalRequestMessage (SRM)

Use: The Signal Request Message is a message sent by a vehicle to the RSU in a signalized intersection. It is used for either a priority signal request or a preemption signal request depending on the way the message flag is set. In either case, the vehicle identifies itself (using its VIN or another method supported by the VehicleIdent data frame), its current speed, heading and location (using the Blob of the BSM), and makes a specific request for service (Vehicle Request) as well as an anticipated time of service (a start time and end time). The specific request for service is typically based on previously decoding and examining the list of supported zones for that intersection (sent in the MAP messages). The outcome of all of the pending requests to a signal can be found in the Signal Status Message (SSM), and may be reflected in the SPAT message contents if successful.

ASN.1 Representation:

```
SignalRequestMsg ::= SEQUENCE {
   msgID             DSRCmsgID,
   msgCnt            MsgCount,

   -- Request Data
   request          SignalRequest,
                   -- the specific request to the intersection
                   -- contains IntersectionID, cancel flags,
                   -- requested action, optional lanes data

   timeOfService    DTime   OPTIONAL,
                   -- the time in the near future when service is
                   -- requested to start

   endOfService     DTime   OPTIONAL,
                   -- the time in the near future when service is
                   -- requested to end

   transitStatus    TransitStatus OPTIONAL,
                   -- additional information pertaining
                   -- to transit events

   -- User Data
   vehicleVIN       VehicleIdent   OPTIONAL,
                   -- a set of unique strings to identify the requesting vehicle

   vehicleData      BSMblob,
                   -- current position data about the vehicle

   status           VehicleRequestStatus   OPTIONAL,
                   -- current status data about the vehicle

   ...
   }
```

XML Representation:

```
<xs:element name=" SignalRequestMsg" type=" SignalRequestMsg"/>
<xs:complexType name=" SignalRequestMsg" >
      <xs:sequence>
         <xs:element name="msgID" type=" DSRCmsgID" />
         <xs:element name="msgCnt" type=" MsgCount" />
        <!-- Request Data -->
         <xs:element name="request" type=" SignalRequest" />
        <!-- the specific request to the intersection
        contains  IntersectionID,  cancel flags,
        requested action,    OPTIONAL   lanes data -->
        <xs:element name="timeOfService" type=" DTime"   minOccurs="0"/>
        <!-- the time in the near future when service is
        requested to start -->
         <xs:element name="endOfService" type=" DTime"   minOccurs="0"/>
```

```
            <!-- the time in the near future when service is
            requested to end -->
             <xs:element name="transitStatus" type=" TransitStatus"   minOccurs="0"/>
            <!-- additional information pertaining
            to transit events
            User Data -->
             <xs:element name="vehicleVIN" type=" VehicleIdent"   minOccurs="0"/>
            <!-- a set of unique strings to identify the requesting vehicle -->
             <xs:element name="vehicleData" type=" BSMblob" />
            <!-- current position data about the vehicle -->
             <xs:element name="status" type=" VehicleRequestStatus"   minOccurs="0"/>
            <!-- current status data about the vehicle -->
        </xs:sequence>
</xs:complexType>
```

In addition, this item may be used by data structures in other ITS standards.

5.14 Message: MSG_SignalStatusMessage (SSM)

Use: The Signal Status Message is a message sent by an RSU in a signalized intersection. It is used to relate the current status of the signal and any collection of pending or active preemption or priority events acknowledged by the controller. The data contained in this message allow other users to determine their "ranking" for any request they have made as well as see the currently active events. When there have been no recently received requests for service messages, this message may not be sent. The outcome of all pending requests to a signal can be found in the Signal Status Message, and the current event may also be reflected in the SPAT message contents if successful.

ASN.1 Representation:

```
SignalStatusMessage  ::= SEQUENCE {
   msgID           DSRCmsgID,
   msgCnt          MsgCount,
   id              IntersectionID,
                  -- this provides a unique mapping to the
                  -- intersection map in question
                  -- which provides complete location
                  -- and approach/move/lane data
                  -- as well as zones for priority/preemption
   status          IntersectionStatusObject,
                  -- general status of the signal controller
   priority        SEQUENCE (SIZE(1..7)) OF  SignalState OPTIONAL,
                  -- all active priority state data
                  -- is found here
    priorityCause  VehicleIdent   OPTIONAL,
                  -- vehicle that requested
                  -- the current priority
   prempt          SEQUENCE (SIZE(1..7)) OF  SignalState OPTIONAL,
                  -- all active preemption state data
                  -- is found here
   preemptCause    VehicleIdent   OPTIONAL,
                  -- vehicle that requested
                  -- the current preempt
    transitStatus  TransitStatus OPTIONAL,
                  -- additional information pertaining
                  -- to transit event, if that is the active event
   ...
   }
```

XML Representation:

```
<xs:element name=" SignalStatusMessage" type=" SignalStatusMessage"/>
<xs:complexType name=" SignalStatusMessage" >
       <xs:sequence>
          <xs:element name="msgID" type=" DSRCmsgID" />
          <xs:element name="msgCnt" type=" MsgCount" />
          <xs:element name="id" type=" IntersectionID" />
          <!-- this provides a unique mapping to the
          intersection map in question
```

```
            which provides complete location
            and approach/move/lane data
            as well as zones for priority/preemption -->
            <xs:element name="status" type=" IntersectionStatusObject" />
           <!-- general status of the signal controller -->
            <xs:element name="priority"  minOccurs="0">
               <xs:complexType>
                  <xs:sequence minOccurs="1" maxOccurs="7">
                     <xs:element name="priority-item" type=" SignalState" />
                    <!-- all active priority state data is found here -->
                  </xs:sequence>
               </xs:complexType>
            </xs:element>
            <xs:element name="priorityCause" type=" VehicleIdent"   minOccurs="0"/>
           <!-- vehicle that requested
            the current priority -->
            <xs:element name="prempt"  minOccurs="0">
               <xs:complexType>
                  <xs:sequence minOccurs="1" maxOccurs="7">
                     <xs:element name="prempt-item" type=" SignalState" />
                    <!-- all active preemption state data is found here -->
                  </xs:sequence>
               </xs:complexType>
            </xs:element>
            <xs:element name="preemptCause" type=" VehicleIdent"   minOccurs="0"/>
           <!-- vehicle that requested
            the current preempt -->
            <xs:element name="transitStatus" type=" TransitStatus"   minOccurs="0"/>
           <!-- additional information pertaining
            to transit event,  if that is the active event -->
         </xs:sequence>
</xs:complexType>
```

In addition, this item may be used by data structures in other ITS standards.

5.15 Message: MSG_TravelerInformation Message (TIM)

Use: The Traveler Information message is used to send various types of messages (advisory and road sign types) over the WSM stack to vehicles. It makes heavy use of the ITIS encoding system to send well known phrases, but allows limited text for local place names. The supported message types specify several sub-dialects of ITIS phrase patterns to further reduce the number of bytes to be sent. The expressed messages are active at a precise start and duration period, which can be specified to a resolution of a minute. The affected local area can be expressed using either a radius system or a system of short defined regions which is similar to the way roadway geometry is defined in the map fragment messages.

ASN.1 Representation:

```
TravelerInformation  ::= SEQUENCE {
   msgID             DSRCmsgID,
   packetID          UniqueMSGID     OPTIONAL,
   urlB              URL-Base        OPTIONAL,
    dataFrameCount   Count           OPTIONAL,

   dataFrames SEQUENCE (SIZE(1..8)) OF SEQUENCE {

      -- Part I, Frame header
      frameType    TravelerInfoType,  -- (enum, advisory or road sign)
      msgId        CHOICE  {
                      furtherInfoID    FurtherInfoID,
                                      -- links to ATIS msg
                      roadSignID       RoadSignID
                                      -- an ID to other data
                      },
      startYear    DYear OPTIONAL,
                  -- Current year used if missing
      startTime    MinuteOfTheYear,
      duratonTime  MinutesDuration,
```

```
        priority     SignPrority,

        -- Part II, Applicable Regions of Use
        commonAnchor          Position3D      OPTIONAL,
                              -- a shared anchorpoint
        commonLaneWidth       LaneWidth       OPTIONAL,
                              -- a shared lane width
        commonDirectionality  DirectionOfUse OPTIONAL,
                              -- a shared direction of use
        regions   SEQUENCE (SIZE(1..16)) OF  ValidRegion,

        -- Part III, Content
        content   CHOICE  {
                     advisory        ITIS.ITIScodesAndText,
                                     -- typical ITIS warnings
                     workZone        WorkZone,
                                     -- work zone signs and directions
                     genericSign     GenericSignage,
                                     -- MUTCD signs and directions
                     speedLimit      SpeedLimit,
                                     -- speed limits and cautions
                     exitService     ExitService
                                     -- roadside avaiable services
                     -- other types may be added in future revisions
                     },  --# UNTAGGED
        url       URL-Short OPTIONAL  -- May link to image or other content
        },
     crc          MsgCRC,
     ... -- #  LOCAL_CONTENT
     }
```

XML Representation:

```
<xs:element  name="travelerInformation"  type=" TravelerInformation"/>
<xs:complexType name=" TravelerInformation" >
      <xs:sequence>
         <xs:element name="msgID" type=" DSRCmsgID" />
        <xs:element  name="packetID"  type=" UniqueMSGID"   minOccurs="0"/>
         <xs:element name="urlB" type=" URL-Base"   minOccurs="0"/>
         <xs:element name="dataFrameCount" type=" Count"   minOccurs="0"/>
         <xs:element name="dataFrames" >
           <xs:complexType>
               <xs:sequence minOccurs="1" maxOccurs="8">
                  <xs:element name="dataFrame" >
                     <xs:complexType>
                        <xs:sequence>
                           <!-- Part I,  Frame header -->
                            <xs:element name="frameType" type=" TravelerInfoType" />
                           <!-- (enum,  advisory or road sign) -->
                            <xs:element name="msgId" >
                               <xs:complexType>
                                  <xs:choice>
                                   <xs:element name="furtherInfoID" type=" FurtherInfoID
" />
                                     <!-- links to ATIS msg -->
                                    <xs:element name="roadSignID" type=" RoadSignID" />
                                     <!-- an ID to other data -->
                                  </xs:choice>
                              </xs:complexType>
                           </xs:element>
                           <xs:element name="startYear" type=" DYear"  minOccurs="0"/>
                          <!-- Current year used if missing -->
                           <xs:element name="startTime" type=" MinuteOfTheYear" />
                            <xs:element name="duratonTime" type=" MinutesDuration" />
                            <xs:element name="priority" type=" SignPrority" />
                          <!-- Part II,  Applicable Regions of Use -->
                            <xs:element name="commonAnchor" type=" Position3D"
minOccurs="0"/>
                           <!-- a shared anchorpoint -->
```

```
                        <xs:element name="commonLaneWidth" type=" LaneWidth"
minOccurs="0"/>
                       <!-- a shared lane width -->
                      <xs:element name="commonDirectionality" type=" DirectionOfUse"
minOccurs="0"/>
                       <!-- a shared direction of use -->
                        <xs:element name="regions" >
                           <xs:complexType>
                              <xs:sequence minOccurs="1" maxOccurs="16">
                                 <xs:element name="region" type=" ValidRegion" />
                              </xs:sequence>
                           </xs:complexType>
                        </xs:element>
                       <!-- Part III,  Content -->
                        <xs:choice >
                          <xs:element name="advisory" type=" itis:ITIScodesAndText"
/>
                            <!-- typical ITIS warnings -->
                             <xs:element name="workZone" type=" WorkZone" />
                            <!-- work zone signs and directions -->
                            <xs:element name="genericSign" type=" GenericSignage" />
                            <!-- MUTCD signs and directions -->
                             <xs:element name="speedLimit" type=" SpeedLimit" />
                            <!-- speed limits and cautions -->
                             <xs:element name="exitService" type=" ExitService" />
                            <!-- roadside avaiable services
                             other types may be added in future revisions -->
                        </xs:choice>
                        <xs:element name="url" type=" URL-Short"  minOccurs="0"/>
                       <!-- May link to image or other content -->
                     </xs:sequence>
                  </xs:complexType>
               </xs:element>
            </xs:sequence>
         </xs:complexType>
      </xs:element>
      <xs:element name="crc" type=" MsgCRC" />
       <xs:element name="localTravelerInformation" type="local:TravelerInformation"
minOccurs="0"/>
    </xs:sequence>
</xs:complexType>
```

In addition, this item may be used by data structures in other ITS standards.

6. Data Frames

This section defines the precise structure of the data frames defined by this standard. The DSRC 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 unless expressly marked otherwise. Definitions for this message set are presented in the following subclauses. The ASN.1 is presented in a section titled ASN.1 Representation. The equivalent XML expression is presented in a section titled XML Representation which follows the translation rule set cited in Clause Two (SAE Standard J2630). Should the two sections conflict in some way, the ASN.1 expression 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. The XML productions follow directly from the ASN.1 specifications and the same rules shall be applied. Users of this standard seeking to be in conformance with it shall follow the normative text outlined here.

6.1 Data Element: DF_AccelerationSet4Way

Use: This data frame is a set of acceleration values in 3 orthogonal directions of the vehicle and with yaw rotation rates, expressed as an octet set. 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. Note the definitions provided in Figure 1 (Tire Axis System) and Figure 2 (Directional Control Axis Systems).

ASN.1 Representation:

```
AccelerationSet4Way ::= OCTET STRING (SIZE(7))
   -- composed of the following:
   -- SEQUENCE {
   --    long Acceleration,          -x- Along the Vehicle Longitudinal axis
   --    lat  Acceleration,          -x- Along the Vehicle Lateral axis
   --    vert VerticalAcceleration,  -x- Along the Vehicle Vertical axis
   --    yaw  YawRate
   --    }
```

XML Representation:

```
<xs:complexType name=" AccelerationSet4Way" >
   <xs:simpleContent>
      <xs:annotation>
         <xs:documentation>
            composed of the following:
            SEQUENCE  {
            long  Acceleration,          -x- Along the Vehicle Longitudinal axis
            lat   Acceleration,          -x- Along the Vehicle Lateral axis
            vert  VerticalAcceleration,  -x- Along the Vehicle Vertical axis
            yaw   YawRate
            }
         </xs:documentation>
      </xs:annotation>
       <xs:extension base="AccelerationSet4Way-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:attribute>
      </xs:extension>
   </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="AccelerationSet4Way-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="10"/>
   </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

DF DF_VehicleStatus <ASN> <XML>, and

MSG MSG_BasicSafetyMessage_Verbose <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

6.2 Data Frame: DF_AccelSteerYawRateConfidence

Use: A single byte long data frame combining multiple related bit fields into one byte.

ASN.1 Representation:

```
AccelSteerYawRateConfidence ::= SEQUENCE {
   yawRate              YawRateConfidence,
                       -- 3 bits
   acceleration         AccelerationConfidence,
                       -- 3 bits
    steeringWheelAngle   SteeringWheelAngleConfidence
                       -- 2 bits
   }
```

XML Representation:

```
<xs:complexType name=" AccelSteerYawRateConfidence" >
      <xs:sequence>
         <xs:element name="yawRate" type=" YawRateConfidence" />
        <!-- 3 bits -->
         <xs:element name="acceleration" type=" AccelerationConfidence" />
        <!-- 3 bits -->
         <xs:element name="steeringWheelAngle" type=" SteeringWheelAngleConfidence" />
        <!-- 2 bits -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

DF DF_ConfidenceSet <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

6.3 Data Frame: DF_AllInclusive

Use: The data frame AllInclusive is used to contain an instance of every item defined in the standard. It is used in the a la carte message.

ASN.1 Representation:

```
AllInclusive ::= SEQUENCE {
   -- Data Frame Items
   item6-1          AccelerationSet4Way                OPTIONAL,
   item6-2          AccelSteerYawRateConfidence        OPTIONAL,
   -- item6-3       AllInclusive                       OPTIONAL,
   item6-4          AntennaOffsetSet                   OPTIONAL,
   item6-5          Approach                           OPTIONAL,
   item6-6          ApproachObject                     OPTIONAL,
   item6-7          BarrierLane                        OPTIONAL,
   item6-8          BrakeSystemStatus                  OPTIONAL,
   item6-9          BSMblob                            OPTIONAL,
   item6-10         BumperHeights                      OPTIONAL,
   item6-11         Circle                             OPTIONAL,
   item6-12         ConfidenceSet                      OPTIONAL,
   item6-13         ConnectsTo                         OPTIONAL,
   item6-14         CrosswalkLane                      OPTIONAL,
   item6-15         DataParameters                     OPTIONAL,
   item6-16         DDate                              OPTIONAL,
   item6-17         DDateTime                          OPTIONAL,
   item6-18         DFullTime                          OPTIONAL,
   item6-19         DMonthDay                          OPTIONAL,
```

```
item6-20        DTime                                   OPTIONAL,
item6-21        DYearMonth                              OPTIONAL,
item6-22        FullPositionVector                      OPTIONAL,
item6-23        Intersection                            OPTIONAL,
item6-24        IntersectionState                       OPTIONAL,
item6-25        ExitService                             OPTIONAL,
item6-26        GenericSignage                          OPTIONAL,
item6-27        SpeedLimit                              OPTIONAL,
item6-28        WorkZone                                OPTIONAL,
item6-29        J1939data                               OPTIONAL,
item6-30        MovementState                           OPTIONAL,
item6-31        NodeList                                OPTIONAL,
item6-32        Offsets                                 OPTIONAL,
item6-33        PathHistory                             OPTIONAL,
item6-34        PathHistoryPointType-01                 OPTIONAL,
item6-35        PathHistoryPointType-02                 OPTIONAL,
item6-36        PathHistoryPointType-03                 OPTIONAL,
item6-37        PathHistoryPointType-04                 OPTIONAL,
item6-38        PathHistoryPointType-05                 OPTIONAL,
item6-39        PathHistoryPointType-06                 OPTIONAL,
item6-40        PathHistoryPointType-07                 OPTIONAL,
item6-41        PathHistoryPointType-08                 OPTIONAL,
item6-42        PathHistoryPointType-09                 OPTIONAL,
item6-43        PathHistoryPointType-10                 OPTIONAL,
item6-44        PathPrediction                          OPTIONAL,
item6-45        Position3D                              OPTIONAL,
item6-46        PositionalAccuracy                      OPTIONAL,
item6-47        PositionConfidenceSet                   OPTIONAL,
item6-48        RegionList                              OPTIONAL,
item6-49        RegionOffsets                           OPTIONAL,
item6-50        RegionPointSet                          OPTIONAL,
item6-51        RoadSignID                              OPTIONAL,
item6-52        RTCMHeader                              OPTIONAL,
item6-53        RTCMmsg                                 OPTIONAL,
item6-54        RTCMPackage                             OPTIONAL,
item6-55        Sample                                  OPTIONAL,
item6-56        ShapePointSet                           OPTIONAL,
item6-57        SignalControlZone                       OPTIONAL,
item6-58        SignalRequest                           OPTIONAL,
item6-59        SnapshotDistance                        OPTIONAL,
item6-60        Snapshot                                OPTIONAL,
item6-61        SnapshotTime                            OPTIONAL,
item6-62        SpecialLane                             OPTIONAL,
item6-63        SpeedandHeadingandThrottleConfidence    OPTIONAL,
item6-64        TransmissionAndSpeed                    OPTIONAL,
item6-65        ValidRegion                             OPTIONAL,
item6-66        VehicleComputedLane                     OPTIONAL,
item6-67        VehicleIdent                            OPTIONAL,
item6-68        VehicleReferenceLane                    OPTIONAL,
item6-69        VehicleSafetyExtension                  OPTIONAL,
item6-70        VehicleSize                             OPTIONAL,
item6-71        VehicleStatusRequest                    OPTIONAL,
item6-72        VehicleStatus                           OPTIONAL,
item6-73        WiperStatus                             OPTIONAL,

-- Data Element Items
item7-1         Acceleration                            OPTIONAL,
item7-2         AccelerationConfidence                  OPTIONAL,
item7-3         AmbientAirPressure                      OPTIONAL,
item7-4         AmbientAirTemperature                   OPTIONAL,
item7-5         AntiLockBrakeStatus                     OPTIONAL,
item7-6         ApproachNumber                          OPTIONAL,
item7-7         AuxiliaryBrakeStatus                    OPTIONAL,
item7-8         BarrierAttributes                       OPTIONAL,
item7-9         BrakeAppliedPressure                    OPTIONAL,
item7-10        BrakeAppliedStatus                      OPTIONAL,
item7-11        BrakeBoostApplied                       OPTIONAL,
item7-12        BumperHeightFront                       OPTIONAL,
item7-13        BumperHeightRear                        OPTIONAL,
```

```
item7-14        CodeWord                                OPTIONAL,
item7-15        CoefficientOfFriction                   OPTIONAL,
item7-16        ColorState                              OPTIONAL,
item7-17        Count                                   OPTIONAL,
item7-18        CrosswalkLaneAttributes                 OPTIONAL,
item7-19        DDay                                    OPTIONAL,
item7-20        DescriptiveName                         OPTIONAL,
item7-21        DHour                                   OPTIONAL,
item7-22        DirectionOfUse                          OPTIONAL,
item7-23        DMinute                                 OPTIONAL,
item7-24        DMonth                                  OPTIONAL,
item7-25        DOffset                                 OPTIONAL,
item7-26        DrivenLineOffset                        OPTIONAL,
item7-27        DrivingWheelAngle                       OPTIONAL,
item7-28        DSecond                                 OPTIONAL,
item7-29        DSignalSeconds                          OPTIONAL,
item7-30        DSRCmsgID                               OPTIONAL,
item7-31        DYear                                   OPTIONAL,
item7-32        ElevationConfidence                     OPTIONAL,
item7-33        Elevation                               OPTIONAL,
item7-34        EmergencyDetails                        OPTIONAL,
item7-35        EventFlags                              OPTIONAL,
item7-36        Extent                                  OPTIONAL,
item7-37        ExteriorLights                          OPTIONAL,
item7-38        FurtherInfoID                           OPTIONAL,
item7-39        GPSstatus                               OPTIONAL,
item7-40        HeadingConfidence                       OPTIONAL,
item7-41        Heading                                 OPTIONAL,
item7-42        HeadingSlice                            OPTIONAL,
item7-43        IntersectionStatusObject                OPTIONAL,
item7-44        IntersectionID                          OPTIONAL,
item7-45        AxleLocation                            OPTIONAL,
item7-46        AxleWeight                              OPTIONAL,
item7-47        CargoWeight                             OPTIONAL,
item7-48        DriveAxleLiftAirPressure                OPTIONAL,
item7-49        DriveAxleLocation                       OPTIONAL,
item7-50        DriveAxleLubePressure                   OPTIONAL,
item7-51        DriveAxleTemperature                    OPTIONAL,
item7-52        SteeringAxleLubePressure                OPTIONAL,
item7-53        SteeringAxleTemperature                 OPTIONAL,
item7-54        TireLeakageRate                         OPTIONAL,
item7-55        TireLocation                            OPTIONAL,
item7-56        TirePressureThresholdDetection          OPTIONAL,
item7-57        TirePressure                            OPTIONAL,
item7-58        TireTemp                                OPTIONAL,
item7-59        TrailerWeight                           OPTIONAL,
item7-60        WheelEndElectFault                      OPTIONAL,
item7-61        WheelSensorStatus                       OPTIONAL,
item7-62        LaneCount                               OPTIONAL,
item7-63        LaneManeuverCode                        OPTIONAL,
item7-64        LaneNumber                             OPTIONAL,
item7-65        LaneSet                                 OPTIONAL,
item7-66        LaneWidth                               OPTIONAL,
item7-67        Latitude                               OPTIONAL,
item7-68        LayerID                                 OPTIONAL,
item7-69        LayerType                               OPTIONAL,
item7-70        LightbarInUse                           OPTIONAL,
item7-71        Longitude                               OPTIONAL,
item7-72        Location-quality                        OPTIONAL,
item7-73        Location-tech                           OPTIONAL,
item7-74        MinuteOfTheYear                         OPTIONAL,
item7-75        MinutesDuration                         OPTIONAL,
item7-76        MsgCount                                OPTIONAL,
item7-77        MsgCRC                                  OPTIONAL,
item7-78        MultiVehicleResponse                    OPTIONAL,
item7-79        MUTCDCode                               OPTIONAL,
item7-80        NMEA-MsgType                            OPTIONAL,
item7-81        NMEA-Payload                            OPTIONAL,
item7-82        NMEA-Revision                           OPTIONAL,
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item7-83        NTCIPVehicleclass                   OPTIONAL,
item7-84        ObjectCount                         OPTIONAL,
item7-85        ObstacleDirection                   OPTIONAL,
item7-86        ObstacleDistance                    OPTIONAL,
item7-87        PayloadData                         OPTIONAL,
item7-88        Payload                             OPTIONAL,
item7-89        PedestrianDetect                    OPTIONAL,
item7-90        PedestrianSignalState               OPTIONAL,
item7-91        PositionConfidence                  OPTIONAL,
item7-92        PreemptState                        OPTIONAL,
item7-93        Priority                            OPTIONAL,
item7-94        PriorityState                       OPTIONAL,
item7-95        ProbeSegmentNumber                  OPTIONAL,
item7-96        RainSensor                          OPTIONAL,
item7-97        RequestedItem                       OPTIONAL,
item7-98        ResponseType                        OPTIONAL,
item7-99        RTCM-ID                             OPTIONAL,
item7-100       RTCM-Payload                       OPTIONAL,
item7-101       RTCM-Revision                       OPTIONAL,
item7-102       SignalLightState                    OPTIONAL,
item7-103       SignalReqScheme                     OPTIONAL,
item7-104       SignalState                         OPTIONAL,
item7-105       SignPrority                         OPTIONAL,
item7-106       SirenInUse                          OPTIONAL,
item7-107       SpecialLaneAttributes               OPTIONAL,
item7-108       SpecialSignalState                  OPTIONAL,
item7-109       SpeedConfidence                     OPTIONAL,
item7-110       Speed                               OPTIONAL,
item7-111       StabilityControlStatus              OPTIONAL,
item7-112       StateConfidence                     OPTIONAL,
item7-113       SteeringWheelAngleConfidence        OPTIONAL,
item7-114       SteeringWheelAngleRateOfChange      OPTIONAL,
item7-115       SteeringWheelAngle                  OPTIONAL,
item7-116       SunSensor                           OPTIONAL,
item7-117       TemporaryID                         OPTIONAL,
item7-118       TermDistance                        OPTIONAL,
item7-119       TermTime                            OPTIONAL,
item7-120       ThrottleConfidence                  OPTIONAL,
item7-121       ThrottlePosition                    OPTIONAL,
item7-122       TimeConfidence                      OPTIONAL,
item7-123       TimeMark                            OPTIONAL,
item7-124       TractionControlState                OPTIONAL,
item7-125       TransitPreEmptionRequest            OPTIONAL,
item7-126       TransitStatus                       OPTIONAL,
item7-127       TransmissionState                   OPTIONAL,
item7-128       TxTime                              OPTIONAL,
item7-129       TravelerInfoType                    OPTIONAL,
item7-130       UniqueMSGID                         OPTIONAL,
item7-131       URL-Base                            OPTIONAL,
item7-132       URL-Link                            OPTIONAL,
item7-133       URL-Short                           OPTIONAL,
item7-134       VehicleHeight                       OPTIONAL,
item7-135       VehicleLaneAttributes               OPTIONAL,
item7-136       VehicleLength                       OPTIONAL,
item7-137       VehicleMass                         OPTIONAL,
item7-138       VehicleRequestStatus                OPTIONAL,
item7-139       VehicleStatusDeviceTypeTag          OPTIONAL,
item7-140       VehicleType                         OPTIONAL,
item7-141       VehicleWidth                        OPTIONAL,
item7-142       VerticalAccelerationThreshold       OPTIONAL,
item7-143       VerticalAcceleration                OPTIONAL,
item7-144       VINstring                           OPTIONAL,
item7-145       WiperRate                           OPTIONAL,
item7-146       WiperStatusFront                    OPTIONAL,
item7-147       WiperStatusRear                     OPTIONAL,
item7-148       YawRateConfidence                   OPTIONAL,
item7-149       YawRate                             OPTIONAL,

-- External Items
```

```
    item8-1         ITIS.IncidentResponseEquipment          OPTIONAL,
    item8-2         ITIS.ITIStext                           OPTIONAL,
    item8-3         ITIS.ResponderGroupAffected             OPTIONAL,
    item8-4         ITIS.VehicleGroupAffected               OPTIONAL,
    item8-5         ITIS.ITIScodesAndText                   OPTIONAL,
    item8-6         NTCIP.EssMobileFriction                 OPTIONAL,
    item8-7         NTCIP.EssPrecipRate                     OPTIONAL,
    item8-8         NTCIP.EssPrecipSituation                OPTIONAL,
    item8-9         NTCIP.EssPrecipYesNo                    OPTIONAL,
    item8-10        NTCIP.EssSolarRadiation                 OPTIONAL,
    item8-11        ITIS.ITIScodes                          OPTIONAL,
    ...
    }
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XML Representation:

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         <xs:element name="item6-43" type=" PathHistoryPointType-10"  minOccurs="0"/>
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            <xs:element name="item7-97" type=" RequestedItem"   minOccurs="0"/>
            <xs:element name="item7-98" type=" ResponseType"   minOccurs="0"/>
            <xs:element name="item7-99" type=" RTCM-ID"   minOccurs="0"/>
            <xs:element name="item7-100" type=" RTCM-Payload"   minOccurs="0"/>
           <xs:element name="item7-101" type=" RTCM-Revision"   minOccurs="0"/>
            <xs:element name="item7-102" type=" SignalLightState"   minOccurs="0"/>
            <xs:element name="item7-103" type=" SignalReqScheme"   minOccurs="0"/>
            <xs:element name="item7-104" type=" SignalState"   minOccurs="0"/>
            <xs:element name="item7-105" type=" SignPrority"  minOccurs="0"/>
            <xs:element name="item7-106" type=" SirenInUse"   minOccurs="0"/>
            <xs:element name="item7-107" type=" SpecialLaneAttributes" minOccurs="0"/>
           <xs:element name="item7-108" type=" SpecialSignalState"   minOccurs="0"/>
            <xs:element name="item7-109" type=" SpeedConfidence"   minOccurs="0"/>
           <xs:element name="item7-110" type=" Speed"   minOccurs="0"/>
            <xs:element name="item7-111" type=" StabilityControlStatus" minOccurs="0"/>
            <xs:element name="item7-112" type=" StateConfidence"   minOccurs="0"/>
```

```
          <xs:element name="item7-113" type=" SteeringWheelAngleConfidence"
minOccurs="0"/>
          <xs:element name="item7-114" type=" SteeringWheelAngleRateOfChange"
minOccurs="0"/>
          <xs:element name="item7-115" type=" SteeringWheelAngle"   minOccurs="0"/>
          <xs:element name="item7-116" type=" SunSensor"   minOccurs="0"/>
          <xs:element name="item7-117" type=" TemporaryID"   minOccurs="0"/>
          <xs:element name="item7-118" type=" TermDistance"   minOccurs="0"/>
          <xs:element name="item7-119" type=" TermTime"   minOccurs="0"/>
          <xs:element name="item7-120" type=" ThrottleConfidence"   minOccurs="0"/>
          <xs:element name="item7-121" type=" ThrottlePosition"   minOccurs="0"/>
          <xs:element name="item7-122" type=" TimeConfidence"   minOccurs="0"/>
          <xs:element name="item7-123" type=" TimeMark"   minOccurs="0"/>
          <xs:element name="item7-124" type=" TractionControlState"   minOccurs="0"/>
          <xs:element name="item7-125" type=" TransitPreEmptionRequest"  minOccurs="0"/>
          <xs:element name="item7-126" type=" TransitStatus"   minOccurs="0"/>
          <xs:element name="item7-127" type=" TransmissionState"   minOccurs="0"/>
          <xs:element name="item7-128" type=" TxTime"   minOccurs="0"/>
          <xs:element name="item7-129" type=" TravelerInfoType"   minOccurs="0"/>
          <xs:element name="item7-130" type=" UniqueMSGID"   minOccurs="0"/>
          <xs:element name="item7-131" type=" URL-Base"   minOccurs="0"/>
          <xs:element name="item7-132" type=" URL-Link"   minOccurs="0"/>
          <xs:element name="item7-133" type=" URL-Short"   minOccurs="0"/>
          <xs:element name="item7-134" type=" VehicleHeight"   minOccurs="0"/>
          <xs:element name="item7-135" type=" VehicleLaneAttributes"  minOccurs="0"/>
          <xs:element name="item7-136" type=" VehicleLength"   minOccurs="0"/>
          <xs:element name="item7-137" type=" VehicleMass"   minOccurs="0"/>
          <xs:element name="item7-138" type=" VehicleRequestStatus"   minOccurs="0"/>
          <xs:element name="item7-139"  type=" VehicleStatusDeviceTypeTag"  minOccurs="0"/>
          <xs:element name="item7-140" type=" VehicleType"   minOccurs="0"/>
          <xs:element name="item7-141" type=" VehicleWidth"   minOccurs="0"/>
          <xs:element name="item7-142" type=" VerticalAccelerationThreshold"
minOccurs="0"/>
          <xs:element name="item7-143" type=" VerticalAcceleration"   minOccurs="0"/>
          <xs:element name="item7-144" type=" VINstring"   minOccurs="0"/>
          <xs:element name="item7-145" type=" WiperRate"   minOccurs="0"/>
          <xs:element name="item7-146" type=" WiperStatusFront"   minOccurs="0"/>
          <xs:element name="item7-147" type=" WiperStatusRear"   minOccurs="0"/>
          <xs:element name="item7-148" type=" YawRateConfidence"   minOccurs="0"/>
          <xs:element name="item7-149" type=" YawRate"   minOccurs="0"/>
         <!-- External Items -->
          <xs:element name="item8-1" type=" itis:IncidentResponseEquipment"
minOccurs="0"/>
          <xs:element name="item8-2" type=" itis:ITIStext"   minOccurs="0"/>
          <xs:element name="item8-3" type=" itis:ResponderGroupAffected"  minOccurs="0"/>
          <xs:element name="item8-4" type=" itis:VehicleGroupAffected"  minOccurs="0"/>
          <xs:element name="item8-5" type=" itis:ITIScodesAndText"   minOccurs="0"/>
          <xs:element name="item8-6" type=" ntcip:EssMobileFriction"  minOccurs="0"/>
          <xs:element name="item8-7" type=" ntcip:EssPrecipRate"   minOccurs="0"/>
          <xs:element name="item8-8" type=" ntcip:EssPrecipSituation"  minOccurs="0"/>
          <xs:element name="item8-9" type=" ntcip:EssPrecipYesNo"   minOccurs="0"/>
          <xs:element name="item8-10" type=" ntcip:EssSolarRadiation"  minOccurs="0"/>
          <xs:element name="item8-11"  type="itis:ITIScodes"   minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is used directly by one other data structure in this standard, a MSG called MSG_A_la_Carte (ACM) <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

6.4 Data Element: DF_AntennaOffsetSet

Use: The DF_AntennaOffset Set data frame is a collection of three orthogonal offset values expressed in 4 bytes which describes how far the electrical center of an antenna is in each axis from a known anchor point in units of 1cm. When the antenna being describes is on a vehicle, the signed offset shall be from the 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.

ASN.1 Representation:

```
AntennaOffsetSet ::= OCTET STRING (SIZE(4))
   -- defined as:
   -- SEQUENCE {
   -- antOffsetX   INTEGER (-8191..8191),
                   -- 14 bits in length
                   -- units of 1cm from center
                   -- 8191 to be used for unavailable
   -- antOffsetY   INTEGER (-255..255),
                   -- 9 bits in length
                   -- units of 1cm from center
                   -- 255 to be used for unavailable
   -- antOffsetZ   INTEGER (0..511)
                   -- 9 bits in length
                   -- units of 1cm from ground
                   -- 511 to be used for unavailable
   -- }
```

XML Representation:

```
<xs:complexType name=" AntennaOffsetSet" >
    <xs:simpleContent>
      <xs:annotation>
         <xs:documentation>
            defined as:
            SEQUENCE  {
            antOffsetX  INTEGER  (-8191..8191) ,
            14 bits in length
            units of 1cm from center
            8191 to be used for unavailable
            antOffsetY  INTEGER  (-255..255) ,
            9 bits in length
            units of 1cm from center
            255 to be used for unavailable
            antOffsetZ  INTEGER  (0..511)
            9 bits in length
            units of 1cm from ground
            511 to be used for unavailable
            }
         </xs:documentation>
       </xs:annotation>
       <xs:extension base="AntennaOffsetSet-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="AntennaOffsetSet-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="6"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

6.5 Data Frame: DF_Approach

Use: The Approach data structure is used to bundle related motor vehicle lanes (both reference lanes and

computed lanes are described) within the intersection for an Approach or Egress description which is part of an intersection. It also allows expressing information about any barriers found between lanes (medians), other types of lanes (such as a train crossings), and information about pedestrian and bicycle lanes or walkways, all of which may cross the described motor vehicle lanes (at arbitrary angles).

ASN.1 Representation:

```
Approach ::= SEQUENCE {
   name             DescriptiveName OPTIONAL,
   id               ApproachNumber  OPTIONAL,
   drivingLanes     SEQUENCE (SIZE(0..32)) OF
                    VehicleReferenceLane OPTIONAL,
   computedLanes    SEQUENCE (SIZE(0..32)) OF
                    VehicleComputedLane OPTIONAL,
   trainsAndBuses   SEQUENCE (SIZE(0..32)) OF
                    SpecialLane OPTIONAL,
   barriers         SEQUENCE (SIZE(0..32)) OF
                    BarrierLane OPTIONAL,
   crosswalks       SEQUENCE (SIZE(0..32)) OF
                    CrosswalkLane OPTIONAL,
   ...
   }
```

XML Representation:

```
<xs:complexType name=" Approach" >
      <xs:sequence>
         <xs:element name="name" type=" DescriptiveName"   minOccurs="0"/>
         <xs:element name="id" type=" ApproachNumber"   minOccurs="0"/>
         <xs:element name="drivingLanes"  minOccurs="0">
            <xs:complexType>
               <xs:sequence minOccurs="0" maxOccurs="32">
                  <xs:element name="drivingLane" type=" VehicleReferenceLane" />
               </xs:sequence>
            </xs:complexType>
         </xs:element>
         <xs:element name="computedLanes"  minOccurs="0">
            <xs:complexType>
               <xs:sequence minOccurs="0" maxOccurs="32">
                  <xs:element name="computedLane" type=" VehicleComputedLane" />
               </xs:sequence>
            </xs:complexType>
         </xs:element>
         <xs:element name="trainsAndBuses"  minOccurs="0">
            <xs:complexType>
               <xs:sequence minOccurs="0" maxOccurs="32">
                  <xs:element name="trainsAndBuse" type=" SpecialLane" />
               </xs:sequence>
            </xs:complexType>
         </xs:element>
         <xs:element name="barriers"   minOccurs="0">
            <xs:complexType>
               <xs:sequence minOccurs="0" maxOccurs="32">
                  <xs:element name="barrier" type=" BarrierLane" />
               </xs:sequence>
            </xs:complexType>
         </xs:element>
         <xs:element name="crosswalks"  minOccurs="0">
            <xs:complexType>
               <xs:sequence minOccurs="0" maxOccurs="32">
                  <xs:element name="crosswalk" type=" CrosswalkLane" />
               </xs:sequence>
            </xs:complexType>
         </xs:element>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ApproachesObject	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that the integer value given to each described item (lane, barrier, crosswalk, etc.) is used in other messages and data frames to refer to that object within the context of the globally unique intersection that this data frame is used in.

6.6 Data Frame: DF_ApproachesObject

Use: The ApproachesObject data structure associates a set of related approaches and egresses with each other in the intersection. Observe that the data structure of each is the same. These approaches then define lanes with properties, each with a unique index value within this link object. The approach name and number is an (optional) convenience assigned in this data structure for human users only during testing. The lane number is the key assignment used to map between this and other objects (such as the movement states found in the SPAT message). The lane number and the intersection number, taken as a set, represent a unique path of travel throughout the link (which may be traversed by specific types of travelers, vehicles, pedestrians, etc. as a function of the signal timing and regulatory environment then in place). It may also contain additional information about the approach such as the road type classification and any barriers which are present.

ASN.1 Representation:

```
ApproachObject  ::= SEQUENCE {
    refPoint       Position3D OPTIONAL,
                   -- optional reference from which subsequent
                   -- data points in this link are offset
    laneWidth      LaneWidth   OPTIONAL,
                   -- reference width used by subsequent
                   -- lanes until a new width is given
    approach       Approach OPTIONAL,
                   -- list of Approaches and their lanes
    egress         Approach OPTIONAL,
                   -- list of Egresses and thier lanes
    ...
    }
```

XML Representation:

```
<xs:complexType name=" ApproachObject" >
       <xs:sequence>
          <xs:element name="refPoint" type=" Position3D"   minOccurs="0"/>
         <!-- OPTIONAL    reference from which subsequent
         data points in this link are offset -->
          <xs:element name="laneWidth" type=" LaneWidth"   minOccurs="0"/>
         <!-- reference width used by subsequent
         lanes until a new width is given -->
          <xs:element name="approach" type=" Approach"   minOccurs="0"/>
         <!-- list of Approaches and their lanes -->
          <xs:element name="egress" type=" Approach"   minOccurs="0"/>
         <!-- list of Egresses and thier lanes -->
       </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_Intersection	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that the offset data found in the underlying data structures will use the values found in the

last Position3D and the last NodeConfig as the basis to which the offset are added values. Normally this will be found in the enclosing object (typically an intersection type) but it may be reestablished here if needed (this is intended for use in the case of very large intersections which may exceed the offset ranges). If present, it applies to the scope of this link object, and not to any subsequent link objects which may be found in the same message. Similar logic is applied to the Node Configuration element, if present.

6.7 Data Frame: DF_BarrierLane

Use: A Barrier Lane data structure provides a unique lane number, as well as various details such as its width and attributes and a path within an approach structure for different types of traffic barriers, medians, and other roadways geometry and the like. The BarrierAttributes data element denotes what generally type of Barrier that it is. The nodeList data element provides a detailed set of offset values to map the path of the Barrier.

ASN.1 Representation:

```
BarrierLane ::= SEQUENCE {
   laneNumber            LaneNumber,
   laneWidth             LaneWidth   OPTIONAL,
   barrierAttributes     BarrierAttributes,
   nodeList              NodeList,
                        -- path details of the Barrier
   ...
   }
```

XML Representation:

```
<xs:complexType name=" BarrierLane" >
      <xs:sequence>
         <xs:element  name="laneNumber"  type=" LaneNumber" />
          <xs:element name="laneWidth" type=" LaneWidth"   minOccurs="0"/>
          <xs:element name="barrierAttributes" type=" BarrierAttributes" />
          <xs:element name="nodeList" type=" NodeList" />
         <!-- path details of the Barrier -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_Approach	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.8 Data Element: DF_BrakeSystemStatus

Use: The Brake System Status data frame conveys a variety of information about the current brake and system control activity of the vehicle. Each of the first four bits indicates whether brakes are active for a given wheel on the vehicle. A value of one shall indicate an active brake. A fifth bit is set to one to indicate when this data is unavailable. The next bit is reserved at this time (and set to zero). The next five 2-bit fields indicate the status respectively of the traction control system, the anti-lock brake system, the stability control system, the brake boost system, and the auxiliary brake system.

ASN.1 Representation:

```
BrakeSystemStatus ::= OCTET STRING (SIZE(2))
   -- Encoded with the packed content of:
   -- SEQUENCE {
   --    wheelBrakes          BrakeAppliedStatus,
   --                        -x- 4 bits
   --    wheelBrakesUnavailable   BOOL
   --                        -x- 1 bit (1=true)
   --    spareBit
   --                        -x- 1 bit, set to zero
```

```
--    traction              TractionControlState,
--                          -x- 2 bits
--    abs                   AntiLockBrakeStatus,
--                          -x- 2 bits
--    scs                   StabilityControlStatus,
--                          -x- 2 bits
--    brakeBoost            BrakeBoostApplied,
--                          -x- 2 bits
--    auxBrakes             AuxiliaryBrakeStatus,
--                          -x- 2 bits
--    }
```

XML Representation:

```
<xs:complexType name=" BrakeSystemStatus" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             Encoded with the packed content of:
             SEQUENCE  {
             wheelBrakes          BrakeAppliedStatus,
             -x- 4 bits
              wheelBrakesUnavailable  BOOL
             -x- 1 bit   (1=true)
             spareBit
             -x- 1 bit,  set to zero
             traction             TractionControlState,
             -x- 2 bits
             abs                  AntiLockBrakeStatus,
             -x- 2 bits
             scs                  StabilityControlStatus,
             -x- 2 bits
             brakeBoost           BrakeBoostApplied,
             -x- 2 bits
             auxBrakes            AuxiliaryBrakeStatus,
             -x- 2 bits
             }
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="BrakeSystemStatus-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="BrakeSystemStatus-string">
    <xs:restriction base="xs:base64Binary">
       <xs:length value="3"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that when the state of a brake or system control changes it will not only be reflected in this data element, but might also be reflected in a flag within the Event Flags data element, for example in Part II of a Basic Safety Message. However, the Event Flags data element is not required, so a safety system

should not depend on its appearance in a message.

6.9 Data Element: DF_BSM_Blob

Use: This octet blob data object is used to convey a vehicle's position and motion and other critical data to be sent in the BSM (the vehicles core state information) . This data frame is used in the Basic Safety Message (hence the name BSM blob) as well as in other messages.

ASN.1 Representation:

```
BSMblob ::= OCTET STRING (SIZE(38))
   -- made up of the following 38 packed bytes:
   -- msgCnt      MsgCount,              -x- 1 byte
   -- id          TemporaryID,           -x- 4 bytes
   -- secMark     DSecond,               -x- 2 bytes

   -- lat         Latitude,              -x- 4 bytes
   -- long        Longitude,             -x- 4 bytes
   -- elev        Elevation,             -x- 2 bytes
   -- accuracy    PositionalAccuracy,    -x- 4 bytes

   -- speed       TransmissionAndSpeed,  -x- 2 bytes
   -- heading     Heading,               -x- 2 byte
   -- angle       SteeringWheelAngle     -x- 1 byte
   -- accelSet    AccelerationSet4Way,   -x- accel set (four way) 7 bytes

   -- brakes      BrakeSystemStatus,     -x- 2 bytes
   -- size        VehicleSize,           -x- 3 bytes
```

XML Representation:

```
<xs:complexType name=" BSMblob" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             made up of the following 38 packed bytes:
             msgCnt       MsgCount,              -x- 1 byte
             id           TemporaryID,           -x- 4 bytes
             secMark      DSecond,               -x- 2 bytes
             lat          Latitude,              -x- 4 bytes
             long         Longitude,             -x- 4 bytes
             elev         Elevation,             -x- 2 bytes
             accuracy     PositionalAccuracy,    -x- 4 bytes
             speed        TransmissionAndSpeed,  -x- 2 bytes
             heading      Heading,               -x- 2 byte
             angle        SteeringWheelAngle    -x- 1 byte
             accelSet     AccelerationSet4Way,   -x- accel set  (four way)  7 bytes
             brakes       BrakeSystemStatus,     -x- 2 bytes
             size         VehicleSize,           -x- 3 bytes
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="BSMblob-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="BSMblob-string">
    <xs:restriction base="xs:base64Binary">
       <xs:length value="51"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage (BSM)	<ASN>	<XML>, and
MSG	MSG_SignalRequestMessage (SRM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: The byte order for packing shall follow the rules of ASN (MSB first). If a data element is not to be transmitted (for example the Temporary ID value) then all bits of that value shall be set to zero. The resulting data object is always exactly 38 bytes in length.

6.10 Data Frame: DF_BumperHeights

Use: The DF Bumper Heights data frame conveys the height of the front and rear bumper of the vehicle.

ASN.1 Representation:

```
BumperHeights ::= SEQUENCE {
   frnt        BumperHeightFront,
   rear        BumperHeightRear
   }
```

XML Representation:

```
<xs:complexType name=" BumperHeights" >
      <xs:sequence>
         <xs:element name="frnt" type=" BumperHeightFront" />
         <xs:element name="rear" type=" BumperHeightRear" />
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.11 Data Frame: DF_Circle

Use: The Circle data frame used to define a circle centered at a given point and extended to the given radius. It is typically used to describe the location of signs so that the receiving vehicle can determine if the sign applies to them and their current path.

ASN.1 Representation:

```
Circle ::= SEQUENCE {
   center     Position3D,
   raduis     CHOICE {
                 radiusSteps   INTEGER (0..32767),
                                -- in unsigned values where
                                -- the LSB is in units of 2.5 cm
                 miles         INTEGER (1..2000),
                 km            INTEGER (1..5000)
              } --# UNTAGGED
   }
```

XML Representation:

```
<xs:complexType name=" Circle" >
      <xs:sequence>
         <xs:element name="center" type=" Position3D" />
        <xs:choice >
```

```
            <xs:element  name="radiusSteps"  >
               <xs:simpleType>
                  <xs:restriction base="xs:unsignedShort">
                     <xs:maxInclusive value="32767"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:element>
            <!-- in unsigned values where
            the LSB is in units of 2.5 cm -->
            <xs:element name="miles" >
               <xs:simpleType>
                  <xs:restriction base="xs:unsignedShort">
                     <xs:minInclusive value="1"/>
                     <xs:maxInclusive value="2000"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:element>
            <xs:element name="km" >
               <xs:simpleType>
                  <xs:restriction base="xs:unsignedShort">
                     <xs:minInclusive value="1"/>
                     <xs:maxInclusive value="5000"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:element>
         </xs:choice>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ValidRegion	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: The values km and miles are typically used for wide area weather alert type uses.

6.12 Data Frame: DF_ConfidenceSet

Use: A set of various measurement confidence values about the vehicle.

ASN.1 Representation:

```
ConfidenceSet ::= SEQUENCE {
   accelConfidence        AccelSteerYawRateConfidence OPTIONAL,
   speedConfidence        SpeedandHeadingandThrottleConfidence OPTIONAL,
   timeConfidence         TimeConfidence OPTIONAL,
   posConfidence          PositionConfidenceSet OPTIONAL,
   steerConfidence        SteeringWheelAngleConfidence OPTIONAL,
   throttleConfidence     ThrottleConfidence OPTIONAL,
   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:complexType name=" ConfidenceSet" >
      <xs:sequence>
         <xs:element name="accelConfidence" type=" AccelSteerYawRateConfidence"
minOccurs="0"/>
         <xs:element name="speedConfidence" type=" SpeedandHeadingandThrottleConfidence"
minOccurs="0"/>
         <xs:element name="timeConfidence" type=" TimeConfidence"   minOccurs="0"/>
         <xs:element name="posConfidence" type=" PositionConfidenceSet"  minOccurs="0"/>
         <xs:element name="steerConfidence" type=" SteeringWheelAngleConfidence"
minOccurs="0"/>
         <xs:element name="throttleConfidence" type=" ThrottleConfidence"
minOccurs="0"/>
```

```
        <xs:element name="localConfidenceSet" type="local:ConfidenceSet" minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.13 Data Element: DF_ConnectsTo

Use: The ConnectsTo data structure is 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 LaneManeuverCode 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.

ASN.1 Representation:

```
ConnectsTo ::= OCTET STRING (SIZE(2..32))
   -- sets of 2 byte pairs,
   -- the first byte is a lane number
   -- the second byte is a LaneManeuverCode
```

XML Representation:

```
<xs:complexType name=" ConnectsTo" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             sets of 2 byte pairs,
             the first byte is a lane number
             the second byte is a  LaneManeuverCode
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="ConnectsTo-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="ConnectsTo-string">
    <xs:restriction base="xs:base64Binary">
       <xs:minLength value="3"/>
       <xs:maxLength value="43"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 5 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_CrosswalkLane	<ASN>	<XML>, and
DF	DF_SpecialLane	<ASN>	<XML>, and
DF	DF_VehicleComputedLane	<ASN>	<XML>, and

DF DF_VehicleReferenceLane <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: The assignment of lanes in the *connects To* structure 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.

6.14 Data Frame: DF_CrosswalkLane

Use: A Crosswalk Lane data structure provides a unique lane number, lane width and lane attributes and a path within an approach structure for a pedestrian cross walk or other non-motorized vehicle path that is part of the approach such as a bicycle lane. The CrosswalkLaneAttributes data element denotes what generally type of crosswalk it is. The nodeList data element provide a detailed set of offset values to map the path of the lane. The keepOutList (which is optional) denotes any segments along the path where users of the path (such as pedestrian traffic) cannot safely stop, and can thereby be used to denote where traffic islands may be found along the path.

ASN.1 Representation:

```
CrosswalkLane ::= SEQUENCE {
   laneNumber          LaneNumber,
   laneWidth           LaneWidth   OPTIONAL,
   laneAttributes      CrosswalkLaneAttributes,
   nodeList            NodeList,
                      -- path details of the lane
                      -- note that this may cross or pass
                      -- by driven lanes
   keepOutList         NodeList OPTIONAL,
                      -- no stop points along the path
                      -- typically the end points unless
                      -- islands are represented in the path
   connectsTo          ConnectsTo   OPTIONAL,
                      -- a list of other lanes and their
                      -- turning use by this lane
   ...
   }
```

XML Representation:

```
<xs:complexType name=" CrosswalkLane" >
      <xs:sequence>
         <xs:element  name="laneNumber"  type=" LaneNumber" />
          <xs:element name="laneWidth" type=" LaneWidth"   minOccurs="0"/>
          <xs:element name="laneAttributes" type=" CrosswalkLaneAttributes" />
          <xs:element name="nodeList" type=" NodeList" />
         <!-- path details of the lane
         note that this may cross or pass
         by driven lanes -->
          <xs:element name="keepOutList" type=" NodeList"   minOccurs="0"/>
         <!-- no stop points along the path
         typically the end points unless
         islands are represented in the path -->
          <xs:element name="connectsTo" type=" ConnectsTo"   minOccurs="0"/>
         <!-- a list of other lanes and their
         turning use by this lane -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

DF DF_Approach <ASN> <XML>.

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In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that the keepOutList is typically the entire path unless traffic islands are to be described where users may stop. Typically this is conveyed with two data points, the start and end points of the path. This is the inverse of the data typically found for motorized vehicle paths where the keepOutList is typically absent or only present to denote segment of the roadway where vehicles may not stop or come to rest (such as "do not block" areas).

6.15 Data Frame: DF_DataParameters

Use: The DataParameters date frame is used to provide basic (static) information on how a map fragment was processed or determined.

ASN.1 Representation:

```
DataParameters ::= SEQUENCE {
    processMethod       IA5String(SIZE(1..255)) OPTIONAL,
    processAgency       IA5String(SIZE(1..255)) OPTIONAL,
    lastCheckedDate     IA5String(SIZE(1..255)) OPTIONAL,
    geiodUsed           IA5String(SIZE(1..255)) OPTIONAL,
    ... -- # LOCAL_CONTENT
    }
```

XML Representation:

```
<xs:complexType name=" DataParameters" >
      <xs:sequence>
         <xs:element name="processMethod"  minOccurs="0">
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:minLength value="1"/>
                  <xs:maxLength value="255"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:element>
         <xs:element name="processAgency"  minOccurs="0">
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:minLength value="1"/>
                  <xs:maxLength value="255"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:element>
         <xs:element name="lastCheckedDate"  minOccurs="0">
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:minLength value="1"/>
                  <xs:maxLength value="255"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:element>
         <xs:element name="geiodUsed"  minOccurs="0">
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:minLength value="1"/>
                  <xs:maxLength value="255"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:element>
         <xs:element name="localDataParameters" type="local:DataParameters"
minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

MSG MSG_MapData (MAP) <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

6.16 Data Frame: DF_DDate

Use: The DSRC style date is a compound value consisting of finite-length sequences of integers (not characters) of the form: "yyyy, mm, dd" - as defined below.

ASN.1 Representation:

```
DDate ::= SEQUENCE {
   year     DYear,            -- 2 bytes
   month    DMonth,           -- 1 byte
   day      DDay              -- 1 byte
   }
```

XML Representation:

```
<xs:complexType name=" DDate" >
      <xs:sequence>
        <xs:element  name="year"  type=" DYear" />
        <!-- 2 bytes -->
         <xs:element name="month" type=" DMonth" />
        <!-- 1 byte -->
         <xs:element name="day" type=" DDay" />
        <!-- 1 byte -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

6.17 Data Frame: DF_DDateTime

Use: The DSRC style date is a compound value consisting of finite-length sequences of integers (not characters) of the form: "yyyy, mm, dd, hh, mm, ss (sss+)" - as defined below.

ASN.1 Representation:

```
DDateTime ::= SEQUENCE {
   year     DYear     OPTIONAL,     -- 2 bytes
   month    DMonth    OPTIONAL,     -- 1 byte
   day      DDay      OPTIONAL,     -- 1 byte
   hour     DHour     OPTIONAL,     -- 1 byte
   minute   DMinute   OPTIONAL,     -- 1 byte
   second   DSecond   OPTIONAL      -- 2 bytes
   }
```

XML Representation:

```
<xs:complexType name=" DDateTime" >
      <xs:sequence>
         <xs:element name="year" type=" DYear"   minOccurs="0"/>
        <!-- 2 bytes -->
         <xs:element name="month" type=" DMonth"   minOccurs="0"/>
        <!-- 1 byte -->
         <xs:element name="day" type=" DDay"   minOccurs="0"/>
        <!-- 1 byte -->
         <xs:element name="hour" type=" DHour"   minOccurs="0"/>
        <!-- 1 byte -->
         <xs:element name="minute" type=" DMinute"   minOccurs="0"/>
        <!-- 1 byte -->
         <xs:element name="second" type=" DSecond"   minOccurs="0"/>
        <!-- 2 bytes -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_FullPositionVector	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that some elements of this structure may not be sent when not needed. At least one element shall be present.

6.18 Data Frame: DF_DFullTime

Use: The DSRC style full time 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" - as defined below.

ASN.1 Representation:

```
DFullTime ::= SEQUENCE {
   year     DYear,            -- 2 bytes
   month    DMonth,           -- 1 byte
   day      DDay,             -- 1 byte
   hour     DHour,            -- 1 byte
   minute   DMinute           -- 1 byte
   }
```

XML Representation:

```
<xs:complexType name=" DFullTime" >
      <xs:sequence>
         <xs:element name="year" type=" DYear" />
        <!-- 2 bytes -->
         <xs:element name="month" type=" DMonth" />
        <!-- 1 byte -->
         <xs:element name="day" type=" DDay" />
        <!-- 1 byte -->
         <xs:element name="hour" type=" DHour" />
        <!-- 1 byte -->
         <xs:element name="minute" type=" DMinute" />
        <!-- 1 byte -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

6.19 Data Frame: DF_DMonthDay

Use: The DSRC style month-day is a compound value consisting of finite-length sequences of integers (not characters) of the form: "mm, dd" - as defined below.

ASN.1 Representation:

```
DMonthDay ::= SEQUENCE {
   month    DMonth,           -- 1 byte
   day      DDay              -- 1 byte
   }
```

XML Representation:

```
<xs:complexType name=" DMonthDay" >
      <xs:sequence>
```

```
        <xs:element name="month" type=" DMonth" />
       <!-- 1 byte -->
        <xs:element name="day" type=" DDay" />
       <!-- 1 byte -->
     </xs:sequence>
</xs:complexType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

6.20 Data Frame: DF_DTime

Use: The DSRC style time is 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.

ASN.1 Representation:

```
DTime ::= SEQUENCE {
   hour      DHour,            -- 1 byte
   minute    DMinute,          -- 1 byte
   second    DSecond           -- 2 bytes
   }
```

XML Representation:

```
<xs:complexType name=" DTime" >
     <xs:sequence>
        <xs:element name="hour" type=" DHour" />
       <!-- 1 byte -->
        <xs:element name="minute" type=" DMinute" />
       <!-- 1 byte -->
        <xs:element name="second" type=" DSecond" />
       <!-- 2 bytes -->
     </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_SignalRequestMessage (SRM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.21 Data Frame: DF_DYearMonth

Use: The DSRC style year-month is a compound value consisting of finite-length sequences of integers (not characters) of the form: "yyyy, mm" - as defined below.

ASN.1 Representation:

```
DYearMonth ::= SEQUENCE {
   year      DYear,            -- 2 bytes
   month     DMonth            -- 1 byte
   }
```

XML Representation:

```
<xs:complexType name=" DYearMonth" >
     <xs:sequence>
        <xs:element name="year" type=" DYear" />
       <!-- 2 bytes -->
```

```
         <xs:element name="month" type=" DMonth" />
        <!-- 1 byte -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

6.22 Data Frame: DF_FullPositionVector

Use: A complete report of the vehicle's position, speed, and heading and an instant in time. 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.

ASN.1 Representation:

```
FullPositionVector ::= SEQUENCE {
   utcTime              DDateTime OPTIONAL,    -- time with mSec precision
   long                 Longitude,             -- 1/10th microdegree
   lat                  Latitude,              -- 1/10th microdegree
   elevation            Elevation OPTIONAL,    -- 3 bytes, 0.1 m
   heading              Heading OPTIONAL,
   speed                TransmissionAndSpeed OPTIONAL,
   posAccuracy          PositionalAccuracy OPTIONAL,
   timeConfidence       TimeConfidence OPTIONAL,
   posConfidence        PositionConfidenceSet OPTIONAL,
   speedConfidence      SpeedandHeadingandThrottleConfidence OPTIONAL,
   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:complexType name=" FullPositionVector" >
      <xs:sequence>
         <xs:element name="utcTime" type=" DDateTime"   minOccurs="0"/>
        <!-- time with mSec precision -->
         <xs:element name="long" type=" Longitude" />
        <!-- 1/10th microdegree -->
         <xs:element name="lat" type=" Latitude" />
        <!-- 1/10th microdegree -->
         <xs:element name="elevation" type=" Elevation"   minOccurs="0"/>
        <!-- 3 bytes,  0.1 m -->
         <xs:element name="heading" type=" Heading"   minOccurs="0"/>
         <xs:element name="speed" type=" TransmissionAndSpeed"   minOccurs="0"/>
         <xs:element name="posAccuracy" type=" PositionalAccuracy"  minOccurs="0"/>
         <xs:element name="timeConfidence" type=" TimeConfidence"   minOccurs="0"/>
         <xs:element name="posConfidence" type=" PositionConfidenceSet" minOccurs="0"/>
         <xs:element name="speedConfidence" type=" SpeedandHeadingandThrottleConfidence"
minOccurs="0"/>
        <xs:element name="localFullPositionVector" type="local:FullPositionVector"
minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 8 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_PathHistory	<ASN>	<XML>, and
DF	DF_RTCMPackage	<ASN>	<XML>, and
DF	DF_Snapshot	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>, and

MSG	MSG_ProbeVehicleData (PVD)	<ASN>	<XML>, and
MSG	MSG_RoadSideAlert (RSA)	<ASN>	<XML>, and
MSG	MSG_RTCM_Corrections (RTCM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: In edition one of the standard the first 2 bytes were a *DSecond* followed by *DFullTime* in 6 bytes. This produced a complete time value in 8 bytes. In this edition, these have been re-ordered into a single value, that of *DDateTime*. This changes the ordering encoded over the air, and the ordering and the tags when expressed in ASN and XML.

6.23 Data Frame: DF_Intersection

Use: 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).

ASN.1 Representation:

```
Intersection ::= SEQUENCE {
   name          DescriptiveName OPTIONAL,
   id            IntersectionID,
                                 -- a gloablly unique value,
                                 -- the upper bytes of which may not
                                 -- be sent if the context is known
   refPoint      Position3D OPTIONAL,
                                 -- the reference from which subsequent
                                 -- data points are offset until a new
                                 -- point is used.
   refInterNum   IntersectionID OPTIONAL,
                                 -- present only if this is a computed
                                 -- intersection instance
   orientation   Heading OPTIONAL,
                                 -- present only if this is a computed
                                 -- intersection instance

   laneWidth     LaneWidth   OPTIONAL,
                                 -- reference width used by subsequent
                                 -- lanes until a new width is given
   type          IntersectionStatusObject OPTIONAL,
                                 -- data about the intersection type
   approaches SEQUENCE (SIZE(1..32)) OF
                 ApproachObject,
                                 -- data about one or more approaches
                                 -- (lane data is found here)
   preemptZones SEQUENCE (SIZE(1..32)) OF
                 SignalControlZone OPTIONAL,
                                 -- data about one or more
                                 -- preempt zones
   priorityZones SEQUENCE (SIZE(1..32)) OF
                 SignalControlZone OPTIONAL,
                                 -- data about one or more
                                 -- priority zones

   ...
   }
```

XML Representation:

```
<xs:complexType name=" Intersection" >
      <xs:sequence>
         <xs:element name="name" type=" DescriptiveName"   minOccurs="0"/>
         <xs:element name="id" type=" IntersectionID" />
        <!-- a gloablly unique value,
        the upper bytes of which may not
        be sent if the context is known -->
         <xs:element name="refPoint" type=" Position3D"   minOccurs="0"/>
        <!-- the reference from which subsequent
```

```
            data points are offset until a new
            point is used. -->
            <xs:element name="refInterNum" type=" IntersectionID"   minOccurs="0"/>
           <!-- present only if this is a computed
            intersection instance -->
            <xs:element name="orientation" type=" Heading"   minOccurs="0"/>
           <!-- present only if this is a computed
            intersection instance -->
            <xs:element name="laneWidth" type=" LaneWidth"   minOccurs="0"/>
           <!-- reference width used by subsequent
           lanes until a new width is given -->
            <xs:element name="type" type=" IntersectionStatusObject"   minOccurs="0"/>
           <!-- data about the intersection type -->
           <xs:element name="approaches" >
              <xs:complexType>
                 <xs:sequence minOccurs="1" maxOccurs="32">
                    <xs:element name="approache" type=" ApproachObject" />
                   <!-- data about one or more approaches (lane data is found here) -->
                 </xs:sequence>
              </xs:complexType>
           </xs:element>
            <xs:element name="preemptZones"  minOccurs="0">
              <xs:complexType>
                 <xs:sequence minOccurs="1" maxOccurs="32">
                    <xs:element name="preemptZone" type=" SignalControlZone" />
                   <!-- data about one or more preempt zones -->
                 </xs:sequence>
              </xs:complexType>
           </xs:element>
            <xs:element name="priorityZones"  minOccurs="0">
              <xs:complexType>
                 <xs:sequence minOccurs="1" maxOccurs="32">
                    <xs:element name="priorityZone" type=" SignalControlZone" />
                   <!-- data about one or more priority zones -->
                 </xs:sequence>
              </xs:complexType>
           </xs:element>
        </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_MapData (MAP)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that refInterNum and orientation are only present when a computed intersection is being described (a concept similar to a computed vehicle lane). The preemptZones and priorityZones are used to relate signal preempt and priority zones to specific request values.

6.24 Data Frame: DF_IntersectionState

Use: The IntersectionState data frame is used to convey all of the SPAT information for one single intersection.

ASN.1 Representation:

```
IntersectionState ::= SEQUENCE {
   name          DescriptiveName OPTIONAL,
                 -- human readable name for intersection
                 -- to be used only in debug mode
   id            IntersectionID,
                 -- this provided a unique mapping to the
                 -- intersection map in question
                 -- which provides complete location
```

```
                -- and approach/move/lane data
    status       IntersectionStatusObject,
                -- general status of the controller
    timeStamp    TimeMark OPTIONAL,
                -- the point in local time that
                -- this message was constructed
    lanesCnt     INTEGER(1..255) OPTIONAL,
                -- number of states to follow (not always
                -- one per lane because sign states may be shared)
    states       SEQUENCE (SIZE(1..255)) OF  MovementState,
                -- each active Movement/lane is given in turn
                -- and contains its state, and seconds
                -- to the next event etc.
    priority     SignalState OPTIONAL,
                -- the active priority state data, if present
    preempt      SignalState OPTIONAL,
                -- the active preemption state data, if present

    ... -- # LOCAL_CONTENT
    }
```

XML Representation:

```
<xs:complexType name=" IntersectionState" >
      <xs:sequence>
         <xs:element name="name" type=" DescriptiveName"   minOccurs="0"/>
        <!-- human readable name for intersection
        to be used only in debug mode -->
         <xs:element name="id" type=" IntersectionID" />
        <!-- this provided a unique mapping to the
         intersection map in question
         which provides complete location
         and approach/move/lane data -->
         <xs:element name="status" type=" IntersectionStatusObject" />
        <!-- general status of the controller -->
         <xs:element name="timeStamp" type=" TimeMark"   minOccurs="0"/>
        <!-- the point in local time that
         this message was constructed -->
         <xs:element name="lanesCnt"   minOccurs="0">
            <xs:simpleType>
                <xs:restriction base="xs:unsignedByte">
                   <xs:minInclusive value="1"/>
                </xs:restriction>
            </xs:simpleType>
         </xs:element>
        <!-- number of states to follow  (not always
         one per lane because sign states may be shared) -->
         <xs:element name="states" >
            <xs:complexType>
                <xs:sequence minOccurs="1" maxOccurs="255">
                   <xs:element name="state" type=" MovementState" />
                  <!-- each active Movement/lane is given in turn and contains its state,
and seconds to the next event etc. -->
                </xs:sequence>
            </xs:complexType>
         </xs:element>
         <xs:element name="priority" type=" SignalState"   minOccurs="0"/>
        <!-- the active priority state data,  if present -->
         <xs:element name="preempt" type=" SignalState"   minOccurs="0"/>
        <!-- the active preemption state data,  if present -->
         <xs:element name="localIntersectionState" type="local:IntersectionState"
minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

MSG MSG_SignalPhaseAndTiming Message (SPAT) <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

6.25 Data Frame: DF_ITIS_Phrase_ExitService

Use: A data frame to allow sequences of ITIS codes, short text strings, and numerical values to be expressed in the normal ITIS vocabulary method and pattern. Note that the allowed text strings are more limited then the normal ITIS format in order to converse bandwidth. All ITIS phrase data, when encoded in a DER form, shall always be expressed as integer values rather then their full text equivalents.

ASN.1 Representation:

```
ExitService ::= SEQUENCE (SIZE(1..10)) OF SEQUENCE {
  item CHOICE     {
       itis     ITIS.ITIScodes,
       text     IA5String  (SIZE(1..16))
       } -- # UNTAGGED
  }
```

XML Representation:

```
<xs:complexType name=" ExitService" >
       <xs:sequence minOccurs="1" maxOccurs="10">
          <xs:element name="exitService-item" >
             <xs:complexType>
                <xs:sequence>
                   <xs:choice >
                       <xs:element name="itis" type="itis:ITIScodes" />
                       <xs:element name="text" >
                          <xs:simpleType>
                              <xs:restriction base="xs:string">
                                 <xs:minLength value="1"/>
                                 <xs:maxLength value="16"/>
                              </xs:restriction>
                          </xs:simpleType>
                       </xs:element>
                   </xs:choice>
                </xs:sequence>
             </xs:complexType>
          </xs:element>
       </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

MSG MSG_TravelerInformation Message (TIM) <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

6.26 Data Frame: DF_ITIS_Phrase_GenericSignage

Use: A data frame to allow sequences of ITIS codes, short text strings, and numerical values to be expressed in the normal ITIS vocabulary method and pattern. Note that the allowed text strings are more limited then the normal ITIS format in order to converse bandwidth. All ITIS phrase data, when encoded in a DER form, shall always be expressed as integer values rather then their full text equivalents.

ASN.1 Representation:

```
GenericSignage ::= SEQUENCE (SIZE(1..10)) OF SEQUENCE {
  item CHOICE     {
       itis     ITIS.ITIScodes,
       text     IA5String  (SIZE(1..16))
       } -- # UNTAGGED
```

```
}
```

XML Representation:

```
<xs:complexType name=" GenericSignage" >
       <xs:sequence minOccurs="1" maxOccurs="10">
          <xs:element name="genericSignage-item" >
             <xs:complexType>
                <xs:sequence>
                   <xs:choice >
                      <xs:element  name="itis"  type="itis:ITIScodes"  />
                      <xs:element name="text" >
                         <xs:simpleType>
                            <xs:restriction base="xs:string">
                               <xs:minLength value="1"/>
                               <xs:maxLength value="16"/>
                            </xs:restriction>
                         </xs:simpleType>
                      </xs:element>
                   </xs:choice>
                </xs:sequence>
             </xs:complexType>
          </xs:element>
       </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.27 Data Frame: DF_ITIS_Phrase_SpeedLimit

Use: A data frame to allow sequences of ITIS codes, short text strings, and numerical values to be expressed in the normal ITIS vocabulary method and pattern. Note that the allowed text strings are more limited then the normal ITIS format in order to converse bandwidth. All ITIS phrase data, when encoded in a DER form, shall always be expressed as integer values rather then their full text equivalents.

ASN.1 Representation:

```
SpeedLimit ::= SEQUENCE (SIZE(1..10)) OF SEQUENCE {
  item CHOICE     {
       itis    ITIS.ITIScodes,
       text    IA5String  (SIZE(1..16))
       } -- # UNTAGGED
  }
```

XML Representation:

```
<xs:complexType name=" SpeedLimit" >
       <xs:sequence minOccurs="1" maxOccurs="10">
          <xs:element name="speedLimit-item" >
             <xs:complexType>
                <xs:sequence>
                   <xs:choice >
                      <xs:element name="itis" type="itis:ITIScodes" />
                      <xs:element name="text" >
                         <xs:simpleType>
                            <xs:restriction base="xs:string">
                               <xs:minLength value="1"/>
                               <xs:maxLength value="16"/>
                            </xs:restriction>
                         </xs:simpleType>
                      </xs:element>
                   </xs:choice>
                </xs:sequence>
```

```
            </xs:complexType>
          </xs:element>
       </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.28 Data Frame: DF_ITIS_Phrase_WorkZone

Use: A data frame to allow sequences of ITIS codes, short text strings, and numerical values to be expressed in the normal ITIS vocabulary method and pattern. Note that the allowed text strings are more limited then the normal ITIS format in order to converse bandwidth. All ITIS phrase data, when encoded in a DER form, shall always be expressed as integer values rather then their full text equivalents.

ASN.1 Representation:

```
WorkZone ::= SEQUENCE (SIZE(1..10)) OF SEQUENCE {
  item CHOICE     {
       itis    ITIS.ITIScodes,
       text    IA5String  (SIZE(1..16))
       } -- # UNTAGGED
  }
```

XML Representation:

```
<xs:complexType name=" WorkZone" >
       <xs:sequence minOccurs="1" maxOccurs="10">
          <xs:element name="workZone-item" >
             <xs:complexType>
                <xs:sequence>
                   <xs:choice >
                      <xs:element name="itis" type="itis:ITIScodes" />
                      <xs:element name="text" >
                         <xs:simpleType>
                            <xs:restriction base="xs:string">
                               <xs:minLength value="1"/>
                               <xs:maxLength value="16"/>
                            </xs:restriction>
                         </xs:simpleType>
                      </xs:element>
                   </xs:choice>
                </xs:sequence>
             </xs:complexType>
          </xs:element>
       </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.29 Data Frame: DF_J1939-Data Items

Use: This a data frame used to sent various J1939 defined data elements from the vehicle.

ASN.1 Representation:

```
J1939data ::= SEQUENCE {
   -- Tire conditions
   tires SEQUENCE (SIZE(0..16)) OF SEQUENCE {
      location                TireLocation                OPTIONAL,
      pressure                TirePressure                OPTIONAL,
      temp                    TireTemp                    OPTIONAL,
      wheelSensorStatus       WheelSensorStatus           OPTIONAL,
      wheelEndElectFault      WheelEndElectFault          OPTIONAL,
      leakageRate             TireLeakageRate             OPTIONAL,
      detection               TirePressureThresholdDetection OPTIONAL,
      ...
      } OPTIONAL,
   -- Vehicle Weight by axle
   axle SEQUENCE (SIZE(0..16)) OF SEQUENCE {
      location                AxleLocation                OPTIONAL,
      weight                  AxleWeight                  OPTIONAL,
      ...
      } OPTIONAL,
   trailerWeight              TrailerWeight               OPTIONAL,
   cargoWeight                CargoWeight                 OPTIONAL,
   steeringAxleTemperature    SteeringAxleTemperature     OPTIONAL,
   driveAxleLocation          DriveAxleLocation           OPTIONAL,
   driveAxleLiftAirPressure   DriveAxleLiftAirPressure    OPTIONAL,
   driveAxleTemperature       DriveAxleTemperature        OPTIONAL,
   driveAxleLubePressure      DriveAxleLubePressure       OPTIONAL,
   steeringAxleLubePressure   SteeringAxleLubePressure    OPTIONAL,
   ...
   }
```

XML Representation:

```
<xs:complexType name=" J1939data" >
      <xs:sequence>
         <!-- Tire conditions -->
          <xs:element name="tires"  minOccurs="0">
             <xs:complexType>
                <xs:sequence minOccurs="0" maxOccurs="16">
                   <xs:element name="tire" >
                      <xs:complexType>
                         <xs:sequence>
                            <xs:element name="location" type=" TireLocation"
minOccurs="0"/>
                            <xs:element name="pressure" type=" TirePressure"
minOccurs="0"/>
                            <xs:element name="temp" type=" TireTemp"  minOccurs="0"/>
                          <xs:element name="wheelSensorStatus" type=" WheelSensorStatus"
minOccurs="0"/>
                            <xs:element name="wheelEndElectFault" type="
 WheelEndElectFault"   minOccurs="0"/>
                            <xs:element name="leakageRate" type=" TireLeakageRate"
minOccurs="0"/>
                            <xs:element name="detection" type="
 TirePressureThresholdDetection"   minOccurs="0"/>
                         </xs:sequence>
                      </xs:complexType>
                   </xs:element>
                  <!-- Vehicle Weight by axle -->
                </xs:sequence>
             </xs:complexType>
          </xs:element>
          <xs:element name="axle"  minOccurs="0">
             <xs:complexType>
                <xs:sequence minOccurs="0" maxOccurs="16">
                   <xs:element name="axle-item" >
                      <xs:complexType>
                         <xs:sequence>
                            <xs:element name="location" type=" AxleLocation"
minOccurs="0"/>
                          <xs:element name="weight" type=" AxleWeight"  minOccurs="0"/>
```

```
                    </xs:sequence>
                  </xs:complexType>
                </xs:element>
              </xs:sequence>
            </xs:complexType>
          </xs:element>
           <xs:element name="trailerWeight" type=" TrailerWeight"   minOccurs="0"/>
          <xs:element name="cargoWeight" type=" CargoWeight"   minOccurs="0"/>
           <xs:element name="steeringAxleTemperature" type=" SteeringAxleTemperature"
minOccurs="0"/>
          <xs:element name="driveAxleLocation" type=" DriveAxleLocation"  minOccurs="0"/>
           <xs:element name="driveAxleLiftAirPressure" type=" DriveAxleLiftAirPressure"
minOccurs="0"/>
           <xs:element name="driveAxleTemperature" type=" DriveAxleTemperature"
minOccurs="0"/>
           <xs:element name="driveAxleLubePressure" type=" DriveAxleLubePressure"
minOccurs="0"/>
           <xs:element name="steeringAxleLubePressure" type=" SteeringAxleLubePressure"
minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.30 Data Frame: DF_MovementState

Use: The MovementState data frame is used to convey various information about the current signal state of a designated collection of one or more lanes of a common type. Note that lane types supported include both motorized vehicle lanes as well as pedestrian lanes and dedicated train and transit lanes. Of the reported data elements, the time to change (the time remaining in the current state) is often of the most of value. Lanes with a common state (typically adjacent sets of lanes in an approach) in a signalized intersection will have individual lane values such as total vehicle counts, summed. It is used in the SPAT message to convey every movement in the approaches in a given intersections so that vehicles, when combined with certain map information, can determine the state of the signal lights.

ASN.1 Representation:

```
MovementState ::= SEQUENCE {
   -- The MovementNumber is contained in the enclosing DF.
   movementName       DescriptiveName OPTIONAL,
                     -- uniquely defines movement by name
   laneCnt            LaneCount OPTIONAL,
                     -- the number of lanes to follow
   laneSet            LaneSet,
                     -- each encoded as a LaneNumber,
                     -- the collection of lanes, by num,
                     -- to which this state data applies
  -- For the current movement State, you may CHOICE one of the below:
          currState      SignalLightState OPTIONAL,
                        -- the state of a Motorised lane
          pedState       PedestrianSignalState OPTIONAL,
                        -- the state of a Pedestrian type lane
          specialState   SpecialSignalState OPTIONAL,
                        -- the state of a special type lane
                        -- such as a dedicated train lane

   timeToChange       TimeMark,
                     -- the point in time this state will change
   stateConfidence    StateConfidence   OPTIONAL,
```

```
    -- Yellow phase time intervals
    -- (used for motorised vehicle lanes and pedestrian lanes)
    -- For the yellow Signal State, a CHOICE of one of the below:
            yellState       SignalLightState OPTIONAL,
                            -- the next state of a
                            -- Motorised lane
            yellPedState    PedestrianSignalState OPTIONAL,
                            -- the next state of a
                            -- Pedestrian type lane

    yellTimeToChange        TimeMark   OPTIONAL,
    yellStateConfidence     StateConfidence   OPTIONAL,

    -- below items are all optional based on use and context
    -- some are used only for ped lane types
    vehicleCount    ObjectCount OPTIONAL,
    pedDetect       PedestrianDetect   OPTIONAL,
                    -- true if ANY ped are detected crossing
                    -- the above lanes
    pedCount        ObjectCount OPTIONAL,
                    -- est count of peds
    ... -- # LOCAL_CONTENT
    }
```

XML Representation:

```
<xs:complexType name=" MovementState" >
      <xs:sequence>
        <!-- The MovementNumber is contained in the enclosing DF. -->
         <xs:element name="movementName" type=" DescriptiveName"  minOccurs="0"/>
        <!-- uniquely defines movement by name -->
         <xs:element name="laneCnt" type=" LaneCount"   minOccurs="0"/>
        <!-- the number of lanes to follow -->
         <xs:element name="laneSet" type=" LaneSet" />
        <!-- each encoded as a  LaneNumber,
        the collection of lanes,  by num,
        to which this state data applies
        For the current movement State,  you may CHOICE one of the below: -->
         <xs:element name="currState" type=" SignalLightState"   minOccurs="0"/>
        <!-- the state of a Motorised lane -->
         <xs:element name="pedState" type=" PedestrianSignalState"  minOccurs="0"/>
        <!-- the state of a Pedestrian type lane -->
         <xs:element name="specialState" type=" SpecialSignalState"  minOccurs="0"/>
        <!-- the state of a special type lane
        such as a dedicated train lane -->
         <xs:element name="timeToChange" type=" TimeMark" />
        <!-- the point in time this state will change -->
         <xs:element name="stateConfidence" type=" StateConfidence"  minOccurs="0"/>
        <!-- Yellow phase time intervals
         (used for motorised vehicle lanes and pedestrian lanes)
        For the yellow Signal State,  a CHOICE of one of the below: -->
         <xs:element name="yellState" type=" SignalLightState"   minOccurs="0"/>
        <!-- the next state of a
        Motorised lane -->
         <xs:element name="yellPedState" type=" PedestrianSignalState"  minOccurs="0"/>
        <!-- the next state of a
        Pedestrian type lane -->
         <xs:element name="yellTimeToChange" type=" TimeMark"   minOccurs="0"/>
        <xs:element name="yellStateConfidence" type=" StateConfidence"  minOccurs="0"/>
        <!-- below items are all   OPTIONAL   based on use and context
        some are used only for ped lane types -->
         <xs:element name="vehicleCount" type=" ObjectCount"   minOccurs="0"/>
         <xs:element name="pedDetect" type=" PedestrianDetect"   minOccurs="0"/>
        <!-- true if ANY ped are detected crossing
        the above lanes -->
         <xs:element name="pedCount" type=" ObjectCount"   minOccurs="0"/>
        <!-- est count of peds -->
       <xs:element name="localMovementState" type="local:MovementState" minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_IntersectionState	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that the value given for the *time to change* will vary in many actuated signalized intersection based on the sensor data received during the phase. The data transmitted always reflects the then most current time value. Therefore, as an example, in a phase which may vary from 15 to 25 seconds of duration based on observed traffic flows, a time to change value of 15 seconds in the future might be transmitted for many seconds on end (as many as 10 seconds) followed by decreasing values as the time runs out. During this entire period of time, the yellow time would also be sent. The *time to change* element can generally be regarded as a guaranteed minimum value of the time that will elapse unless a preemption event occurs.

6.31 Data Frame: DF_NodeList

Use: The NodeList data structure provides the sequence of signed offset values for determining the Xs and Ys (and, possibly Width or Zs when present) using the then current Position3D object to build a path for the enclosing ReferenceLane relating to a lane in the current intersection.

ASN.1 Representation:

```
NodeList ::= SEQUENCE (SIZE(1..64)) OF Offsets
   -- the Position3D ref point (starting point or anchor)
   -- is found in the outer object.
   -- Offsets are additive from the last point.
```

XML Representation:

```
<xs:complexType name=" NodeList" >
       <xs:sequence minOccurs="1" maxOccurs="64">
         <xs:element name="node" type=" Offsets" />
       </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 8 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_BarrierLane	<ASN>	<XML>, and
DF	DF_CrosswalkLane	<ASN>	<XML>, and
DF	DF_ShapePointSet	<ASN>	<XML>, and
DF	DF_SignalControlZone	<ASN>	<XML>, and
DF	DF_SpecialLane	<ASN>	<XML>, and
DF	DF_VehicleComputedLane	<ASN>	<XML>, and
DF	DF_VehicleReferenceLane	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: When describing a path, the first node is the one closest to the intersection for the lane or the beginning point in a roadway segment. Typically, this is located on the stop line for approaches. Safety applications can use this to identify their stop line without having to consult the Intersection Message. For egresses, the first node indicates where the outbound lane begins.

When the node list is used to describe "non stopping areas" in a path (such as a stripped do not block area

or a railroad crossing) then the offsets are taken in paired sets. The first offset provides the start of the area to be avoided, while the 2nd offset provides the end of that area. The path is presumed to follow the same linear path described by the node list for the lane.

Subsequent nodes provide points further and further away along the lane's driven line. Include as many as necessary to characterize lane curvature "within tolerance."

6.32 Data Element: DF_Offsets

Use: The Offsets data structure provides one set of signed offset values for determining the Xs and Ys (and, possibly Zs when present) using the then current ReferencePoint object to build a single point in a path for the enclosing ReferenceLane relating to a lane in the current intersection.

ASN.1 Representation:

```
Offsets ::= OCTET STRING (SIZE(4..8))
   -- Made up of
   -- SEQUENCE {
   -- xOffset   INTEGER (-32767..32767),
   -- yOffset   INTEGER (-32767..32767),
   -- if 6 or 8 bytes in length:
   -- zOffset   INTEGER (-32767..32767) OPTIONAL,
            -- all above in signed values where
            -- the LSB is in units of 1.0 cm

   -- if 8 bytes in length:
   -- width     LaneWidth                OPTIONAL
   -- a length of 7 bytes is never used
   -- }
```

XML Representation:

```
<xs:complexType name=" Offsets" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             Made up of
             SEQUENCE  {
             xOffset  INTEGER  (-32767..32767) ,
             yOffset  INTEGER  (-32767..32767) ,
             if 6 or 8 bytes in length:
             zOffset  INTEGER  (-32767..32767)    OPTIONAL ,
             all above in signed values where
             the LSB is in units of 1.0 cm
             if 8 bytes in length:
             width     LaneWidth                OPTIONAL
             a length of 7 bytes is never used
             }
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="Offsets-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="Offsets-string">
   <xs:restriction base="xs:base64Binary">
      <xs:minLength value="6"/>
      <xs:maxLength value="11"/>
   </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_NodeList	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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 zOffset or for LaneWidth is given, that value persists until changed again for additional nodes in the list.

6.33 Data Frame: DF_PathHistory

Use: The PathHistory data frame defines an adaptable set of PathHistoryPointSets reflecting recent vehicle movement over some period of time and/or distance. The points present in the history 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).

The initial anchor point shall be the initialPostion data frame or be provided in the message in which the PathHistory is sent (such as the BSM Part I). If the Path History is sent in a message which provides the Full Position vector or similar initial position data then the optional initialPosition element shall not be sent.

The initial anchor point is used to create the offset values of the set. All path history points are older in time than the anchor point used. 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.

The PathHistory data itself allows many optional variants of data to be encoded. Each possible set of PathHistoryPointSets data elements is supported in an octet blob style, and the sets of data in that type (a 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 PathHistoryPointSets 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 lat and long. The elevation offset units are in 10cm units. The time is expressed in units of 10 milliseconds. The GPSstatus uses 4 bytes the relate the pseudorange noise measured in the system. The heading and speed are not offset values, and follow the units defined in the ASN comments. All of these items are defined further in the relevant data entry.

ASN.1 Representation:

```
PathHistory ::= SEQUENCE {
    initialPosition    FullPositionVector    OPTIONAL,
    currGPSstatus      GPSstatus             OPTIONAL,
    itemCnt            Count                 OPTIONAL,
                      -- Limited to range 1 to 23
                      -- number of points in set to follow
    crumbData   CHOICE {
                -- select one of the possible data sets to be used

                 pathHistoryPointSets-01 SEQUENCE (SIZE(1..23)) OF
                       PathHistoryPointType-01,
                      -- made up of sets of the: PathHistoryPointType-1
                      -- a set of all data elements, it is
                      -- non-uniform in size, each item tagged in BER

                 pathHistoryPointSets-02 OCTET STRING (SIZE(15..345)),
                      -- made up of sets of the: PathHistoryPointType-02
```

```
                    -- sets of all data elements including:
                    -- lat, long, elev, time, accuracy, heading, and speed
                    -- offsets sent as a packed blob of 15 bytes per point

               pathHistoryPointSets-03 OCTET STRING (SIZE(12..276)),
                    -- made up of sets of the: PathHistoryPointType-03
                    -- sets of the following data elements:
                    -- lat, long, elev, time, and accuracy
                    -- offsets sent as a packed blob of 12 bytes per point

               pathHistoryPointSets-04 OCTET STRING (SIZE(8..184)),
                    -- made up of sets of the: PathHistoryPointType-04
                    -- sets of the following data elements:
                    -- lat, long, elev, and time
                    -- offsets sent as a packed blob of 8 bytes per point

               pathHistoryPointSets-05 OCTET STRING (SIZE(10..230)),
                    -- made up of sets of the: PathHistoryPointType-05
                    -- sets of the following data elements:
                    -- lat, long, elev, and accuracy
                    -- offsets sent as a packed blob of 10 bytes per point

               pathHistoryPointSets-06 OCTET STRING (SIZE(6..138)),
                    -- made up of sets of the: PathHistoryPointType-06
                    -- sets of the following data elements:
                    -- lat, long, and elev
                    -- offsets sent as a packed blob of 6 bytes per point

               pathHistoryPointSets-07 OCTET STRING (SIZE(11..242)),
                    -- made up of sets of the: PathHistoryPointType-07
                    -- sets of the following data elements:
                    -- lat, long, time, and accuracy
                    -- offsets sent as a packed blob of 10.5 bytes per point

               pathHistoryPointSets-08 OCTET STRING (SIZE(7..161)),
                    -- made up of sets of the: PathHistoryPointType-08
                    -- sets of the following data elements:
                    -- lat, long, and time
                    -- offsets sent as a packed blob of 7 bytes per point

               pathHistoryPointSets-09 OCTET STRING (SIZE(9..196)),
                    -- made up of sets of the: PathHistoryPointType-09
                    -- sets of the following data elements:
                    -- lat, long, and accuracy
                    -- offsets sent as a packed blob of 8.5 bytes per point

               pathHistoryPointSets-10 OCTET STRING (SIZE(5..104))
                    -- made up of sets of the: PathHistoryPointType-10
                    -- sets of the following data elements:
                    -- lat and long
                    -- offsets sent as a packed blob of 4.5 bytes per point

               },
    ... -- # LOCAL_CONTENT
    }
```

XML Representation:

```
<xs:complexType name=" PathHistory" >
       <xs:sequence>
          <xs:element name="initialPosition" type=" FullPositionVector"  minOccurs="0"/>
          <xs:element name="currGPSstatus" type=" GPSstatus"   minOccurs="0"/>
          <xs:element name="itemCnt" type=" Count"   minOccurs="0"/>
         <!-- Limited to range 1 to 23
         number of points in set to follow -->
          <xs:element name="crumbData" >
             <xs:complexType>
                <xs:choice>
                   <!-- select one of the possible data sets to be used -->
                    <xs:element name="pathHistoryPointSets-01" >
```

```
                    <xs:complexType>
                       <xs:sequence minOccurs="1" maxOccurs="23">
                          <xs:element name="pathHistoryPointSets-01-item" type="
 PathHistoryPointType-01" />
                           <!-- made up of sets of the: PathHistoryPointType-1 a set of
all data elements,  it is non-uniform in size,  each item tagged in BER -->
                       </xs:sequence>
                    </xs:complexType>
                 </xs:element>
                 <xs:element name="pathHistoryPointSets-02" >
                    <xs:complexType><xs:simpleContent>
                       <xs:extension base="pathHistoryPointSets-02-string" >
                          <xs:attribute name="EncodingType" use="required">
                             <xs:simpleType>
                                <xs:restriction base="xs:NMTOKEN">
                                   <xs:enumeration value="base64Binary"/>
                                </xs:restriction>
                             </xs:simpleType>
                          </xs:attribute>
                       </xs:extension>
                    </xs:simpleContent> </xs:complexType>
                 </xs:element>
                 <!-- made up of sets of the:  PathHistoryPointType-02
                 sets of all data elements including:
                 lat,  long,  elev,  time,  accuracy,  heading,  and speed
                 offsets sent as a packed blob of 15 bytes per point -->
                  <xs:element name="pathHistoryPointSets-03" >
                    <xs:complexType> <xs:simpleContent>
                       <xs:extension base="pathHistoryPointSets-03-string" >
                          <xs:attribute name="EncodingType" use="required">
                             <xs:simpleType>
                                <xs:restriction base="xs:NMTOKEN">
                                   <xs:enumeration value="base64Binary"/>
                                </xs:restriction>
                             </xs:simpleType>
                          </xs:attribute>
                       </xs:extension>
                    </xs:simpleContent> </xs:complexType>
                 </xs:element>
                 <!-- made up of sets of the:  PathHistoryPointType-03
                  sets of the following data elements:
                 lat,  long,  elev,  time,  and accuracy
                 offsets sent as a packed blob of 12 bytes per point -->
                  <xs:element name="pathHistoryPointSets-04" >
                    <xs:complexType> <xs:simpleContent>
                       <xs:extension base="pathHistoryPointSets-04-string" >
                          <xs:attribute name="EncodingType" use="required">
                             <xs:simpleType>
                                <xs:restriction base="xs:NMTOKEN">
                                   <xs:enumeration value="base64Binary"/>
                                </xs:restriction>
                             </xs:simpleType>
                          </xs:attribute>
                       </xs:extension>
                    </xs:simpleContent> </xs:complexType>
                 </xs:element>
                 <!-- made up of sets of the:  PathHistoryPointType-04
                  sets of the following data elements:
                 lat,  long,  elev,  and time
                 offsets sent as a packed blob of 8 bytes per point -->
                  <xs:element name="pathHistoryPointSets-05" >
                    <xs:complexType><xs:simpleContent>
                       <xs:extension base="pathHistoryPointSets-05-string" >
                          <xs:attribute name="EncodingType" use="required">
                             <xs:simpleType>
                                <xs:restriction base="xs:NMTOKEN">
                                   <xs:enumeration value="base64Binary"/>
                                </xs:restriction>
                             </xs:simpleType>
```

```
            </xs:attribute>
          </xs:extension>
       </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- made up of sets of the:  PathHistoryPointType-05
 sets of the following data elements:
 lat,  long,  elev,  and accuracy
 offsets sent as a packed blob of 10 bytes per point -->
  <xs:element name="pathHistoryPointSets-06" >
     <xs:complexType><xs:simpleContent>
        <xs:extension base="pathHistoryPointSets-06-string" >
           <xs:attribute name="EncodingType" use="required">
             <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
             </xs:simpleType>
           </xs:attribute>
      </xs:extension>
     </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- made up of sets of the:  PathHistoryPointType-06
sets of the following data elements:
 lat,  long,  and elev
 offsets sent as a packed blob of 6 bytes per point -->
  <xs:element name="pathHistoryPointSets-07" >
    <xs:complexType> <xs:simpleContent>
        <xs:extension base="pathHistoryPointSets-07-string" >
           <xs:attribute name="EncodingType" use="required">
             <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
             </xs:simpleType>
           </xs:attribute>
        </xs:extension>
    </xs:simpleContent> </xs:complexType>
 </xs:element>
<!-- made up of sets of the:  PathHistoryPointType-07
 sets of the following data elements:
 lat,  long,  time,  and accuracy
 offsets sent as a packed blob of 10.5 bytes per point -->
  <xs:element name="pathHistoryPointSets-08" >
    <xs:complexType><xs:simpleContent>
        <xs:extension base="pathHistoryPointSets-08-string" >
           <xs:attribute name="EncodingType" use="required">
             <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
             </xs:simpleType>
           </xs:attribute>
        </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- made up of sets of the:  PathHistoryPointType-08
 sets of the following data elements:
 lat,  long,  and time
 offsets sent as a packed blob of 7 bytes per point -->
  <xs:element name="pathHistoryPointSets-09" >
    <xs:complexType><xs:simpleContent>
        <xs:extension base="pathHistoryPointSets-09-string" >
           <xs:attribute name="EncodingType" use="required">
             <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
             </xs:simpleType>
           </xs:attribute>
```

```
                    </xs:extension>
                  </xs:simpleContent> </xs:complexType>
                </xs:element>
                <!-- made up of sets of the:  PathHistoryPointType-09
                sets of the following data elements:
                lat,  long,  and accuracy
                offsets sent as a packed blob of 8.5 bytes per point -->
                <xs:element name="pathHistoryPointSets-10" >
                    <xs:complexType><xs:simpleContent>
                       <xs:extension base="pathHistoryPointSets-10-string" >
                          <xs:attribute name="EncodingType" use="required">
                            <xs:simpleType>
                               <xs:restriction base="xs:NMTOKEN">
                                  <xs:enumeration value="base64Binary"/>
                               </xs:restriction>
                            </xs:simpleType>
                          </xs:attribute>
                       </xs:extension>
                    </xs:simpleContent></xs:complexType>
                </xs:element>
                <!-- made up of sets of the:  PathHistoryPointType-10
                sets of the following data elements:
                lat and long
                offsets sent as a packed blob of 4.5 bytes per point -->
             </xs:choice>
          </xs:complexType>
       </xs:element>
        <xs:element name="localPathHistory" type="local:PathHistory" minOccurs="0"/>
    </xs:sequence>
</xs:complexType>

                <xs:simpleType name="pathHistoryPointSets-02-string">
                   <xs:restriction base="xs:base64Binary">
                      <xs:minLength value="20"/>
                      <xs:maxLength value="460"/>
                   </xs:restriction>
                </xs:simpleType >
                <xs:simpleType name="pathHistoryPointSets-03-string">
                   <xs:restriction base="xs:base64Binary">
                      <xs:minLength value="16"/>
                      <xs:maxLength value="368"/>
                   </xs:restriction>
                </xs:simpleType >
                <xs:simpleType  name="pathHistoryPointSets-04-string">
                   <xs:restriction base="xs:base64Binary">
                      <xs:minLength value="11"/>
                      <xs:maxLength value="246"/>
                   </xs:restriction>
                </xs:simpleType >
                <xs:simpleType name="pathHistoryPointSets-05-string">
                   <xs:restriction base="xs:base64Binary">
                      <xs:minLength value="14"/>
                      <xs:maxLength value="307"/>
                   </xs:restriction>
                </xs:simpleType >
                <xs:simpleType name="pathHistoryPointSets-06-string">
                   <xs:restriction base="xs:base64Binary">
                      <xs:minLength value="8"/>
                      <xs:maxLength value="184"/>
                   </xs:restriction>
                </xs:simpleType >
                <xs:simpleType name="pathHistoryPointSets-07-string">
                   <xs:restriction base="xs:base64Binary">
                      <xs:minLength value="15"/>
                      <xs:maxLength value="323"/>
                   </xs:restriction>
                </xs:simpleType >
                <xs:simpleType name="pathHistoryPointSets-08-string">
                   <xs:restriction base="xs:base64Binary">
```

```
            <xs:minLength value="10"/>
            <xs:maxLength value="215"/>
         </xs:restriction>
      </xs:simpleType >
      <xs:simpleType name="pathHistoryPointSets-09-string">
         <xs:restriction base="xs:base64Binary">
            <xs:minLength value="12"/>
            <xs:maxLength value="266"/>
         </xs:restriction>
      </xs:simpleType >
      <xs:simpleType name="pathHistoryPointSets-10-string">
         <xs:restriction base="xs:base64Binary">
            <xs:minLength value="7"/>
            <xs:maxLength value="139"/>
         </xs:restriction>
      </xs:simpleType >
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleSafetyExtension	<ASN>	<XML>, and
MSG	MSG_IntersectionCollisionAvoidance (ICA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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.

6.34 Data Frame: DF_PathHistoryPointType-01

Use: The PathHistoryPointType-1 data frame one of a set of related items to carry prior position data (typically vehicle trials). In use, sequences of this data set are sent (one per point). In this data frame each element is delimited by tags, in other variants the data is expressed in a single octet blob.

ASN.1 Representation:

```
PathHistoryPointType-01 ::= SEQUENCE {
   latOffset   INTEGER (-131072..131071),
               -- in 1/10th micro degrees
               -- value  131071 to be used for  131071 or greater
               -- value -131071 to be used for -131071 or less
               -- value -131072 to be used for unavailable lat or long

   longOffset INTEGER (-131072..131071),
               -- in 1/10th micro degrees
               -- value  131071 to be used for  131071 or greater
               -- value -131071 to be used for -131071 or less
               -- value -131072 to be used for unavailable lat or long

    elevationOffset INTEGER (-2048..2047)  OPTIONAL,
               -- LSB units of of 10 cm
               -- value  2047 to be used for  2047 or greater
               -- value -2047 to be used for -2047 or greater
               -- value -2048 to be unavailable

    timeOffset INTEGER (1..65535) OPTIONAL,
               -- LSB units of of 10 mSec
               -- value  65534 to be used for 65534 or greater
               -- value  65535 to be unavailable

    posAccuracy  PositionalAccuracy OPTIONAL,
               -- four packed bytes
```

```
    heading     INTEGER (-128..127) OPTIONAL,
                -- where the LSB is in
                -- units of 1.5 degrees
                -- value -128 for unavailable
                -- not an offset value

    speed       TransmissionAndSpeed   OPTIONAL
                -- upper bits encode transmission
                -- where the LSB is in
                -- units of 0.02 m/s
                -- not an offset value
}
```

XML Representation:

```
<xs:complexType name=" PathHistoryPointType-01" >
      <xs:sequence>
         <xs:element name="latOffset" >
            <xs:simpleType>
               <xs:restriction base="xs:int">
                  <xs:minInclusive value="-131072"/>
                  <xs:maxInclusive value="131071"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:element>
         <!-- in 1/10th micro degrees
         value  131071 to be used for  131071 or greater
         value -131071 to be used for -131071 or less
         value -131072 to be used for unavailable lat or long -->
          <xs:element name="longOffset" >
            <xs:simpleType>
               <xs:restriction base="xs:int">
                  <xs:minInclusive value="-131072"/>
                  <xs:maxInclusive value="131071"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:element>
         <!-- in 1/10th micro degrees
         value  131071 to be used for  131071 or greater
         value -131071 to be used for -131071 or less
         value -131072 to be used for unavailable lat or long -->
          <xs:element name="elevationOffset"  minOccurs="0">
            <xs:simpleType>
              <xs:restriction base="xs:short">
                  <xs:minInclusive value="-2048"/>
                  <xs:maxInclusive value="2047"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:element>
         <!-- LSB units of of 10 cm
         value  2047 to be used for  2047 or greater
         value -2047 to be used for -2047 or greater
         value -2048 to be unavailable -->
          <xs:element name="timeOffset"  minOccurs="0">
            <xs:simpleType>
              <xs:restriction base="xs:unsignedShort">
                  <xs:minInclusive value="1"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:element>
         <!-- LSB units of of 10 mSec
         value  65534 to be used for 65534 or greater
         value  65535 to be unavailable -->
          <xs:element name="posAccuracy" type=" PositionalAccuracy"  minOccurs="0"/>
         <!-- four packed bytes -->
          <xs:element name="heading"  minOccurs="0">
            <xs:simpleType>
               <xs:restriction base="xs:byte">
                  <xs:minInclusive value="-128"/>
```

```
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <!-- where the LSB is in
        units of 1.5 degrees
        value -128 for unavailable
        not an offset value -->
        <xs:element name="speed" type=" TransmissionAndSpeed"   minOccurs="0"/>
        <!-- upper bits encode transmission
        where the LSB is in
        units of 0.02 m/s
        not an offset value -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_PathHistory	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.35 Data Element: DF_PathHistoryPointType-02

Use: The PathHistoryPointType-2 data element is one of a set of related items to carry past position data (typically vehicle trails). In use, sequences of this data set are sent (one per data point), typically combined into a single final octet string.

ASN.1 Representation:

```
PathHistoryPointType-02 ::= OCTET STRING (SIZE(15))
   -- To be made up of packed bytes as follows:
   -- latOffset  INTEGER (-131072..131071)  (18 signed bits)
   -- longOffset INTEGER (-131072..131071)  (18 signed bits)
    -- in 1/10th micro degrees
    -- value  131071 to be used for  131071 or greater
    -- value -131071 to be used for -131071 or less
    -- value -131072 to be used for unavailable lat or long

   -- elevationOffset     INTEGER (-2048..2047), (12 signed bits)
    -- LSB units of 10 cm
    -- value  2047 to be used for  2047 or greater
    -- value -2047 to be used for -2047 or greater
    -- value -2048 to be unavailable

   -- timeOffset INTEGER (0..65535), (16 unsigned bits)
    -- LSB units of of 10 mSec
    -- value  65534 to be used for 65534 or greater
    -- value  65535 to be unavailable

   -- accuracy    PositionalAccuracy
    -- four packed bytes

   -- heading     INTEGER (-128..127), (8 signed bits)
    -- where the LSB is in
    -- units of 1.5 degrees
    -- value -128 for unavailable
    -- not an offset value

   -- speed       TransmissionAndSpeed (16 encoded bits)
    -- upper bits encode transmission
    -- where the LSB is in
    -- units of 0.02 m/s
    -- not an offset value
```

XML Representation:

```
<xs:complexType name=" PathHistoryPointType-02" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             To be made up of packed bytes as follows:
             latOffset  INTEGER  (-131072..131071)    (18 signed bits)
             longOffset INTEGER  (-131072..131071)    (18 signed bits)
             in 1/10th micro degrees
             value  131071 to be used for  131071 or greater
             value -131071 to be used for -131071 or less
             value -131072 to be used for unavailable lat or long
             elevationOffset    INTEGER  (-2048..2047) ,    (12 signed bits)
             LSB units of 10 cm
             value  2047 to be used for  2047 or greater
             value -2047 to be used for -2047 or greater
             value -2048 to be unavailable
             timeOffset INTEGER  (0..65535) ,    (16 unsigned bits)
             LSB units of of 10 mSec
             value  65534 to be used for 65534 or greater
             value  65535 to be unavailable
             accuracy    PositionalAccuracy
             four packed bytes
             heading    INTEGER  (-128..127) ,    (8 signed bits)
             where the LSB is in
             units of 1.5 degrees
             value -128 for unavailable
             not an offset value
             speed       TransmissionAndSpeed  (16 encoded bits)
             upper bits encode transmission
             where the LSB is in
             units of 0.02 m/s
             not an offset value
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="PathHistoryPointType-02-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PathHistoryPointType-02-string">
    <xs:restriction base="xs:base64Binary">
       <xs:length value="20"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The delta units used in the latOffset and Long offset are 1/10th micro degrees from the anchor point given by the full position vector. The delta units used in the elevationOffset are 10 cm from the elevation of the full position vector. The delta units of time used in the time offset are unsigned 10 mSec. The delta units used in the heading are units of 1.2 deg. The delta units used in the speed are unsigned units of 0.02 m/Sec.

6.36 Data Element: DF_PathHistoryPointType-03

Use: The PathHistoryPointType-3 data element is one of a set of related items to carry past position data (typically vehicle trails). In use, sequences of this data set are sent (one per data point), typically combined

into a single final octet string.

ASN.1 Representation:

```
PathHistoryPointType-03 ::= OCTET STRING (SIZE(12))
   -- To be made up of packed bytes as follows:
   -- latOffset   INTEGER (-131072..131071)  (18 signed bits)
   -- longOffset  INTEGER (-131072..131071)  (18 signed bits)
    -- in 1/10th micro degrees
    -- value  131071 to be used for  131071 or greater
    -- value -131071 to be used for -131071 or less
    -- value -131072 to be used for unavailable lat or long

   -- elevationOffset     INTEGER (-2048..2047), (12 signed bits)
    -- LSB units of 10 cm
    -- value  2047 to be used for  2047 or greater
    -- value -2047 to be used for -2047 or greater
    -- value -2048 to be unavailable

   -- timeOffset INTEGER (0..65535), (16 unsigned bits)
    -- LSB units of of 10 mSec
    -- value  65534 to be used for 65534 or greater
    -- value  65535 to be unavailable

   -- accuracy    PositionalAccuracy
    -- four packed bytes
```

XML Representation:

```
<xs:complexType name=" PathHistoryPointType-03" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             To be made up of packed bytes as follows:
             latOffset  INTEGER  (-131072..131071)    (18 signed bits)
             longOffset INTEGER  (-131072..131071)    (18 signed bits)
             in 1/10th micro degrees
             value  131071 to be used for  131071 or greater
            value -131071 to be used for -131071 or less
            value -131072 to be used for unavailable lat or long
             elevationOffset    INTEGER  (-2048..2047) ,    (12 signed bits)
             LSB units of 10 cm
             value  2047 to be used for  2047 or greater
            value -2047 to be used for -2047 or greater
            value -2048 to be unavailable
             timeOffset INTEGER  (0..65535) ,    (16 unsigned bits)
             LSB units of of 10 mSec
             value  65534 to be used for 65534 or greater
             value  65535 to be unavailable
            accuracy    PositionalAccuracy
             four packed bytes
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="PathHistoryPointType-03-string" >
           <xs:attribute name="EncodingType" use="required">
             <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
             </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PathHistoryPointType-03-string">
    <xs:restriction base="xs:base64Binary">
       <xs:length value="16"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The delta units used in the latOffset and Long offset are 1/10th micro degrees from the anchor point given by the full position vector. The delta units used in the elevationOffset are 10 cm from the elevation of the full position vector. The delta units of time used in the time offset are unsigned 10 mSec.

6.37 Data Element: DF_PathHistoryPointType-04

Use: The PathHistoryPointType-4 data element is one of a set of related items to carry past position data (typically vehicle trails). In use, sequences of this data set are sent (one per data point), typically combined into a single final octet string.

ASN.1 Representation:

```
PathHistoryPointType-04 ::= OCTET STRING (SIZE(8))
   -- To be made up of packed bytes as follows:
   -- latOffset   INTEGER (-131072..131071)  (18 signed bits)
   -- longOffset  INTEGER (-131072..131071)  (18 signed bits)
    -- in 1/10th micro degrees
    -- value  131071 to be used for  131071 or greater
    -- value -131071 to be used for -131071 or less
    -- value -131072 to be used for unavailable lat or long

   -- elevationOffset     INTEGER (-2048..2047), (12 signed bits)
    -- LSB units of 10 cm
    -- value  2047 to be used for  2047 or greater
    -- value -2047 to be used for -2047 or greater
    -- value -2048 to be unavailable

   -- timeOffset INTEGER (0..65535), (16 unsigned bits)
    -- LSB units of of 10 mSec
    -- value  65534 to be used for 65534 or greater
    -- value  65535 to be unavailable
```

XML Representation:

```
<xs:complexType name=" PathHistoryPointType-04" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             To be made up of packed bytes as follows:
             latOffset  INTEGER  (-131072..131071)    (18 signed bits)
             longOffset INTEGER  (-131072..131071)    (18 signed bits)
             in 1/10th micro degrees
             value  131071 to be used for  131071 or greater
             value -131071 to be used for -131071 or less
             value -131072 to be used for unavailable lat or long
             elevationOffset    INTEGER  (-2048..2047) ,    (12 signed bits)
             LSB units of 10 cm
             value  2047 to be used for  2047 or greater
             value -2047 to be used for -2047 or greater
             value -2048 to be unavailable
             timeOffset INTEGER  (0..65535) ,    (16 unsigned bits)
             LSB units of of 10 mSec
             value  65534 to be used for 65534 or greater
             value  65535 to be unavailable
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="PathHistoryPointType-04-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
```

```
      </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PathHistoryPointType-04-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="11"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The delta units used in the latOffset and Long offset are 1/10th micro degrees from the anchor point given by the full position vector. The delta units used in the elevationOffset are 10 cm from the elevation of the full position vector. The delta units of time used in the time offset are unsigned 10 mSec.

6.38 Data Element: DF_PathHistoryPointType-05

Use: The PathHistoryPointType-5 data element is one of a set of related items to carry past position data (typically vehicle trails). In use, sequences of this data set are sent (one per data point), typically combined into a single final octet string.

ASN.1 Representation:

```
PathHistoryPointType-05 ::= OCTET STRING (SIZE(10))
   -- To be made up of packed bytes as follows:
   -- latOffset  INTEGER (-131072..131071)  (18 signed bits)
   -- longOffset INTEGER (-131072..131071)  (18 signed bits)
    -- in 1/10th micro degrees
    -- value  131071 to be used for  131071 or greater
    -- value -131071 to be used for -131071 or less
    -- value -131072 to be used for unavailable lat or long

   -- elevationOffset    INTEGER (-2048..2047), (12 signed bits)
    -- LSB units of 10 cm
    -- value  2047 to be used for  2047 or greater
    -- value -2047 to be used for -2047 or greater
    -- value -2048 to be unavailable

   -- accuracy    PositionalAccuracy
    -- four packed bytes
```

XML Representation:

```
<xs:complexType name=" PathHistoryPointType-05" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             To be made up of packed bytes as follows:
             latOffset  INTEGER  (-131072..131071)    (18 signed bits)
             longOffset INTEGER  (-131072..131071)    (18 signed bits)
             in 1/10th micro degrees
             value  131071 to be used for  131071 or greater
             value -131071 to be used for -131071 or less
             value -131072 to be used for unavailable lat or long
             elevationOffset    INTEGER  (-2048..2047) ,    (12 signed bits)
             LSB units of 10 cm
             value  2047 to be used for  2047 or greater
             value -2047 to be used for -2047 or greater
             value -2048 to be unavailable
             accuracy    PositionalAccuracy
             four packed bytes
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="PathHistoryPointType-05-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
```

```
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
             </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PathHistoryPointType-05-string">
    <xs:restriction base="xs:base64Binary">
       <xs:length value="14"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The delta units used in the latOffset and Long offset are 1/10th micro degrees from the anchor point given by the full position vector. The delta units used in the elevationOffset are 10 cm from the elevation of the full position vector.

6.39 Data Element: DF_PathHistoryPointType-06

Use: The PathHistoryPointType-6 data element is one of a set of related items to carry past position data (typically vehicle trails). In use, sequences of this data set are sent (one per data point), typically combined into a single final octet string.

ASN.1 Representation:

```
PathHistoryPointType-06 ::= OCTET STRING (SIZE(6))
   -- To be made up of packed bytes as follows:
   -- latOffset   INTEGER (-131072..131071)  (18 signed bits)
   -- longOffset INTEGER (-131072..131071)  (18 signed bits)
    -- in 1/10th micro degrees
    -- value  131071 to be used for  131071 or greater
    -- value -131071 to be used for -131071 or less
    -- value -131072 to be used for unavailable lat or long

   -- elevationOffset     INTEGER (-2048..2047),  (12 signed bits)
    -- LSB units of 10 cm
    -- value  2047 to be used for  2047 or greater
    -- value -2047 to be used for -2047 or greater
    -- value -2048 to be unavailable
```

XML Representation:

```
<xs:complexType name=" PathHistoryPointType-06" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             To be made up of packed bytes as follows:
             latOffset   INTEGER  (-131072..131071)   (18 signed bits)
             longOffset INTEGER  (-131072..131071)   (18 signed bits)
             in 1/10th micro degrees
             value  131071 to be used for  131071 or greater
             value -131071 to be used for -131071 or less
             value -131072 to be used for unavailable lat or long
             elevationOffset     INTEGER  (-2048..2047) ,    (12 signed bits)
             LSB units of 10 cm
             value  2047 to be used for  2047 or greater
             value -2047 to be used for -2047 or greater
             value -2048 to be unavailable
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="PathHistoryPointType-06-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
```

```
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
             </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PathHistoryPointType-06-string">
    <xs:restriction base="xs:base64Binary">
       <xs:length value="8"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The delta units used in the latOffset and Long offset are 1/10th micro degrees from the anchor point given by the full position vector. The delta units used in the elevationOffset are 10 cm from the elevation of the full position vector.

6.40 Data Element: DF_PathHistoryPointType-07

Use: The PathHistoryPointType-7 data element is one of a set of related items to carry past position data (typically vehicle trails). In use, sequences of this data set are sent (one per data point), typically combined into a single final octet string.

ASN.1 Representation:

```
PathHistoryPointType-07 ::= OCTET STRING (SIZE(11)) -- in fact 10.5
   -- To be made up of packed bytes as follows:
   -- latOffset  INTEGER (-131072..131071)  (18 signed bits)
   -- longOffset INTEGER (-131072..131071)  (18 signed bits)
    -- in 1/10th micro degrees
    -- value  131071 to be used for  131071 or greater
    -- value -131071 to be used for -131071 or less
    -- value -131072 to be used for unavailable lat or long

   -- timeOffset INTEGER (0..65535), (16 unsigned bits)
    -- LSB units of of 10 mSec
    -- value  65534 to be used for 65534 or greater
    -- value  65535 to be unavailable

   -- accuracy    PositionalAccuracy
    -- four packed bytes
```

XML Representation:

```
<xs:complexType name=" PathHistoryPointType-07" >
   <xs:simpleContent>
      <xs:annotation>
         <xs:documentation>
            in fact 10.5
            To be made up of packed bytes as follows:
            latOffset  INTEGER  (-131072..131071)    (18 signed bits)
            longOffset INTEGER  (-131072..131071)    (18 signed bits)
            in 1/10th micro degrees
            value  131071 to be used for  131071 or greater
            value -131071 to be used for -131071 or less
            value -131072 to be used for unavailable lat or long
            timeOffset INTEGER  (0..65535) ,   (16 unsigned bits)
            LSB units of of 10 mSec
            value  65534 to be used for 65534 or greater
            value  65535 to be unavailable
            accuracy    PositionalAccuracy
            four packed bytes
         </xs:documentation>
```

```
        </xs:annotation>
        <xs:extension base="PathHistoryPointType-07-string" >
           <xs:attribute name="EncodingType" use="required">
             <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
             </xs:simpleType>
           </xs:attribute>
        </xs:extension>
     </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PathHistoryPointType-07-string">
     <xs:restriction base="xs:base64Binary">
        <xs:length value="15"/>
     </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The delta units used in the latOffset and Long offset are 1/10th micro degrees from the anchor point given by the full position vector. The delta units of time used in the time offset are unsigned 10 mSec.

6.41 Data Element: DF_PathHistoryPointType-08

Use: The PathHistoryPointType-8 data element is one of a set of related items to carry past position data (typically vehicle trails). In use, sequences of this data set are sent (one per data point), typically combined into a single final octet string.

ASN.1 Representation:

```
PathHistoryPointType-08 ::= OCTET STRING (SIZE(7)) -- in fact 6.5
   -- To be made up of packed bytes as follows:
   -- latOffset  INTEGER (-131072..131071)  (18 signed bits)
   -- longOffset INTEGER (-131072..131071)  (18 signed bits)
    -- in 1/10th micro degrees
    -- value  131071 to be used for  131071 or greater
    -- value -131071 to be used for -131071 or less
    -- value -131072 to be used for unavailable lat or long

   -- timeOffset INTEGER (0..65535), (16 unsigned bits)
    -- LSB units of of 10 mSec
    -- value  65534 to be used for 65534 or greater
    -- value  65535 to be unavailable
```

XML Representation:

```
<xs:complexType name=" PathHistoryPointType-08" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             in fact 6.5
             To be made up of packed bytes as follows:
             latOffset  INTEGER  (-131072..131071)    (18 signed bits)
             longOffset INTEGER  (-131072..131071)    (18 signed bits)
             in 1/10th micro degrees
             value  131071 to be used for  131071 or greater
             value -131071 to be used for -131071 or less
             value -131072 to be used for unavailable lat or long
             timeOffset INTEGER  (0..65535) ,   (16 unsigned bits)
             LSB units of of 10 mSec
             value  65534 to be used for 65534 or greater
             value  65535 to be unavailable
          </xs:documentation>
       </xs:annotation>
```

```
        <xs:extension base="PathHistoryPointType-08-string" >
           <xs:attribute name="EncodingType" use="required">
             <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
             </xs:simpleType>
           </xs:attribute>
        </xs:extension>
     </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PathHistoryPointType-08-string">
     <xs:restriction base="xs:base64Binary">
        <xs:length value="10"/>
     </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The delta units used in the latOffset and Long offset are 1/10th micro degrees from the anchor point given by the full position vector. The delta units of time used in the time offset are unsigned 10 mSec.

6.42 Data Element: DF_PathHistoryPointType-09

Use: The PathHistoryPointType-9 data element is one of a set of related items to carry past position data (typically vehicle trails). In use, sequences of this data set are sent (one per data point), typically combined into a single final octet string.

ASN.1 Representation:

```
PathHistoryPointType-09 ::= OCTET STRING (SIZE(9)) -- in fact 8.5
   -- To be made up of packed bytes as follows:
   -- latOffset  INTEGER (-131072..131071)  (18 signed bits)
   -- longOffset INTEGER (-131072..131071)  (18 signed bits)
    -- in 1/10th micro degrees
    -- value  131071 to be used for  131071 or greater
    -- value -131071 to be used for -131071 or less
    -- value -131072 to be used for unavailable lat or long

   -- accuracy    PositionalAccuracy
    -- four packed bytes
```

XML Representation:

```
<xs:complexType name=" PathHistoryPointType-09" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             in fact 8.5
             To be made up of packed bytes as follows:
             latOffset  INTEGER  (-131072..131071)    (18 signed bits)
             longOffset INTEGER  (-131072..131071)    (18 signed bits)
             in 1/10th micro degrees
             value  131071 to be used for  131071 or greater
             value -131071 to be used for -131071 or less
             value -131072 to be used for unavailable lat or long
             accuracy    PositionalAccuracy
             four packed bytes
          </xs:documentation>
       </xs:annotation>
        <xs:extension base="PathHistoryPointType-09-string" >
           <xs:attribute name="EncodingType" use="required">
             <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
```

```
            </xs:restriction>
          </xs:simpleType>
        </xs:attribute>
      </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PathHistoryPointType-09-string">
    <xs:restriction  base="xs:base64Binary">
      <xs:length value="12"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The delta units used in the latOffset and Long offset are 1/10th micro degrees from the anchor point given by the full position vector.

6.43 Data Element: DF_PathHistoryPointType-10

Use: The PathHistoryPointType-10 data element is one of a set of related items to carry past position data (typically vehicle trails). In use, sequences of this data set are sent (one per data point), typically combined into a single final octet string.

ASN.1 Representation:

```
PathHistoryPointType-10 ::= OCTET STRING (SIZE(5))    -- in fact 4.5
   -- To be made up of packed bytes as follows:
   -- latOffset  INTEGER (-131072..131071)  (18 signed bits)
   -- longOffset INTEGER (-131072..131071)  (18 signed bits)
    -- in 1/10th micro degrees
    -- value  131071 to be used for  131071 or greater
    -- value -131071 to be used for -131071 or less
    -- value -131072 to be used for unavailable lat or long
```

XML Representation:

```
<xs:complexType name=" PathHistoryPointType-10" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             in fact 4.5
             To be made up of packed bytes as follows:
             latOffset  INTEGER  (-131072..131071)    (18 signed bits)
             longOffset INTEGER  (-131072..131071)    (18 signed bits)
             in 1/10th micro degrees
             value  131071 to be used for  131071 or greater
             value -131071 to be used for -131071 or less
             value -131072 to be used for unavailable lat or long
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="PathHistoryPointType-10-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PathHistoryPointType-10-string">
    <xs:restriction  base="xs:base64Binary">
       <xs:length value="7"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The delta units used in the latOffset and Long offset are 1/10th micro degrees from the anchor point given by the full position vector.

6.44 Data Frame: DF_PathPrediction

Use: The DF_PathPrediction data frame 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 in the Path Prediction data element 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 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 >2s). 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.), signal confidence is reduced.

ASN.1 Representation:

```
PathPrediction ::= SEQUENCE {
    radiusOfCurve INTEGER (-32767..32767),
                  -- LSB units of 10cm
                  -- straight path to use value of 32767
    confidence     INTEGER (0..200),
                  -- LSB units of 0.5 percent

    ... -- # LOCAL_CONTENT
    }
```

XML Representation:

```
<xs:complexType name=" PathPrediction" >
       <xs:sequence>
          <xs:element name="radiusOfCurve" >
             <xs:simpleType>
                <xs:restriction base="xs:short">
                   <xs:minInclusive value="-32767"/>
                </xs:restriction>
             </xs:simpleType>
          </xs:element>
          <!-- LSB units of 10cm
          straight path to use value of 32767 -->
          <xs:element name="confidence" >
             <xs:simpleType>
                <xs:restriction base="xs:unsignedByte">
                   <xs:maxInclusive value="200"/>
                </xs:restriction>
             </xs:simpleType>
          </xs:element>
          <!-- LSB units of 0.5 percent -->
           <xs:element name="localPathPrediction" type="local:PathPrediction"
minOccurs="0"/>
```

```
        </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleSafetyExtension	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.45 Data Frame: DF_Position3D

Use: A data concept which provides a definitive and precise location in the WSG-84 coordinate system from which short offsets may then used to create additional data using a flat earth projection centered from this point.. Typically used in the description of maps and intersections as well as signs and traveler data. A collection of the two 4 byte lat-long information elements and the one 2 byte elevation used to build a complete 3D position set in 10 bytes.

ASN.1 Representation:

```
Position3D ::= SEQUENCE {
   lat          Latitude,    -- in 1/10th micro degrees
   long         Longitude,   -- in 1/10th micro degrees
   elevation    Elevation    OPTIONAL
   }
```

XML Representation:

```
<xs:complexType name=" Position3D" >
       <xs:sequence>
          <xs:element name="lat" type=" Latitude" />
         <!-- in 1/10th micro degrees -->
          <xs:element name="long" type=" Longitude" />
         <!-- in 1/10th micro degrees -->
          <xs:element  name="elevation"  type=" Elevation"   minOccurs="0"/>
       </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 8 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ApproachesObject	<ASN>	<XML>, and
DF	DF_Circle	<ASN>	<XML>, and
DF	DF_Intersection	<ASN>	<XML>, and
DF	DF_RegionPointSet	<ASN>	<XML>, and
DF	DF_RoadSignID	<ASN>	<XML>, and
DF	DF_ShapePointSet	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: In use to describe paths, all subsequent offset values are added to this point in order to determine the absolute position to be described. In some data structures more than one Position3D may be present. Data values are interpreted in a stream fashion. That is, until a new Position3D is read, the value for the last one is used as the basis for all offset values found in the same structure.

6.46 Data Element: DF_PositionalAccuracy

Use: The DE_ Positional Accuracy element is a 4 octet field of packed data consisting of various parameters of quality used to model the accuracy of the positional determination with respect to each given axis. Note that because the 3 data elements are packed as one single data object, this is treated as a data frame.

ASN.1 Representation:

```
PositionalAccuracy ::= OCTET STRING (SIZE(4))
  -- And the bytes defined as folllows

  -- Byte 1: semi-major accuracy at one standard dev
  -- range 0-12.7 meter, LSB = .05m
  -- 0xFE=254=any value equal or greater than 12.70 meter
  -- 0xFF=255=unavailable semi-major value

  -- Byte 2: semi-minor accuracy at one standard dev
  -- range 0-12.7 meter, LSB = .05m
  -- 0xFE=254=any value equal or greater than 12.70 meter
  -- 0xFF=255=unavailable semi-minor value

  -- Bytes 3-4: orientation of semi-major axis
  -- relative to true north (0~359.9945078786 degrees)
  -- LSB units of 360/65535 deg  = 0.0054932479
  -- a value of 0x0000 =0 shall be 0 degrees
  -- a value of 0x0001 =1 shall be 0.0054932479degrees
  -- a value of 0xFFFE =65534 shall be 359.9945078786 deg
  -- a value of 0xFFFF =65535 shall be used for orientation unavailable
  -- (In NMEA GPGST)
```

XML Representation:

```
<xs:complexType name=" PositionalAccuracy" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             And the bytes defined as folllows
             Byte 1: semi-major accuracy at one standard dev
             range 0-12.7 meter,  LSB = .05m
              0xFE=254=any value equal or greater than 12.70 meter
              0xFF=255=unavailable semi-major value
             Byte 2: semi-minor accuracy at one standard dev
             range 0-12.7 meter,  LSB = .05m
              0xFE=254=any value equal or greater than 12.70 meter
              0xFF=255=unavailable semi-minor value
             Bytes 3-4: orientation of semi-major axis
              relative to true north  (0~359.9945078786 degrees)
              LSB units of 360/65535 deg  = 0.0054932479
              a value of 0x0000 =0 shall be 0 degrees
              a value of 0x0001 =1 shall be 0.0054932479degrees
              a value of 0xFFFE =65534 shall be 359.9945078786 deg
              a value of 0xFFFF =65535 shall be used for orientation unavailable
              (In NMEA GPGST)
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="PositionalAccuracy-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PositionalAccuracy-string">
    <xs:restriction base="xs:base64Binary">
       <xs:length value="6"/>
```

```
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_FullPositionVector	<ASN>	<XML>, and
DF	DF_PathHistoryPointType-01	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.47 Data Element: DF_PositionConfidenceSet

Use: A single byte long data frame combining multiple related bit fields into one byte.

ASN.1 Representation:

```
PositionConfidenceSet ::= OCTET STRING (SIZE(1))
-- To be encoded as:
-- SEQUENCE {
--    pos          PositionConfidence,
--                 -x- 4 bits, for both horizontal directions
--    elevation    ElevationConfidence
--                 -x- 4 bits
--    }
```

XML Representation:

```
<xs:complexType name=" PositionConfidenceSet" >
    <xs:simpleContent>
      <xs:annotation>
         <xs:documentation>
            To be encoded as:
            SEQUENCE  {
            pos          PositionConfidence,
            -x- 4 bits,   for both horizontal directions
            elevation    ElevationConfidence
            -x- 4 bits
            }
         </xs:documentation>
      </xs:annotation>
      <xs:extension base="PositionConfidenceSet-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:attribute>
      </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PositionConfidenceSet-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="2"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ConfidenceSet	<ASN>	<XML>, and

DF DF_FullPositionVector <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

6.48 Data Frame: DF_RegionList

Use: The DF_RegionList data structure provides the sequence of signed offset values for determining the Xs and Ys (and, possibly Zs when present) using the then current Position3D object to build a path to enclose a region.

ASN.1 Representation:

```
RegionList ::= SEQUENCE (SIZE(1..64)) OF RegionOffsets
   -- the Position3D ref point (starting point or anchor)
   -- is found in the outer object.
```

XML Representation:

```
<xs:complexType name=" RegionList" >
       <xs:sequence minOccurs="1" maxOccurs="64">
          <xs:element name="region" type=" RegionOffsets" />
       </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

DF DF_RegionPointSet <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: When describing a path, subsequent nodes provide points further and further away along the developed line. Include as many point as necessary to characterize curvature "within tolerance."

6.49 Data Frame: DF_RegionOffsets

Use: The RegionOffsetsdata structure provides one set of signed offset values for determining the Xs and Ys (and, possibly Zs when present) using the then current ReferencePoint object to build a single point in a path. Typically is it used to describe large enclosed regions.

ASN.1 Representation:

```
RegionOffsets ::= SEQUENCE {
   xOffset   INTEGER (-32767..32767),
   yOffset   INTEGER (-32767..32767),
   zOffset   INTEGER (-32767..32767) OPTIONAL
             -- all in signed values where
             -- the LSB is in units of 1 meter
   }
```

XML Representation:

```
<xs:complexType name=" RegionOffsets" >
       <xs:sequence>
          <xs:element  name="xOffset" >
             <xs:simpleType>
                <xs:restriction base="xs:short">
                   <xs:minInclusive value="-32767"/>
                </xs:restriction>
             </xs:simpleType>
          </xs:element>
          <xs:element  name="yOffset" >
             <xs:simpleType>
                <xs:restriction base="xs:short">
                   <xs:minInclusive value="-32767"/>
                </xs:restriction>
             </xs:simpleType>
```

```
            </xs:element>
            <xs:element name="zOffset"    minOccurs="0">
               <xs:simpleType>
                  <xs:restriction base="xs:short">
                     <xs:minInclusive value="-32767"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:element>
            <!-- all in signed values where
            the LSB is in units of 1 meter -->
         </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

DF DF_RegionList <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

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 meter) of offset. When a value for zOffset is given, that value persists until changed again for additional nodes in the list.

6.50 Data Frame: DF_RegionPointSet

Use: The DF_RegionPointSet DF is used to represent or describe an enclosed region. It is typically employed to define a region where signs or advisories would be valid.

ASN.1 Representation:

```
RegionPointSet ::= SEQUENCE {
   anchor             Position3D   OPTIONAL,
   nodeList           RegionList,
                     -- path details of the regions outline
   ...
   }
```

XML Representation:

```
<xs:complexType name=" RegionPointSet" >
      <xs:sequence>
         <xs:element name="anchor" type=" Position3D"   minOccurs="0"/>
         <xs:element name="nodeList" type=" RegionList" />
        <!-- path details of the regions outline -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

DF DF_ValidRegion <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

6.51 Data Frame: DF_RoadSignID

Use: The RoadSignID data frame is used to provide a precise location of one or more roadside signs.

ASN.1 Representation:

```
RoadSignID ::= SEQUENCE {
   position          Position3D,
                    -- Location of sign
```

```
   viewAngle         HeadingSlice,
                     -- Vehicle direction of travel while
                     -- facing active side of sign
   mutcdCode         MUTCDCode OPTIONAL,
                     -- Tag for MUTCD code or "generic sign"
   crc               MsgCRC OPTIONAL
                     -- Used to provide a check sum
   }
```

XML Representation:

```
<xs:complexType name=" RoadSignID" >
      <xs:sequence>
         <xs:element name="position" type=" Position3D" />
        <!-- Location of sign -->
         <xs:element name="viewAngle" type=" HeadingSlice" />
        <!-- Vehicle direction of travel while
         facing active side of sign -->
         <xs:element name="mutcdCode" type=" MUTCDCode"   minOccurs="0"/>
        <!-- Tag for MUTCD code or &quot;generic sign&quot; -->
         <xs:element name="crc" type=" MsgCRC"   minOccurs="0"/>
        <!-- Used to provide a check sum -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.52 Data Element: DF_RTCMHeader

Use: The DF_RTCMHeader data frame is a collection of data values used to convey RTCM information between users. It is encoded as an octet blob string.

ASN.1 Representation:

```
RTCMHeader ::= OCTET STRING (SIZE(5))
   -- defined as:
   -- SEQUENCE {
   -- status      GPSstatus,
                  -- to occupy 1 byte
   -- offsetSet   AntennaOffsetSet
                  -- to occupy 4 bytes
   -- }
```

XML Representation:

```
<xs:complexType name=" RTCMHeader" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             defined as:
             SEQUENCE  {
             status      GPSstatus,
             to occupy 1 byte
             offsetSet   AntennaOffsetSet
             to occupy 4 bytes
             }
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="RTCMHeader-string" >
          <xs:attribute name="EncodingType" use="required">
           <xs:simpleType>
              <xs:restriction base="xs:NMTOKEN">
                 <xs:enumeration value="base64Binary"/>
```

```
            </xs:restriction>
          </xs:simpleType>
        </xs:attribute>
      </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="RTCMHeader-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="7"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_RTCMPackage	<ASN>	<XML>, and
MSG	MSG_RTCM_Corrections (RTCM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.53 Data Frame: DF_RTCMmsg

Use: The DF_RTCMmsg 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.

ASN.1 Representation:

```
RTCMmsg ::= SEQUENCE {
   rev         RTCM-Revision OPTIONAL,
   rtcmID      RTCM-ID       OPTIONAL,
               -- the message and sub-message type, as
               -- defined in the RTCM revision being used
   payload     RTCM-Payload,
               -- the payload bytes
   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:complexType name=" RTCMmsg" >
      <xs:sequence>
         <xs:element name="rev" type=" RTCM-Revision"   minOccurs="0"/>
         <xs:element name="rtcmID" type=" RTCM-ID"   minOccurs="0"/>
        <!-- the message and sub-message type,  as
         defined in the RTCM revision being used -->
         <xs:element name="payload" type=" RTCM-Payload" />
        <!-- the payload bytes -->
         <xs:element name="localRTCMmsg" type="local:RTCMmsg" minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_RTCM_Corrections (RTCM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.54 Data Frame: DF_RTCMPackage

Use: The RTCMPackage data frame is 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.

ASN.1 Representation:

```
RTCMPackage ::= SEQUENCE {
    anchorPoint  FullPositionVector OPTIONAL,
    -- precise observer position, if needed

    rtcmHeader    RTCMHeader,
    -- an octet blob consisting of:
    -- one byte with:
    -- GPSstatus
    -- 4 bytes with:
    -- AntennaOffsetSet  containing x,y,z data

    -- note that a max of 16 satellites are allowed
    msg1001     OCTET STRING (SIZE(16..124))   OPTIONAL,
                -- pRange data GPS L1
    msg1002     OCTET STRING (SIZE(18..156))   OPTIONAL,
                -- pRange data GPS L1

    msg1003     OCTET STRING (SIZE(21..210))   OPTIONAL,
                 -- pRange data GPS L1, L2
    msg1004     OCTET STRING (SIZE(24..258))   OPTIONAL,
                 -- pRange data GPS L1, L2

    msg1005     OCTET STRING (SIZE(19))   OPTIONAL,
                -- observer station data
    msg1006     OCTET STRING (SIZE(21))   OPTIONAL,
                -- observer station data

    msg1007     OCTET STRING (SIZE(5..36))   OPTIONAL,
                -- antenna of observer station data
    msg1008     OCTET STRING (SIZE(6..68))   OPTIONAL,
                -- antenna of observer station data

    msg1009     OCTET STRING (SIZE(16..136))   OPTIONAL,
                 -- pRange data GLONASS L1
    msg1010     OCTET STRING (SIZE(18..166))   OPTIONAL,
                 -- pRange data GLONASS L1

    msg1011     OCTET STRING (SIZE(21..222))   OPTIONAL,
                 -- pRange data GLONASS L1, L2
    msg1012     OCTET STRING (SIZE(24..268))   OPTIONAL,
                 -- pRange data GLONASS L1, L2

    msg1013     OCTET STRING (SIZE(13..27))   OPTIONAL,
                 -- system parameters data

    ..., -- # LOCAL_CONTENT
    -- The below items shall never be sent
    -- over WSM stack encoding (other encodings may be used)
    -- and may be removed from the ASN

    msg1014     OCTET STRING (SIZE(15))   OPTIONAL,
                -- Network Aux Station (NAS) data
    msg1015     OCTET STRING (SIZE(13..69))   OPTIONAL,
                -- Ionospheric Correction data
    msg1016     OCTET STRING (SIZE(14..81))   OPTIONAL,
                -- Geometry Correction data
    msg1017     OCTET STRING (SIZE(16..115))   OPTIONAL,
                -- Combined Ionospheric and Geometry data

    -- msg1018 is reserved at this time

    msg1019     OCTET STRING (SIZE(62))   OPTIONAL,
```

```
            -- Satellite Ephermeris data
    msg1020     OCTET STRING (SIZE(45))   OPTIONAL,
            -- Satellite Ephermeris data
    msg1021     OCTET STRING (SIZE(62))   OPTIONAL,
            -- Helmert-Abridged Molodenski Transform data
    msg1022     OCTET STRING (SIZE(75))   OPTIONAL,
            -- Molodenski-Badekas Transform data
    msg1023     OCTET STRING (SIZE(73))   OPTIONAL,
            -- Ellipse Residuals data
    msg1024     OCTET STRING (SIZE(74))   OPTIONAL,
            -- Plane-Grid Residuals data
    msg1025     OCTET STRING (SIZE(25))   OPTIONAL,
            -- Non-Lab Conic Project data
    msg1026     OCTET STRING (SIZE(30))   OPTIONAL,
            -- Lab Conic Conform Project data
    msg1027     OCTET STRING (SIZE(33))   OPTIONAL,
            -- Ob Mercator Project data

    -- msg1028 is reserved at this time

    msg1029     OCTET STRING (SIZE(10..69))   OPTIONAL,
            -- Unicode test type data
    msg1030     OCTET STRING (SIZE(14..105))   OPTIONAL,
            -- GPS Residuals data
    msg1031     OCTET STRING (SIZE(15..107))   OPTIONAL,
            -- GLONASS Residuals data
    msg1032     OCTET STRING (SIZE(20))   OPTIONAL,
            -- Ref Station Position data

    -- Proprietary Data content (msg40xx to msg4095)
    -- may be added as needed

    ... -- # LOCAL_CONTENT
    }
```

XML Representation:

```
<xs:complexType name=" RTCMPackage" >
      <xs:sequence>
         <xs:element name="anchorPoint" type=" FullPositionVector"  minOccurs="0"/>
        <!-- precise observer position,  if needed -->
         <xs:element name="rtcmHeader" type=" RTCMHeader" />
        <!-- an octet blob consisting of:
        one byte with:
         GPSstatus
        4 bytes with:
         AntennaOffsetSet  containing x, y, z data
        note that a max of 16 satellites are allowed -->
         <xs:element name="msg1001"  minOccurs="0">
            <xs:complexType><xs:simpleContent>
               <xs:extension base="msg1001-string" >
                  <xs:attribute name="EncodingType" use="required">
                   <xs:simpleType>
                      <xs:restriction base="xs:NMTOKEN">
                        <xs:enumeration value="base64Binary"/>
                      </xs:restriction>
                   </xs:simpleType>
                  </xs:attribute>
               </xs:extension>
            </xs:simpleContent></xs:complexType>
         </xs:element>
        <!-- pRange data GPS L1 -->
         <xs:element name="msg1002"  minOccurs="0">
            <xs:complexType><xs:simpleContent>
               <xs:extension base="msg1002-string" >
                  <xs:attribute name="EncodingType" use="required">
                   <xs:simpleType>
                      <xs:restriction base="xs:NMTOKEN">
                        <xs:enumeration value="base64Binary"/>
                      </xs:restriction>
```

```
            </xs:simpleType>
          </xs:attribute>
        </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- pRange data GPS L1 -->
 <xs:element name="msg1003"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
      <xs:extension base="msg1003-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
      </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- pRange data GPS L1,  L2 -->
 <xs:element name="msg1004"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1004-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
     </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- pRange data GPS L1,  L2 -->
 <xs:element name="msg1005"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
      <xs:extension base="msg1005-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
      </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- observer station data -->
 <xs:element name="msg1006"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1006-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- observer station data -->
 <xs:element name="msg1007"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1007-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
```

```
            </xs:restriction>
          </xs:simpleType>
        </xs:attribute>
      </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- antenna of observer station data -->
 <xs:element name="msg1008"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
      <xs:extension base="msg1008-string" >
         <xs:attribute name="EncodingType" use="required">
          <xs:simpleType>
             <xs:restriction base="xs:NMTOKEN">
                <xs:enumeration value="base64Binary"/>
             </xs:restriction>
          </xs:simpleType>
        </xs:attribute>
      </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- antenna of observer station data -->
 <xs:element name="msg1009"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
      <xs:extension base="msg1009-string" >
         <xs:attribute name="EncodingType" use="required">
          <xs:simpleType>
             <xs:restriction base="xs:NMTOKEN">
                <xs:enumeration value="base64Binary"/>
             </xs:restriction>
          </xs:simpleType>
        </xs:attribute>
      </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- pRange data GLONASS L1 -->
 <xs:element name="msg1010"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
      <xs:extension base="msg1010-string" >
         <xs:attribute name="EncodingType" use="required">
          <xs:simpleType>
             <xs:restriction base="xs:NMTOKEN">
                <xs:enumeration value="base64Binary"/>
             </xs:restriction>
          </xs:simpleType>
        </xs:attribute>
      </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- pRange data GLONASS L1 -->
 <xs:element name="msg1011"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
      <xs:extension base="msg1011-string" >
         <xs:attribute name="EncodingType" use="required">
          <xs:simpleType>
             <xs:restriction base="xs:NMTOKEN">
                <xs:enumeration value="base64Binary"/>
             </xs:restriction>
          </xs:simpleType>
        </xs:attribute>
      </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- pRange data GLONASS L1,  L2 -->
<xs:element name="msg1012"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
      <xs:extension base="msg1012-string" >
         <xs:attribute name="EncodingType" use="required">
          <xs:simpleType>
             <xs:restriction base="xs:NMTOKEN">
```

```
                    <xs:enumeration value="base64Binary"/>
                  </xs:restriction>
                </xs:simpleType>
              </xs:attribute>
            </xs:extension>
          </xs:simpleContent></xs:complexType>
        </xs:element>
        <!-- pRange data GLONASS L1,  L2 -->
        <xs:element name="msg1013"  minOccurs="0">
          <xs:complexType><xs:simpleContent>
            <xs:extension base="msg1013-string" >
              <xs:attribute name="EncodingType" use="required">
                <xs:simpleType>
                  <xs:restriction base="xs:NMTOKEN">
                    <xs:enumeration value="base64Binary"/>
                  </xs:restriction>
                </xs:simpleType>
              </xs:attribute>
            </xs:extension>
          </xs:simpleContent></xs:complexType>
        </xs:element>
        <!-- system parameters data -->
        <!-- The below items shall never be sent
        over WSM stack encoding  (other encodings may be used)
        and may be removed from the ASN -->
        <xs:element name="localRTCMPackage" type="local:RTCMPackage" minOccurs="0"/>
        <xs:element name="msg1014"   minOccurs="0">
          <xs:complexType><xs:simpleContent>
            <xs:extension base="msg1014-string" >
              <xs:attribute name="EncodingType" use="required">
                <xs:simpleType>
                  <xs:restriction base="xs:NMTOKEN">
                    <xs:enumeration value="base64Binary"/>
                  </xs:restriction>
                </xs:simpleType>
              </xs:attribute>
            </xs:extension>
          </xs:simpleContent></xs:complexType>
        </xs:element>
        <!-- Network Aux Station  (NAS)  data -->
        <xs:element name="msg1015"  minOccurs="0">
          <xs:complexType><xs:simpleContent>
            <xs:extension base="msg1015-string" >
              <xs:attribute name="EncodingType" use="required">
                <xs:simpleType>
                  <xs:restriction base="xs:NMTOKEN">
                    <xs:enumeration value="base64Binary"/>
                  </xs:restriction>
                </xs:simpleType>
              </xs:attribute>
            </xs:extension>
          </xs:simpleContent></xs:complexType>
        </xs:element>
        <!-- Ionospheric Correction data -->
        <xs:element name="msg1016"   minOccurs="0">
          <xs:complexType><xs:simpleContent>
            <xs:extension base="msg1016-string" >
              <xs:attribute name="EncodingType" use="required">
                <xs:simpleType>
                  <xs:restriction base="xs:NMTOKEN">
                    <xs:enumeration value="base64Binary"/>
                  </xs:restriction>
                </xs:simpleType>
              </xs:attribute>
            </xs:extension>
          </xs:simpleContent></xs:complexType>
        </xs:element>
        <!-- Geometry Correction data -->
        <xs:element name="msg1017"  minOccurs="0">
```

```
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1017-string" >
          <xs:attribute name="EncodingType" use="required">
           <xs:simpleType>
              <xs:restriction base="xs:NMTOKEN">
                 <xs:enumeration value="base64Binary"/>
              </xs:restriction>
           </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- Combined Ionospheric and Geometry data
msg1018 is reserved at this time -->
 <xs:element name="msg1019"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1019-string" >
          <xs:attribute name="EncodingType" use="required">
           <xs:simpleType>
              <xs:restriction base="xs:NMTOKEN">
                 <xs:enumeration value="base64Binary"/>
              </xs:restriction>
           </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- Satellite Ephermeris data -->
 <xs:element name="msg1020"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1020-string" >
          <xs:attribute name="EncodingType" use="required">
           <xs:simpleType>
              <xs:restriction base="xs:NMTOKEN">
                 <xs:enumeration value="base64Binary"/>
              </xs:restriction>
           </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- Satellite Ephermeris data -->
 <xs:element name="msg1021"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1021-string" >
          <xs:attribute name="EncodingType" use="required">
           <xs:simpleType>
              <xs:restriction base="xs:NMTOKEN">
                 <xs:enumeration value="base64Binary"/>
              </xs:restriction>
           </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- Helmert-Abridged Molodenski Transform data -->
 <xs:element name="msg1022"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1022-string" >
          <xs:attribute name="EncodingType" use="required">
           <xs:simpleType>
              <xs:restriction base="xs:NMTOKEN">
                <xs:enumeration value="base64Binary"/>
              </xs:restriction>
           </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
```

```
<!-- Molodenski-Badekas Transform data -->
 <xs:element name="msg1023"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1023-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- Ellipse Residuals data -->
 <xs:element name="msg1024"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1024-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                 <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- Plane-Grid Residuals data -->
 <xs:element name="msg1025"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1025-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- Non-Lab Conic Project data -->
 <xs:element name="msg1026"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1026-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                 <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent></xs:complexType>
 </xs:element>
<!-- Lab Conic Conform Project data -->
 <xs:element name="msg1027"  minOccurs="0">
    <xs:complexType><xs:simpleContent>
       <xs:extension base="msg1027-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent></xs:complexType>
```

```
        </xs:element>
        <!-- Ob Mercator Project data
        msg1028 is reserved at this time -->
        <xs:element name="msg1029"  minOccurs="0">
            <xs:complexType><xs:simpleContent>
              <xs:extension base="msg1029-string" >
                 <xs:attribute name="EncodingType" use="required">
                   <xs:simpleType>
                      <xs:restriction base="xs:NMTOKEN">
                         <xs:enumeration value="base64Binary"/>
                      </xs:restriction>
                   </xs:simpleType>
                 </xs:attribute>
              </xs:extension>
            </xs:simpleContent></xs:complexType>
        </xs:element>
        <!-- Unicode test type data -->
        <xs:element name="msg1030"  minOccurs="0">
            <xs:complexType><xs:simpleContent>
              <xs:extension base="msg1030-string" >
                 <xs:attribute  name="EncodingType"  use="required">
                   <xs:simpleType>
                      <xs:restriction base="xs:NMTOKEN">
                         <xs:enumeration value="base64Binary"/>
                      </xs:restriction>
                   </xs:simpleType>
                 </xs:attribute>
              </xs:extension>
            </xs:simpleContent></xs:complexType>
        </xs:element>
        <!-- GPS Residuals data -->
        <xs:element name="msg1031"  minOccurs="0">
            <xs:complexType><xs:simpleContent>
              <xs:extension base="msg1031-string" >
                 <xs:attribute name="EncodingType" use="required">
                   <xs:simpleType>
                      <xs:restriction base="xs:NMTOKEN">
                         <xs:enumeration value="base64Binary"/>
                      </xs:restriction>
                   </xs:simpleType>
                 </xs:attribute>
              </xs:extension>
            </xs:simpleContent></xs:complexType>
        </xs:element>
        <!-- GLONASS Residuals data -->
        <xs:element name="msg1032"  minOccurs="0">
            <xs:complexType><xs:simpleContent>
              <xs:extension base="msg1032-string" >
                 <xs:attribute name="EncodingType" use="required">
                   <xs:simpleType>
                      <xs:restriction base="xs:NMTOKEN">
                         <xs:enumeration value="base64Binary"/>
                      </xs:restriction>
                   </xs:simpleType>
                 </xs:attribute>
              </xs:extension>
            </xs:simpleContent></xs:complexType>
        </xs:element>
        <!-- Ref Station Position data
        Proprietary Data content  (msg40xx to msg4095)
        may be added as needed -->
        <xs:element name="localRTCMPackage2" type="local:RTCMPackage2" minOccurs="0"/>
      </xs:sequence>
</xs:complexType>

        <xs:simpleType name="msg1001-string">
            <xs:restriction base="xs:base64Binary">
              <xs:minLength value="22"/>
              <xs:maxLength value="166"/>
```

```
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1002-string">
   <xs:restriction base="xs:base64Binary">
     <xs:minLength value="24"/>
      <xs:maxLength value="208"/>
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1003-string">
   <xs:restriction base="xs:base64Binary">
      <xs:minLength value="28"/>
      <xs:maxLength value="280"/>
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1004-string">
   <xs:restriction base="xs:base64Binary">
      <xs:minLength value="32"/>
      <xs:maxLength  value="344"/>
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1005-string">
   <xs:restriction base="xs:base64Binary">
      <xs:length value="26"/>
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1006-string">
   <xs:restriction base="xs:base64Binary">
      <xs:length value="28"/>
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1007-string">
   <xs:restriction base="xs:base64Binary">
      <xs:minLength value="7"/>
      <xs:maxLength value="48"/>
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1008-string">
   <xs:restriction base="xs:base64Binary">
      <xs:minLength value="8"/>
      <xs:maxLength value="91"/>
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1009-string">
  <xs:restriction base="xs:base64Binary">
      <xs:minLength value="22"/>
      <xs:maxLength value="182"/>
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1010-string">
   <xs:restriction base="xs:base64Binary">
      <xs:minLength value="24"/>
      <xs:maxLength value="222"/>
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1011-string">
   <xs:restriction base="xs:base64Binary">
      <xs:minLength value="28"/>
      <xs:maxLength value="296"/>
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1012-string">
   <xs:restriction base="xs:base64Binary">
     <xs:minLength  value="32"/>
      <xs:maxLength value="358"/>
   </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1013-string">
   <xs:restriction base="xs:base64Binary">
     <xs:minLength value="18"/>
```

```
      <xs:maxLength value="36"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1014-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="20"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1015-string">
    <xs:restriction base="xs:base64Binary">
      <xs:minLength value="18"/>
      <xs:maxLength value="92"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1016-string">
    <xs:restriction base="xs:base64Binary">
      <xs:minLength value="19"/>
      <xs:maxLength value="108"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1017-string">
    <xs:restriction base="xs:base64Binary">
      <xs:minLength value="22"/>
      <xs:maxLength value="154"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1019-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="83"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1020-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="60"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1021-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="83"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1022-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="100"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1023-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="98"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1024-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="99"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1025-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="34"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1026-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="40"/>
    </xs:restriction>
</xs:simpleType >
<xs:simpleType name="msg1027-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="44"/>
```

```
    </xs:restriction>
  </xs:simpleType >
  <xs:simpleType name="msg1029-string">
     <xs:restriction base="xs:base64Binary">
        <xs:minLength value="14"/>
        <xs:maxLength value="92"/>
     </xs:restriction>
  </xs:simpleType >
  <xs:simpleType name="msg1030-string">
     <xs:restriction base="xs:base64Binary">
        <xs:minLength value="19"/>
        <xs:maxLength value="140"/>
     </xs:restriction>
  </xs:simpleType >
  <xs:simpleType name="msg1031-string">
    <xs:restriction base="xs:base64Binary">
        <xs:minLength value="20"/>
        <xs:maxLength value="143"/>
     </xs:restriction>
  </xs:simpleType >
  <xs:simpleType name="msg1032-string">
     <xs:restriction base="xs:base64Binary">
        <xs:length value="27"/>
     </xs:restriction>
  </xs:simpleType >
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleSafetyExtension	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: The octets defined here shall be set in accordance with the presentation layer data values defined by RTCM 10403.1 and its successors.

6.55 Data Frame: DF_Sample

Use: Allows the Probe Management message to apply its settings to a random sample of vehicles (all vehicles within the stated range). This uses the last single digit of the current probe segment number (PSN) to determine if probe management is to be used. 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.

ASN.1 Representation:

```
Sample ::= SEQUENCE {
    sampleStart   INTEGER(0..255),    --  Sample Starting Point
    sampleEnd     INTEGER(0..255)     --  Sample Ending Point
    }
```

XML Representation:

```
<xs:complexType name=" Sample" >
      <xs:sequence>
         <xs:element name="sampleStart" >
            <xs:simpleType>
               <xs:restriction base="xs:unsignedByte"/>
            </xs:simpleType>
         </xs:element>
        <!--  Sample Starting Point -->
         <xs:element name="sampleEnd" >
            <xs:simpleType>
               <xs:restriction base="xs:unsignedByte"/>
            </xs:simpleType>
         </xs:element>
```

```
        <!--  Sample Ending Point -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_ProbeDataManagement (PDM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.56 Data Frame: DF_ShapePointSet

Use: The DF_ShapePointSet DF use used to represent a short segment of described roadway. It is typically employed to define a region where signs or advisories would be valid.

ASN.1 Representation:

```
ShapePointSet ::= SEQUENCE {
   anchor             Position3D      OPTIONAL,
   laneWidth          LaneWidth       OPTIONAL,
   directionality     DirectionOfUse OPTIONAL,
   nodeList           NodeList,       -- path details of the lane and width
   ...
   }
```

XML Representation:

```
<xs:complexType name=" ShapePointSet" >
      <xs:sequence>
         <xs:element name="anchor" type=" Position3D"   minOccurs="0"/>
         <xs:element name="laneWidth" type=" LaneWidth"   minOccurs="0"/>
         <xs:element name="directionality" type=" DirectionOfUse"   minOccurs="0"/>
         <xs:element name="nodeList" type=" NodeList" />
        <!-- path details of the lane and width -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ValidRegion	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.57 Data Frame: DF_SignalControlZone

Use: A data frame used to relate the geo-physical region zones of an intersection to a numbering system used for an approaching vehicle to assert a *preempt* to a signal system or to assert a *priority* request for a signal. The regions work together with the map intersection object to describe the intersections and what SignalReqScheme value is needed to control it to obtain a given movement state.

ASN.1 Representation:

```
SignalControlZone ::= SEQUENCE {
   name             DescriptiveName OPTIONAL,
                    -- used only for debugging
   pValue           SignalReqScheme,
                    -- preempt or priorty value (0..7),
                    -- and any strategy value to be used

   data             CHOICE {

         laneSet   SEQUENCE (SIZE(1..32)) OF  LaneNumber,
```

```
                -- a seq of of defined LaneNumbers,
                -- to be used with this p value
                -- see thier nodelists for paths

        zones    SEQUENCE (SIZE(1..32)) OF SEQUENCE {

            enclosed   SEQUENCE (SIZE(1..32)) OF  LaneNumber OPTIONAL,
                              -- lanes in this region
            laneWidth          LaneWidth   OPTIONAL,
            nodeList           NodeList,
                              -- path details of
                              -- the region starting from
                              -- the stop line
            ...
            }
            -- Note: unlike a nodelist for lanes,
            -- zones may overlap by a considerable degree
        },
    ... -- # LOCAL_CONTENT
    }
```

XML Representation:

```
<xs:complexType name=" SignalControlZone" >
      <xs:sequence>
         <xs:element name="name" type=" DescriptiveName"   minOccurs="0"/>
        <!-- used only for debugging -->
         <xs:element name="pValue" type=" SignalReqScheme" />
        <!-- preempt or priorty value  (0..7) ,
        and any strategy value to be used -->
         <xs:element name="data" >
            <xs:complexType>
               <xs:choice>
                  <xs:element name="laneSet" >
                     <xs:complexType>
                        <xs:sequence minOccurs="1" maxOccurs="32">
                           <xs:element name="laneSet-item" type=" LaneNumber" />
                          <!-- a seq of of defined LaneNumbers, to be used with this p
value see thier nodelists for paths -->
                        </xs:sequence>
                     </xs:complexType>
                  </xs:element>
                  <xs:element name="zones" >
                     <xs:complexType>
                        <xs:sequence minOccurs="1" maxOccurs="32">
                           <xs:element name="zone" >
                              <xs:complexType>
                                 <xs:sequence>
                                    <xs:element name="enclosed"  minOccurs="0">
                                       <xs:complexType>
                                          <xs:sequence minOccurs="1" maxOccurs="32">
                                             <xs:element name="enclosed-item" type="
 LaneNumber" />
                                             <!-- lanes in this region -->
                                          </xs:sequence>
                                       </xs:complexType>
                                    </xs:element>
                                    <xs:element name="laneWidth" type=" LaneWidth"
minOccurs="0"/>
                                    <xs:element name="nodeList" type=" NodeList" />
                                   <!-- path details of
                                    the region starting from
                                    the stop line -->
                                 </xs:sequence>
                              </xs:complexType>
                           </xs:element>
                          <!-- Note: unlike a nodelist for lanes, zones may overlap by a
considerable degree -->
                        </xs:sequence>
                     </xs:complexType>
```

```
                </xs:element>
              </xs:choice>
            </xs:complexType>
          </xs:element>
           <xs:element name="localSignalControlZone" type="local:SignalControlZone"
minOccurs="0"/>
        </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_Intersection	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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 signal control zone was created to cover both uses.

6.58 Data Frame: DF_SignalRequest

Use: The *SignalRequest* is used (as part of a request message) to request either a priority or a preemption service from a signalized intersection. It relates the intersection ID as well as the specific request (a value of 0~7 for the request and a value of 0~7 for the strategy requested - both in the SignalReqScheme data element). Additional information includes the approach and egress values or lanes to be used.

ASN.1 Representation:

```
SignalRequest ::= SEQUENCE {
   -- the regionally unique ID of the target intersection
   id      IntersectionID,  --  intersection ID

   -- Below present only when canceling a prior request
   isCancel    SignalReqScheme OPTIONAL,

   -- In typical use either a SignalReqScheme
   -- or a lane number would be given, this
   -- indicates the scheme to use or the
   -- path through the intersection
   -- to the degree it is known.
   -- Note that SignalReqScheme can hold either
   -- a preempt or a priority value.
    requestedAction   SignalReqScheme OPTIONAL,
                           --  preempt ID or the
                           --  priority ID
                           --   (and strategy)
   inLane       LaneNumber OPTIONAL,
                           --  approach Lane
   outLane      LaneNumber OPTIONAL,
                           --  egress Lane
   type         NTCIPVehicleclass,
                           --  Two 4 bit nibbles as:
                           --  NTCIP vehicle class type
                           --  NTCIP vehicle class level

   -- any validation string used by the system
   codeWord     CodeWord OPTIONAL,
   ...
   }
```

XML Representation:

```
<xs:complexType name=" SignalRequest" >
      <xs:sequence>
        <!-- the regionally unique ID of the target intersection -->
         <xs:element name="id" type=" IntersectionID" />
        <!-- intersection ID
```

```
            Below present only when canceling a prior request -->
             <xs:element name="isCancel" type=" SignalReqScheme"   minOccurs="0"/>
            <!-- In typical use either a  SignalReqScheme
            or a lane number would be given,  this
            indicates the scheme to use or the
            path through the intersection
            to the degree it is known.
            Note that  SignalReqScheme can hold either
            a preempt or a priority value. -->
             <xs:element name="requestedAction" type=" SignalReqScheme"  minOccurs="0"/>
            <!-- preempt ID or the
            priority ID
            (and strategy) -->
             <xs:element name="inLane" type=" LaneNumber"   minOccurs="0"/>
            <!-- approach Lane -->
             <xs:element name="outLane" type=" LaneNumber"   minOccurs="0"/>
            <!-- egress Lane -->
             <xs:element name="type" type=" NTCIPVehicleclass" />
            <!-- Two 4 bit nibbles as:
            NTCIP vehicle class type
            NTCIP vehicle class level
            any validation string used by the system -->
             <xs:element name="codeWord" type=" CodeWord"   minOccurs="0"/>
        </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_SignalRequestMessage (SRM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.59 Data Frame: DF_SnapshotDistance

Use: 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 D1, S1 and D2, S2 to be used by the OBU as follows:

- If speed is S1 then distance to next snapshot is D1
- If speed is S2 then distance to next snapshot is D2
- If speed is > S1 and < S2 then distance to snapshot is linearly interpolated between D1 and D2

If S1 is set to zero then the distance to the next snapshot is always D1.

ASN.1 Representation:

```
SnapshotDistance ::= SEQUENCE {
    d1    INTEGER(0..999),    -- meters
    s1    INTEGER(0..50),     -- meters\second
    d2    INTEGER(0..999),    -- meters
    s2    INTEGER(0..50)      -- meters\second
    }
```

XML Representation:

```
<xs:complexType name=" SnapshotDistance" >
        <xs:sequence>
           <xs:element name="d1" >
              <xs:simpleType>
                 <xs:restriction base="xs:unsignedShort">
                    <xs:maxInclusive value="999"/>
                 </xs:restriction>
              </xs:simpleType>
           </xs:element>
```

```
            <!-- meters -->
            <xs:element name="s1" >
               <xs:simpleType>
                  <xs:restriction base="xs:unsignedByte">
                     <xs:maxInclusive value="50"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:element>
            <!-- meters\second -->
            <xs:element name="d2" >
               <xs:simpleType>
                  <xs:restriction base="xs:unsignedShort">
                     <xs:maxInclusive value="999"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:element>
            <!-- meters -->
            <xs:element name="s2" >
               <xs:simpleType>
                  <xs:restriction base="xs:unsignedByte">
                     <xs:maxInclusive value="50"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:element>
            <!-- meters\second -->
         </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_ProbeDataManagement (PDM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.60 Data Frame: DF_Snapshot

Use: A report on one or more status elements in the vehicle which may have changed along with a set of position and heading elements representing the location of the report. Each report can contain status information from a number of defined vehicle devices.

ASN.1 Representation:

```
Snapshot ::= SEQUENCE {
   thePosition    FullPositionVector,
                  -- data of the position and speed,
   safetyExt      VehicleSafetyExtension OPTIONAL,
   datSet         VehicleStatus          OPTIONAL,
                  -- a seq of data frames
                  -- which encodes the data
  ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:complexType name=" Snapshot" >
      <xs:sequence>
         <xs:element name="thePosition" type=" FullPositionVector" />
         <!-- data of the position and speed, -->
         <xs:element name="safetyExt" type=" VehicleSafetyExtension" minOccurs="0"/>
         <xs:element name="datSet" type=" VehicleStatus"  minOccurs="0"/>
         <!-- a seq of data frames
         which encodes the data -->
         <xs:element name="localSnapshot" type="local:Snapshot" minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_ProbeVehicleData (PVD)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Either the VehicleSafetyExtension or the VehicleStatus must be present in the message.

6.61 Data Frame: DF_SnapshotTime

Use: To allow Network Users to change the snapshot collection policy based in elapsed time. Two times and two speeds are included in the message T1, S1 and T2, S2 to be used by the OBU as follows:

- If speed is S1 then time to next snapshot is T1 - default 20 mph (8.9 m/s) and 6 secs
- If speed is S2 then time to next snapshot is T2 - default 60 mph (26.8 m/s) and 20 secs
- If speed is > S1 and < S2 then time to snapshot is linearly interpolated between T1 and T2

If S1 is set to zero then the time to the next snapshot is always T1

ASN.1 Representation:

```
SnapshotTime ::= SEQUENCE {
    t1    INTEGER(1..99),
          -- m/sec - the instantaneous speed when the
          -- calculation is performed
    s1    INTEGER(0..50),
          -- seconds
    t2    INTEGER(1..99),
          -- m/sec - the instantaneous speed when the
          -- calculation is performed
    s2    INTEGER(0..50)
          -- seconds
    }
```

XML Representation:

```
<xs:complexType name=" SnapshotTime" >
      <xs:sequence>
         <xs:element name="t1" >
            <xs:simpleType>
               <xs:restriction base="xs:unsignedByte">
                  <xs:minInclusive value="1"/>
                  <xs:maxInclusive value="99"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:element>
         <!-- m/sec - the instantaneous speed when the
          calculation is performed -->
          <xs:element name="s1" >
            <xs:simpleType>
               <xs:restriction base="xs:unsignedByte">
                  <xs:maxInclusive value="50"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:element>
         <!-- seconds -->
          <xs:element name="t2" >
            <xs:simpleType>
               <xs:restriction base="xs:unsignedByte">
                 <xs:minInclusive value="1"/>
                  <xs:maxInclusive value="99"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:element>
```

```
            <!-- m/sec - the instantaneous speed when the
             calculation is performed -->
             <xs:element name="s2" >
                <xs:simpleType>
                    <xs:restriction base="xs:unsignedByte">
                       <xs:maxInclusive value="50"/>
                    </xs:restriction>
                </xs:simpleType>
             </xs:element>
            <!-- seconds -->
        </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_ProbeDataManagement (PDM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.62 Data Frame: DF_SpecialLane

Use: A SpecialLane data structure provides lane number, lane width and lane attributes within an approach structure for special types of lanes including lanes for use by trains (tracked vehicles) and transit vehicles. The SpecialLaneAttributes data elements denotes what general type of lane it is. The nodeList data element provide a detailed set of offset values to map the path of the lane. The keepOutList (which is optional) denotes any segments along the path where users of the path cannot safely stop.

ASN.1 Representation:

```
SpecialLane ::= SEQUENCE {
   laneNumber          LaneNumber,
   laneWidth           LaneWidth   OPTIONAL,
   laneAttributes      SpecialLaneAttributes,
   nodeList            NodeList,
                      -- path details of the lane and width
   keepOutList         NodeList OPTIONAL,
                      -- no stop points along the path
   connectsTo          ConnectsTo   OPTIONAL,
                      -- a list of other lanes and their
                      -- turning use by this lane
   ...
   }
```

XML Representation:

```
<xs:complexType name=" SpecialLane" >
       <xs:sequence>
          <xs:element name="laneNumber" type=" LaneNumber" />
          <xs:element name="laneWidth" type=" LaneWidth"   minOccurs="0"/>
          <xs:element name="laneAttributes" type=" SpecialLaneAttributes" />
          <xs:element name="nodeList" type=" NodeList" />
         <!-- path details of the lane and width -->
          <xs:element name="keepOutList" type=" NodeList"   minOccurs="0"/>
         <!-- no stop points along the path -->
          <xs:element name="connectsTo" type=" ConnectsTo"   minOccurs="0"/>
         <!-- a list of other lanes and their
          turning use by this lane -->
       </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and

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DF DF_Approach <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

6.63 Data Element: DF_Speed_Heading_Throttle_Confidence

Use: A single byte long data frame combining multiple related bit fields into one byte.

ASN.1 Representation:

```
SpeedandHeadingandThrottleConfidence ::= OCTET STRING (SIZE(1))
-- to be packed as follows:
-- SEQUENCE {
--    heading    HeadingConfidence,    -x- 3 bits
--    speed      SpeedConfidence,      -x- 3 bits
--    throttle   ThrottleConfidence    -x- 2 bits
--    }
```

XML Representation:

```
<xs:complexType name=" SpeedandHeadingandThrottleConfidence" >
    <xs:simpleContent>
      <xs:annotation>
         <xs:documentation>
            to be packed as follows:
            SEQUENCE  {
            heading    HeadingConfidence,     -x- 3 bits
            speed      SpeedConfidence,       -x- 3 bits
            throttle   ThrottleConfidence    -x- 2 bits
            }
         </xs:documentation>
      </xs:annotation>
       <xs:extension base="SpeedandHeadingandThrottleConfidence-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
      </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="SpeedandHeadingandThrottleConfidence-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="2"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

DF DF_ConfidenceSet <ASN> <XML>, and

DF DF_FullPositionVector <ASN> <XML>, and

DF DF_VehicleStatus <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

6.64 Data Frame: DF_TransmissionAndSpeed

Use: The vehicle DF_TransmissionAndSpeed shall be expressed as a speed value in unsigned units of 0.02 meters per second combined with a 3 bit transmission state data value to indicate the transmission state. The transmission data state value shall occupy the first three MSB of the

octets. The combined data concept shall occupy 2 bytes.

ASN.1 Representation:

```
TransmissionAndSpeed ::= OCTET STRING (SIZE(2))
    -- Bits 14~16 to be made up of the data element
    -- DE_TransmissionState
    -- Bits 1~13 to be made up of the data element
    -- DE_Speed
```

XML Representation:

```
<xs:complexType name=" TransmissionAndSpeed" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             bits 13~15 to be made up of the data element
             DE_TransmissionState
             bits 0~12 to be made up of the data element
             DE_Speed
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="TransmissionAndSpeed-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="TransmissionAndSpeed-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="3"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_FullPositionVector	<ASN>	<XML>, and
DF	DF_PathHistoryPointType-01	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.65 Data Frame: DF_ValidRegion

Use: The ValidRegion DF is used to describe one or more geographic locations to which a message (typically road signs or advisories of some sort) is applied or considered valid.

ASN.1 Representation:

```
ValidRegion ::= SEQUENCE {

   direction          HeadingSlice,
                      -- field of view over which this applies,
   extent             Extent OPTIONAL,
                      -- the spatial distance over which this
                      -- message applies and should be presented
                      -- to the driver
   area     CHOICE  {
      shapePointSet   ShapePointSet,
                      -- A short road segment
```

```
        circle          Circle,
                        -- A point and radius
        regionPointSet  RegionPointSet
                        -- Wide area enclosed regions
        }
    }
```

XML Representation:

```
<xs:complexType name=" ValidRegion" >
      <xs:sequence>
         <xs:element name="direction" type=" HeadingSlice" />
         <!-- field of view over which this applies, -->
          <xs:element name="extent" type=" Extent"   minOccurs="0"/>
         <!-- the spatial distance over which this
         message applies and should be presented
         to the driver -->
          <xs:element name="area" >
             <xs:complexType>
                <xs:choice>
                    <xs:element name="shapePointSet" type=" ShapePointSet" />
                   <!-- A short road segment -->
                    <xs:element name="circle" type=" Circle" />
                   <!-- A point and radius -->
                    <xs:element name="regionPointSet" type=" RegionPointSet" />
                   <!-- Wide area enclosed regions -->
                </xs:choice>
             </xs:complexType>
          </xs:element>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.66 Data Frame: DF_VehicleComputedLane

Use: A VehicleComputedLane data structure provides lane number, lane width and lane attributes within an approach structure for a drivable motorized vehicle lane. There is at least one ReferenceLane object present and may be zero or more ComputedLane objects as well in the enclosing Approach structure. Each ComputedLane references a ReferenceLane found in the same intersection and an laterals offset value to map the path of the lane.

ASN.1 Representation:

```
VehicleComputedLane  ::= SEQUENCE {
   laneNumber          LaneNumber,
   laneWidth           LaneWidth   OPTIONAL,
   laneAttributes      VehicleLaneAttributes   OPTIONAL,
                       -- if not present, same as ref lane
   refLaneNum          LaneNumber,
                       -- number of the ref lane to be used
   lineOffset          DrivenLineOffset,
   keepOutList         NodeList OPTIONAL,
                       -- no stop points along the path
   connectsTo          ConnectsTo   OPTIONAL,
                       -- a list of other lanes and their
                       -- turning use by this lane
   ...
   }
```

XML Representation:

```
<xs:complexType name=" VehicleComputedLane" >
```

```
        <xs:sequence>
           <xs:element name="laneNumber" type=" LaneNumber" />
           <xs:element name="laneWidth" type=" LaneWidth"   minOccurs="0"/>
          <xs:element name="laneAttributes" type=" VehicleLaneAttributes"  minOccurs="0"/>
          <!-- if not present,  same as ref lane -->
           <xs:element name="refLaneNum" type=" LaneNumber" />
          <!-- number of the ref lane to be used -->
           <xs:element name="lineOffset" type=" DrivenLineOffset" />
           <xs:element name="keepOutList" type=" NodeList"   minOccurs="0"/>
          <!-- no stop points along the path -->
           <xs:element name="connectsTo" type=" ConnectsTo"   minOccurs="0"/>
          <!-- a list of other lanes and their
           turning use by this lane -->
        </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_Approach	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: A Vehicle Computed Lane has its own lane number, width and attributes (see also the Reference Lane). The Reference Lane Number indicates which lane it parallels. The Driven Line Offset gives the distance between the computed lane with respect to.its reference lane. Lane Width indicates the width of the driven portion of the lane in decimeters. If the width is absent or set to zero, it is inherited from the Reference Lane.

6.67 Data Frame: DF_VehicleIdent

Use: The VehicleIdent data frame is used to provide identity information about a selected vehicle. This data frame is typical 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.

ASN.1 Representation:

```
VehicleIdent ::= SEQUENCE {
   name             DescriptiveName OPTIONAL,
                    -- a human readable name for debugging use
   vin              VINstring OPTIONAL,
                    -- vehicle VIN value
   ownerCode        IA5String(SIZE(1..32)) OPTIONAL,
                    -- vehicle owner code
   id               TemporaryID OPTIONAL,
                    -- same value used in the BSM

   vehicleType      VehicleType   OPTIONAL,
   vehicleClass     CHOICE
                    {
                    vGroup  ITIS.VehicleGroupAffected,
                    rGroup  ITIS.ResponderGroupAffected,
                    rEquip  ITIS.IncidentResponseEquipment
                    } OPTIONAL,
   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:complexType name=" VehicleIdent" >
        <xs:sequence>
           <xs:element name="name" type=" DescriptiveName"   minOccurs="0"/>
          <!-- a human readable name for debugging use -->
           <xs:element name="vin" type=" VINstring"   minOccurs="0"/>
          <!-- vehicle VIN value -->
```

```
            <xs:element  name="ownerCode"   minOccurs="0">
               <xs:simpleType>
                  <xs:restriction base="xs:string">
                     <xs:minLength value="1"/>
                     <xs:maxLength value="32"/>
                  </xs:restriction>
               </xs:simpleType>
            </xs:element>
            <!-- vehicle owner code -->
             <xs:element name="id" type=" TemporaryID"   minOccurs="0"/>
            <!-- same value used in the BSM -->
             <xs:element name="vehicleType" type=" VehicleType"   minOccurs="0"/>
             <xs:element name="vehicleClass"  minOccurs="0">
               <xs:complexType>
                  <xs:choice>
                     <xs:element name="vGroup" type=" itis:VehicleGroupAffected" />
                     <xs:element name="rGroup" type=" itis:ResponderGroupAffected" />
                     <xs:element name="rEquip" type=" itis:IncidentResponseEquipment" />
                  </xs:choice>
               </xs:complexType>
            </xs:element>
           <xs:element name="localVehicleIdent" type="local:VehicleIdent" minOccurs="0"/>
         </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 5 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>, and
MSG	MSG_ProbeVehicleData (PVD)	<ASN>	<XML>, and
MSG	MSG_SignalRequestMessage (SRM)	<ASN>	<XML>, and
MSG	MSG_SignalStatusMessage (SSM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.68 Data Frame: DF_VehicleReferenceLane

Use: A VehicleReferenceLane data structure provides lane number, lane width and lane attributes within an approach structure for a drivable lane for motor vehicles. There is typically at least one ReferenceLane present for each approach and may be zero or more VehicleComputedLane objects, barrier objects, and crosswalk objects as well in the enclosing approach structure. The nodeList provide a detailed set of offset values to map the path and width of the lane.

ASN.1 Representation:

```
VehicleReferenceLane  ::=  SEQUENCE  {
   laneNumber          LaneNumber,
   laneWidth           LaneWidth   OPTIONAL,
   laneAttributes      VehicleLaneAttributes,
   nodeList            NodeList,
                      -- path details of the lane and width
   keepOutList         NodeList OPTIONAL,
                      -- no stop points along the path
   connectsTo          ConnectsTo   OPTIONAL,
                      -- a list of other lanes and their
                      -- turning use by this lane
   ...
   }
```

XML Representation:

```
<xs:complexType name=" VehicleReferenceLane" >
      <xs:sequence>
```

```
        <xs:element name="laneNumber" type=" LaneNumber" />
        <xs:element  name="laneWidth"  type=" LaneWidth"   minOccurs="0"/>
        <xs:element name="laneAttributes" type=" VehicleLaneAttributes" />
        <xs:element name="nodeList" type=" NodeList" />
        <!-- path details of the lane and width -->
        <xs:element name="keepOutList" type=" NodeList"   minOccurs="0"/>
        <!-- no stop points along the path -->
        <xs:element name="connectsTo" type=" ConnectsTo"   minOccurs="0"/>
        <!-- a list of other lanes and their
        turning use by this lane -->
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_Approach	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.69 Data Frame: DF_VehicleSafetyExtension

Use: The VehicleSafetyExtension data frame is 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 BSM Part I at the same or reduced frequency (it is typically not present in every message).

ASN.1 Representation:

```
VehicleSafetyExtension ::= SEQUENCE {
   events               EventFlags      OPTIONAL,
   pathHistory          PathHistory     OPTIONAL,
   pathPrediction       PathPrediction OPTIONAL,
   theRTCM              RTCMPackage     OPTIONAL,
   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:complexType name=" VehicleSafetyExtension" >
      <xs:sequence>
         <xs:element name="events" type=" EventFlags"   minOccurs="0"/>
         <xs:element name="pathHistory" type=" PathHistory"   minOccurs="0"/>
         <xs:element name="pathPrediction" type=" PathPrediction"   minOccurs="0"/>
         <xs:element name="theRTCM" type=" RTCMPackage"   minOccurs="0"/>
         <xs:element name="localVehicleSafetyExtension"
type="local:VehicleSafetyExtension" minOccurs="0"/>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_Snapshot	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage (BSM)	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

6.70 Data Frame: DF_VehicleSize

Use: The VehicleSize is a data frame representing the vehicle length and vehicle width in a three byte value.

ASN.1 Representation:

```
VehicleSize ::= SEQUENCE {
   width      VehicleWidth,
   length     VehicleLength
   }  -- 3 bytes in length
```

XML Representation:

```
<xs:complexType name=" VehicleSize" >
       <xs:annotation>
          <xs:documentation>
             3 bytes in length
          </xs:documentation>
       </xs:annotation>
       <xs:sequence>
          <xs:element name="width" type=" VehicleWidth" />
          <xs:element name="length" type=" VehicleLength" />
       </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that besides the width and length, which are always present in the BSM Part I, other vehicle data, for example vehicle mass and bumper heights, can be included in Part II.

6.71 Data Frame: DF_VehicleStatusRequest

Use: The VehicleStatusRequest is used to request complex content along with threshold settings in the vehicle probe management process.

ASN.1 Representation:

```
VehicleStatusRequest ::= SEQUENCE {
   dataType               VehicleStatusDeviceTypeTag,
   subType                INTEGER (1..15)    OPTIONAL,
    sendOnLessThenValue   INTEGER (-32767..32767) OPTIONAL,
    sendOnMoreThenValue   INTEGER (-32767..32767) OPTIONAL,
   sendAll                BOOLEAN OPTIONAL,
   ...
   }
```

XML Representation:

```
<xs:complexType name=" VehicleStatusRequest" >
       <xs:sequence>
          <xs:element  name="dataType"  type=" VehicleStatusDeviceTypeTag" />
           <xs:element name="subType"  minOccurs="0">
              <xs:simpleType>
                  <xs:restriction base="xs:unsignedByte">
                     <xs:minInclusive value="1"/>
                     <xs:maxInclusive value="15"/>
                  </xs:restriction>
              </xs:simpleType>
           </xs:element>
           <xs:element name="sendOnLessThenValue"  minOccurs="0">
              <xs:simpleType>
                  <xs:restriction base="xs:short">
                     <xs:minInclusive value="-32767"/>
```

```
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="sendOnMoreThenValue"  minOccurs="0">
          <xs:simpleType>
            <xs:restriction base="xs:short">
              <xs:minInclusive value="-32767"/>
            </xs:restriction>
          </xs:simpleType>
        </xs:element>
        <xs:element name="sendAll"   minOccurs="0">
          <xs:simpleType>
            <xs:restriction base="xs:boolean"/>
          </xs:simpleType>
        </xs:element>
      </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_ProbeDataManagement (PDM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Range settings must match the range allowed by the subject data item. Units are as defined by the subject data item.

6.72 Data Frame: DF_VehicleStatus

Use: 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 a BSM 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 BSM 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 VehicleStatus instance and that this data follows the definition of each defined elsewhere.

ASN.1 Representation:

```
VehicleStatus ::= SEQUENCE {
   lights           ExteriorLights OPTIONAL,                -- Exterior Lights
   lightBar         LightbarInUse  OPTIONAL,                -- PS Lights

   wipers    SEQUENCE {
         statusFront     WiperStatusFront,
         rateFront       WiperRate,
         statusRear      WiperStatusRear       OPTIONAL,
         rateRear        WiperRate             OPTIONAL
         } OPTIONAL,                                        -- Wipers

   brakeStatus   BrakeSystemStatus OPTIONAL,
                 -- 2 bytes with the following in it:
                 --   wheelBrakes         BrakeAppliedStatus,
                 --                      -x- 4 bits
                 --   traction            TractionControlState,
                 --                      -x- 2 bits
                 --   abs                 AntiLockBrakeStatus,
                 --                      -x- 2 bits
                 --   scs                 StablityControlStatus,
                 --                      -x- 2 bits
                 --   brakeBoost          BrakeBoostApplied,
                 --                      -x- 2 bits
                 --   spareBits
```

```
                --                          -x- 4 bits
                -- Note that is present in BSM Part I
                                                        -- Braking Data
brakePressure     BrakeAppliedPressure  OPTIONAL,        -- Braking Pressure
roadFriction      CoefficientOfFriction OPTIONAL,        -- Roadway Friction


sunData           SunSensor             OPTIONAL,        -- Sun Sensor
rainData          RainSensor            OPTIONAL,        -- Rain Sensor
airTemp           AmbientAirTemperature OPTIONAL,        -- Air Temperature
airPres           AmbientAirPressure    OPTIONAL,        -- Air Pressure

steering    SEQUENCE {
      angle       SteeringWheelAngle,
      confidence  SteeringWheelAngleConfidence   OPTIONAL,
      rate        SteeringWheelAngleRateOfChange OPTIONAL,
      wheels      DrivingWheelAngle              OPTIONAL
      } OPTIONAL,                                       -- steering data

accelSets   SEQUENCE {
      accel4way        AccelerationSet4Way           OPTIONAL,
      vertAccelThres   VerticalAccelerationThreshold OPTIONAL,
                                                    -- Wheel Exceeded point
      yawRateCon       YawRateConfidence             OPTIONAL,
                                                    -- Yaw Rate Confidence
      hozAccelCon      AccelerationConfidence        OPTIONAL,
                                                    -- Acceleration Confidence
      confidenceSet    ConfidenceSet                 OPTIONAL
                                                    -- general ConfidenceSet
      } OPTIONAL,


object      SEQUENCE {
      obDist           ObstacleDistance,          -- Obstacle Distance
      obDirect         ObstacleDirection,         -- Obstacle Direction
      dateTime         DDateTime                  -- time detected
      } OPTIONAL,                                       -- detected Obstacle data


fullPos           FullPositionVector OPTIONAL,      -- complete set of time and
                                                    -- position, speed, heading
throttlePos       ThrottlePosition OPTIONAL,
speedHeadC        SpeedandHeadingandThrottleConfidence OPTIONAL,
speedC            SpeedConfidence OPTIONAL,

vehicleData    SEQUENCE {
      height          VehicleHeight,
      bumpers         BumperHeights,
      mass            VehicleMass,
      trailerWeight   TrailerWeight,
      type            VehicleType
      -- values for width and length are sent in BSM part I as well.
      } OPTIONAL,                                       -- vehicle data

vehicleIdent     VehicleIdent OPTIONAL,                 -- comm vehicle data

j1939data        J1939data OPTIONAL,           -- Various SAE J1938 data items

weatherReport SEQUENCE {
      isRaining          NTCIP.EssPrecipYesNo,
      rainRate           NTCIP.EssPrecipRate       OPTIONAL,
      precipSituation    NTCIP.EssPrecipSituation  OPTIONAL,
      solarRadiation     NTCIP.EssSolarRadiation   OPTIONAL,
      friction           NTCIP.EssMobileFriction   OPTIONAL
      } OPTIONAL,                                       -- local weather data

gpsStatus        GPSstatus          OPTIONAL,          -- vehicle's GPS
```

```
    ... -- # LOCAL_CONTENT OPTIONAL,
    }
```

XML Representation:

```
<xs:complexType name=" VehicleStatus" >
      <xs:sequence>
         <xs:element name="lights" type=" ExteriorLights"   minOccurs="0"/>
        <!-- Exterior Lights -->
         <xs:element name="lightBar" type=" LightbarInUse"   minOccurs="0"/>
        <!-- PS Lights -->
         <xs:element name="wipers"   minOccurs="0">
            <xs:complexType>
               <xs:sequence>
                  <xs:element name="statusFront" type=" WiperStatusFront" />
                  <xs:element name="rateFront" type=" WiperRate" />
                 <xs:element name="statusRear" type=" WiperStatusRear"  minOccurs="0"/>
                  <xs:element name="rateRear" type=" WiperRate"   minOccurs="0"/>
               </xs:sequence>
            </xs:complexType>
         </xs:element>
        <!-- Wipers -->
         <xs:element name="brakeStatus" type=" BrakeSystemStatus"   minOccurs="0"/>
        <!-- 2 bytes with the following in it:
        wheelBrakes          BrakeAppliedStatus,
        -x- 4 bits
        traction             TractionControlState,
        -x- 2 bits
        abs                  AntiLockBrakeStatus,
        -x- 2 bits
        scs                  StablityControlStatus,
        -x- 2 bits
        brakeBoost           BrakeBoostApplied,
        -x- 2 bits
        spareBits
        -x- 4 bits
        Note that is present in BSM Part I
        Braking Data -->
         <xs:element name="brakePressure" type=" BrakeAppliedPressure"  minOccurs="0"/>
        <!-- Braking Pressure -->
         <xs:element name="roadFriction" type=" CoefficientOfFriction"  minOccurs="0"/>
        <!-- Roadway Friction -->
         <xs:element name="sunData" type=" SunSensor"   minOccurs="0"/>
        <!-- Sun Sensor -->
         <xs:element name="rainData" type=" RainSensor"   minOccurs="0"/>
        <!-- Rain Sensor -->
         <xs:element name="airTemp" type=" AmbientAirTemperature"   minOccurs="0"/>
        <!-- Air Temperature -->
         <xs:element name="airPres" type=" AmbientAirPressure"   minOccurs="0"/>
        <!-- Air Pressure -->
         <xs:element name="steering"  minOccurs="0">
            <xs:complexType>
               <xs:sequence>
                  <xs:element name="angle" type=" SteeringWheelAngle" />
                 <xs:element  name="confidence"  type=" SteeringWheelAngleConfidence"
minOccurs="0"/>
                  <xs:element name="rate" type=" SteeringWheelAngleRateOfChange"
minOccurs="0"/>
                  <xs:element name="wheels" type=" DrivingWheelAngle"  minOccurs="0"/>
               </xs:sequence>
            </xs:complexType>
         </xs:element>
        <!-- steering data -->
         <xs:element name="accelSets"  minOccurs="0">
            <xs:complexType>
               <xs:sequence>
                  <xs:element name="accel4way" type=" AccelerationSet4Way"
minOccurs="0"/>
                 <xs:element name="vertAccelThres" type=" VerticalAccelerationThreshold"
minOccurs="0"/>
```

```
                  <!-- Wheel Exceeded point -->
                   <xs:element name="yawRateCon" type=" YawRateConfidence"
minOccurs="0"/>
                  <!-- Yaw Rate Confidence -->
                   <xs:element name="hozAccelCon" type=" AccelerationConfidence"
minOccurs="0"/>
                  <!--  Acceleration Confidence -->
                  <xs:element name="confidenceSet" type=" ConfidenceSet"  minOccurs="0"/>
                   <!-- general  ConfidenceSet -->
                </xs:sequence>
             </xs:complexType>
          </xs:element>
          <xs:element name="object"  minOccurs="0">
             <xs:complexType>
                <xs:sequence>
                   <xs:element name="obDist" type=" ObstacleDistance" />
                  <!--  Obstacle Distance -->
                   <xs:element name="obDirect" type=" ObstacleDirection" />
                  <!--  Obstacle Direction -->
                   <xs:element name="dateTime" type=" DDateTime" />
                  <!--  time detected -->
                </xs:sequence>
             </xs:complexType>
          </xs:element>
          <!--  detected Obstacle data -->
           <xs:element name="fullPos" type=" FullPositionVector"   minOccurs="0"/>
          <!--  complete set of time and
          position,  speed,  heading -->
           <xs:element name="throttlePos" type=" ThrottlePosition"   minOccurs="0"/>
           <xs:element name="speedHeadC" type=" SpeedandHeadingandThrottleConfidence"
minOccurs="0"/>
           <xs:element name="speedC" type=" SpeedConfidence"   minOccurs="0"/>
           <xs:element name="vehicleData"  minOccurs="0">
             <xs:complexType>
                <xs:sequence>
                   <xs:element name="height" type=" VehicleHeight" />
                   <xs:element name="bumpers" type=" BumperHeights" />
                   <xs:element name="mass" type=" VehicleMass" />
                   <xs:element name="trailerWeight" type=" TrailerWeight" />
                   <xs:element name="type" type=" VehicleType" />
                  <!-- values for width and length are sent in BSM part I as well. -->
                </xs:sequence>
             </xs:complexType>
          </xs:element>
          <!--  vehicle data -->
           <xs:element name="vehicleIdent" type=" VehicleIdent"   minOccurs="0"/>
          <!--  comm vehicle data -->
           <xs:element name="j1939data" type=" J1939data"   minOccurs="0"/>
          <!--  Various SAE J1938 data items -->
           <xs:element name="weatherReport"  minOccurs="0">
             <xs:complexType>
                <xs:sequence>
                   <xs:element name="isRaining" type=" ntcip:EssPrecipYesNo" />
                   <xs:element name="rainRate" type=" ntcip:EssPrecipRate"
minOccurs="0"/>
                   <xs:element name="precipSituation" type=" ntcip:EssPrecipSituation"
minOccurs="0"/>
                   <xs:element name="solarRadiation" type=" ntcip:EssSolarRadiation"
minOccurs="0"/>
                   <xs:element name="friction" type=" ntcip:EssMobileFriction"
minOccurs="0"/>
                </xs:sequence>
             </xs:complexType>
          </xs:element>
          <!--  local weather data -->
           <xs:element name="gpsStatus" type=" GPSstatus"   minOccurs="0"/>
          <!--  vehicle&apos;s GPS -->
        <xs:element name="localVehicleStatus" type="local:VehicleStatus" minOccurs="0"/>
       </xs:sequence>
```

```
</xs:complexType>
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_Snapshot	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage (BSM)	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: See also the VehicleSafetyExtension data frame for additional content.

6.73 Data Frame: DF_WiperStatus

Use: The current status of the wiper systems on the subject vehicle, including front and rear wiper systems (where equipped)

ASN.1 Representation:

```
WiperStatus ::= SEQUENCE {
   statusFront      WiperStatusFront,
   rateFront        WiperRate,
   statusRear       WiperStatusRear       OPTIONAL,
   rateRear         WiperRate             OPTIONAL
   }
```

XML Representation:

```
<xs:complexType name=" WiperStatus" >
       <xs:sequence>
          <xs:element name="statusFront" type=" WiperStatusFront" />
         <xs:element  name="rateFront"  type=" WiperRate" />
          <xs:element name="statusRear" type=" WiperStatusRear"   minOccurs="0"/>
          <xs:element name="rateRear" type=" WiperRate"   minOccurs="0"/>
       </xs:sequence>
</xs:complexType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that when the state changes an event flag may be raised in the BSM and this data frame may be transmitted in Part II of that message to relate the new state.

7. Data Elements

This section defines the precise structure the data elements defined by this standard. The DSRC 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 unless expressly marked otherwise. Definitions for this message set are presented in the following subclauses. The ASN.1 is presented in a section titled ASN.1 Representation. The equivalent XML expression is presented in a section titled XML Representation

which follows the translation rule set cited in Clause Two (SAE Standard J2630). Should the two sections conflict in some way, the ASN.1 expression 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. The XML productions follow directly from the ASN.1 specifications and the same rules shall be applied. Users of this standard seeking to be in conformance with it shall follow the normative text outlined here.

7.1 Data Element: DE_Acceleration

Use: A data element representing the signed acceleration of the vehicle along some known axis in units of 0.01 meters per second squared. A range of over 2Gs is supported. Accelerations in the directions of forward and to the right are taken as positive. A 2 byte long value when sent.

Longitudinal acceleration is the acceleration along the X axis or the vehicle's direction of travel in parallel with a front to rear centerline. Negative values indicate braking action.

Lateral acceleration is the acceleration along the Y axis or perpendicular to the vehicle's direction of travel in parallel with a left-to right centerline. Negative values indicate left turning action and positive values indicate right-turning action.

ASN.1 Representation:

```
Acceleration ::= INTEGER (-2000..2001)
    -- LSB units are 0.01 m/s^2
   -- the value 2000 shall be used for values greater than 2000
   -- the value -2000 shall be used for values less than -2000
   -- a value of 2001 shall be used for Unavailable
```

XML Representation:

```
<xs:simpleType name=" Acceleration" >
       <xs:annotation>
          <xs:documentation>
             LSB units are 0.01 m/s^2
             the value 2000 shall be used for values greater than 2000
             the value -2000 shall be used for values less than -2000
             a value of 2001 shall be used for Unavailable
          </xs:documentation>
       </xs:annotation>
       <xs:restriction base="xs:short">
          <xs:minInclusive value="-2000"/>
          <xs:maxInclusive value="2001"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The upper four bits of this 2 byte value are reserved and should not be used.

7.2 Data Element: DE_AccelerationConfidence

Use: This DE is used to provide the confidence interval of the 95% confidence level for the currently reported value of DE_Acceleration, taking into account the current calibration and precision of the sensor(s) used to measure and/or calculate the value. This data element is only to provide the listener with information on the limitations of the sensing system; not to support any type of automatic error correction or to imply a guaranteed maximum error. This data element should not be used for fault detection or

diagnosis, but if a vehicle is able to detect a fault, the confidence interval should be increased accordingly.

The frame of references and axis of rotation used shall be accordance with that defined in SAE J670, Issued 1976-07 and its successors. Note the definitions provided in Figure 1 (Tire Axis System) and Figure 2 (Directional Control Axis Systems).

ASN.1 Representation:

```
AccelerationConfidence ::= ENUMERATED {
    unavailable   (0), -- B'000   Not Equipped or data is unavailable
    accl-100-00   (1), -- B'001   100  meters / second squared
    accl-010-00   (2), -- B'010   10   meters / second squared
    accl-005-00   (3), -- B'011   5    meters / second squared
    accl-001-00   (4), -- B'100   1    meters / second squared
    accl-000-10   (5), -- B'101   0.1  meters / second squared
    accl-000-05   (6), -- B'110   0.05 meters / second squared
    accl-000-01   (7)  -- B'111   0.01 meters / second squared
    }
    -- Encoded as a 3 bit value
```

XML Representation:

```
<xs:simpleType name=" AccelerationConfidence" >
       <xs:annotation>
          <xs:appinfo>
             unavailable (0) -- B&apos;000   Not Equipped or data is unavailable
             accl 100 00 (1) -- B&apos;001   100  meters / second squared
             accl 010 00 (2) -- B&apos;010   10   meters / second squared
             accl 005 00 (3) -- B&apos;011   5    meters / second squared
             accl 001 00 (4) -- B&apos;100   1    meters / second squared
             accl 000 10 (5) -- B&apos;101   0.1  meters / second squared
             accl 000 05 (6) -- B&apos;110   0.05 meters / second squared
             accl 000 01 (7) -- B&apos;111   0.01 meters / second squared
          </xs:appinfo>
          <xs:documentation>
             Encoded as a 3 bit value
           </xs:documentation>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
              <xs:restriction base="xs:unsignedInt">
                 <xs:minInclusive value="0"/>
                  <xs:maxInclusive value="7"/>
              </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
              <xs:restriction base="xs:string">
                  <xs:enumeration value="unavailable"/>
                 <xs:enumeration value="accl 100 00"/>
                  <xs:enumeration value="accl 010 00"/>
                  <xs:enumeration value="accl 005 00"/>
                  <xs:enumeration value="accl 001 00"/>
                  <xs:enumeration value="accl 000 10"/>
                 <xs:enumeration value="accl 000 05"/>
                  <xs:enumeration value="accl 000 01"/>
              </xs:restriction>
          </xs:simpleType >
       </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AccelSteerYawRateConfidence	<ASN>	<XML>, and
DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.3 Data Element: DE_AmbientAirPressure (Barometric Pressure)

Use: This data element is used to relate the measured Ambient Pressure (Barometric Pressure) from a vehicle or other device. The value of zero shall be used when not equipped. The value of one indicates a pressure of 580 hPa.

ASN.1 Representation:

```
AmbientAirPressure ::= INTEGER (0..255)
   -- 8 Bits in hPa starting at 580 with a resolution of
   -- 2 hPa resulting in a range of 580 to 1090
```

XML Representation:

```
<xs:simpleType name=" AmbientAirPressure" >
       <xs:annotation>
          <xs:documentation>
             8 Bits in hPa starting at 580 with a resolution of
             2 hPa resulting in a range of 580 to 1090
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedByte"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Definition: The pressure exerted by the weight of the earth's atmosphere, equal to one bar, 100 kilopascals, or 14.7 psi (often rounded off to 15 psi) at sea level. Barometric 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.

Note that 1 kPa = 10 hPa,

To convert pounds per square inch to kilopascals, multiply the PSI value by 6.894757293168361.

To convert kilopascals to pounds per square inch, multiply the kpa value by .14503773773020923.

7.4 Data Element: DE_AmbientAirTemperature

Use: This data element is used to relate the measured Ambient Air Temperature from a vehicle or other device. Its measurement range and precision follows that defined by the relevant ODB-II standards. This provides for a precision of one degree centigrade and a range of -40 to +150 degrees encoded in a one byte value. The value of -40 deg C is encoded as zero and every degree above that increments the transmitted value by one resulting in a transmission range of 0 to 191. Hence, a measurement value representing 25 degrees centigrade is transmitted as 40+25=65 or Hex 0x41.

ASN.1 Representation:

```
AmbientAirTemperature ::= INTEGER (0..191) -- in deg C with a -40 offset
```

XML Representation:

```
<xs:simpleType name=" AmbientAirTemperature" >
       <xs:annotation>
          <xs:documentation>
             in deg C with a -40 offset
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedByte">
          <xs:maxInclusive value="191"/>
       </xs:restriction>
```

```
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.5 Data Element: DE_AntiLockBrakeStatus

Use: The DE_AntiLockBrakeStatus data element conveys in two bits the state of the sender's anti-lock braking system. The four defined states are: Vehicle not equipped with anti-lock braking system (00), an anti-lock braking system is off (01), an anti-lock braking system is on but not engaged (10), and an anti-lock braking system is on and engaged (11). 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 involving a specific vehicle or road location.

ASN.1 Representation:

```
AntiLockBrakeStatus  ::=  ENUMERATED  {
    unavailable  (0), -- B'00   Vehicle Not Equipped with ABS
                      -- or ABS status is unavailable
    off          (1), -- B'01   Vehicle's ABS is Off
    on           (2), -- B'10   Vehicle's ABS is On (but not engaged)
    engaged      (3)  -- B'11   Vehicle's ABS is Engaged
    }
    -- Encoded as a 2 bit value
```

XML Representation:

```
<xs:simpleType name=" AntiLockBrakeStatus" >
       <xs:annotation>
          <xs:appinfo>
             unavailable (0) -- B&apos;00  Vehicle Not Equipped with ABS
              -- or ABS status is unavailable
             off (1) -- B&apos;01  Vehicle&apos;s ABS is Off
             on (2) -- B&apos;10  Vehicle&apos;s ABS is On  (but not engaged)
             engaged (3) -- B&apos;11  Vehicle&apos;s ABS is Engaged
          </xs:appinfo>
          <xs:documentation>
             Encoded as a 2 bit value
           </xs:documentation>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
              <xs:restriction base="xs:unsignedInt">
                 <xs:minInclusive value="0"/>
                 <xs:maxInclusive value="3"/>
              </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
              <xs:restriction base="xs:string">
                 <xs:enumeration value="unavailable"/>
                 <xs:enumeration value="off"/>
                 <xs:enumeration value="on"/>
                 <xs:enumeration value="engaged"/>
              </xs:restriction>
          </xs:simpleType >
       </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

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Remarks: The value for notEquipped shall be used when data is not available.

7.6 Data Element: DE_ApproachNumber

Use: The ApproachNumber data concept conveys a unique index value for an approach or an egress in an intersection for the convenience of human users. It is typically used along with an optional human readable string name for the object. Note the ApproachNumber is not used in numbering the lanes, refer to the LaneNumber data element and the ApproachesObject data structure for a description of how indexing works.

ASN.1 Representation:

```
ApproachNumber  ::=  INTEGER  (0..127)
```

XML Representation:

```
<xs:simpleType name=" ApproachNumber" >
       <xs:restriction base="xs:unsignedByte">
          <xs:maxInclusive value="127"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_Approach	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.7 Data Element: DE_AuxiliaryBrakeStatus

Use: The AuxiliaryBrakeStatus data element conveys in two bits the state of the sender's Auxiliary Brake system (often also called a parking brake). The three defined states are: Vehicle not equipped (00), Aux Brake not applied (01), and Aux Brake System applied (10). The state 11 is reserved.

ASN.1 Representation:

```
AuxiliaryBrakeStatus  ::=  ENUMERATED  {
    unavailable  (0), -- B'00   Vehicle Not Equipped with Aux Brakes
                      -- or Aux Brakes status is unavailable
    off          (1), -- B'01   Vehicle's Aux Brakes are Off
    on           (2), -- B'10   Vehicle's Aux Brakes are On  ( Engaged )
    reserved     (3)  -- B'11
    }
    -- Encoded as a 2 bit value
```

XML Representation:

```
<xs:simpleType name=" AuxiliaryBrakeStatus" >
       <xs:annotation>
          <xs:appinfo>
             unavailable (0) -- B&amp;apos;00  Vehicle Not Equipped with Aux Brakes
             -- or Aux Brakes status is unavailable
             off (1) -- B&amp;apos;01  Vehicle&amp;apos;s Aux Brakes are Off
             on (2) -- B&amp;apos;10  Vehicle&amp;apos;s Aux Brakes are On  ( Engaged )
             reserved (3) -- B&amp;apos;11
          </xs:appinfo>
          <xs:documentation>
             Encoded as a 2 bit value
          </xs:documentation>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
             <xs:restriction base="xs:unsignedInt">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="3"/>
```

```
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unavailable"/>
               <xs:enumeration value="off"/>
               <xs:enumeration value="on"/>
               <xs:enumeration value="reserved"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The value for notEquipped shall be used when data is not available.

7.8 Data Element: DE_BarrierAttributes

Use: The BarrierAttributes data element relates the type of barrier being described. A barrier in this context is any described lane style of object which normal vehicle traffic can or cannot transverse.

ASN.1 Representation:

```
BarrierAttributes ::= INTEGER (0..8192)
-- With bits as defined:
   noData                    BarrierAttributes ::= 0
                             -- ('0000-0000-0000-0000'B)
   median                    BarrierAttributes ::= 1
                             -- ('0000-0000-0000-0001'B)
   whiteLine                 BarrierAttributes ::= 2
                             -- ('0000-0000-0000-0010'B)
   strippedLines             BarrierAttributes ::= 4
                             -- ('0000-0000-0000-0100'B)
   doubleStrippedLines       BarrierAttributes ::= 8
                             -- ('0000-0000-0000-1000'B)
   trafficCones              BarrierAttributes ::= 16
                             -- ('0000-0000-0001-0000'B)
   constructionBarrier       BarrierAttributes ::= 32
                             -- ('0000-0000-0010-0000'B)
   trafficChannels           BarrierAttributes ::= 64
                             -- ('0000-0000-0100-0000'B)
   noCurbs                   BarrierAttributes ::= 128
                             -- ('0000-0000-1000-0000'B)
   lowCurbs                  BarrierAttributes ::= 256
                             -- ('0000-0000-1000-0000'B)
   highCurbs                 BarrierAttributes ::= 512
                             -- ('0000-0001-0000-0000'B)
   hovDoNotCross             BarrierAttributes ::= 1024
                             -- ('0000-0010-0000-0000'B)
   hovEntryAllowed           BarrierAttributes ::= 2048
                             -- ('0000-0100-0000-0000'B)
   hovExitAllowed            BarrierAttributes ::= 4096
                             -- ('0000-1000-0000-0000'B)
```

XML Representation:

```
<xs:simpleType name=" BarrierAttributes" >
      <xs:annotation>
         <xs:documentation>
            With bits as defined:
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="8192"/>
      </xs:restriction>
</xs:simpleType>
```


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Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_BarrierLane	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.9 Data Element: DE_BrakeAppliedPressure

Use: The applied pressure of the vehicle brake system.

ASN.1 Representation:

```
BrakeAppliedPressure  ::= ENUMERATED {
    unavailable   (0),  -- B'0000 Not Equipped
                        -- or Brake Pres status is unavailable
    minPressure   (1),  -- B'0001 Minimum Braking Pressure
    bkLvl-2       (2),  -- B'0010
    bkLvl-3       (3),  -- B'0011
    bkLvl-4       (4),  -- B'0100
    bkLvl-5       (5),  -- B'0101
    bkLvl-6       (6),  -- B'0110
    bkLvl-7       (7),  -- B'0111
    bkLvl-8       (8),  -- B'1000
    bkLvl-9       (9),  -- B'1001
    bkLvl-10      (10), -- B'1010
    bkLvl-11      (11), -- B'1011
    bkLvl-12      (12), -- B'1100
    bkLvl-13      (13), -- B'1101
    bkLvl-14      (14), -- B'1110
    maxPressure   (15)  -- B'1111 Maximum Braking Pressure
    }
    -- Encoded as a 4 bit value
```

XML Representation:

```
<xs:simpleType name=" BrakeAppliedPressure" >
      <xs:annotation>
         <xs:appinfo>
            unavailable (0) -- B&apos;0000 Not Equipped
             -- or Brake Pres status is unavailable
            minPressure (1) -- B&apos;0001 Minimum Braking Pressure
            bkLvl 2 (2) -- B&apos;0010
            bkLvl 3 (3) -- B&apos;0011
            bkLvl 4 (4) -- B&apos;0100
            bkLvl 5 (5) -- B&apos;0101
            bkLvl 6 (6) -- B&apos;0110
            bkLvl 7 (7) -- B&apos;0111
            bkLvl 8 (8) -- B&apos;1000
            bkLvl 9 (9) -- B&apos;1001
            bkLvl 10 (10) -- B&apos;1010
            bkLvl 11 (11) -- B&apos;1011
            bkLvl 12 (12) -- B&apos;1100
            bkLvl 13 (13) -- B&apos;1101
            bkLvl 14 (14) -- B&apos;1110
            maxPressure (15) -- B&apos;1111 Maximum Braking Pressure
         </xs:appinfo>
         <xs:documentation>
            Encoded as a 4 bit value
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
             <xs:restriction base="xs:unsignedInt">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="15"/>
             </xs:restriction>
```

```
            </xs:simpleType>
            <xs:simpleType>
               <xs:restriction base="xs:string">
                   <xs:enumeration value="unavailable"/>
                   <xs:enumeration value="minPressure"/>
                   <xs:enumeration value="bkLvl 2"/>
                   <xs:enumeration value="bkLvl 3"/>
                  <xs:enumeration  value="bkLvl  4"/>
                   <xs:enumeration value="bkLvl 5"/>
                   <xs:enumeration value="bkLvl 6"/>
                   <xs:enumeration value="bkLvl 7"/>
                   <xs:enumeration value="bkLvl 8"/>
                   <xs:enumeration value="bkLvl  9"/>
                   <xs:enumeration value="bkLvl 10"/>
                   <xs:enumeration value="bkLvl 11"/>
                   <xs:enumeration value="bkLvl 12"/>
                   <xs:enumeration value="bkLvl 13"/>
                   <xs:enumeration value="bkLvl 14"/>
                   <xs:enumeration value="maxPressure"/>
               </xs:restriction>
            </xs:simpleType >
         </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.10 Data Element: DE_BrakeAppliedStatus

Use: The Brake Applied Status data element indicates independently for each of 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. If a vehicle has more than two front wheels (respectively more than two rear wheels) with independent braking, the collective brake-applied status of these wheels is mapped to the Left Front and Right Front (respectively Left Rear and Right Rear) indicators in a locally defined manner. Brake Applied Status could be used by a traffic management center to determine that an incident has occurred or congestion may be present. It is possible for some vehicles to provide an indication of how hard the braking action, this is handled in another data element (DE_BrakeAppliedPressure).

ASN.1 Representation:

```
BrakeAppliedStatus ::= BIT STRING {
   allOff       (0), -- B'0000   The condition All Off
   leftFront    (1), -- B'0001   Left Front Active
   leftRear     (2), -- B'0010   Left Rear Active
   rightFront   (4), -- B'0100   Right Front Active
   rightRear    (8)  -- B'1000   Right Rear Active
   } -- to fit in 4 bits
```

XML Representation:

```
<xs:simpleType name="BrakeAppliedStatus-item" >
      <xs:annotation>
         <xs:appinfo>
            allOff (0) -- B&apos;0000   The condition All Off
            leftFront (1) -- B&apos;0001   Left Front Active
```

```
            leftRear (2) -- B&amp;apos;0010  Left Rear Active
            rightFront (4) -- B&amp;apos;0100  Right Front Active
            rightRear (8) -- B&amp;apos;1000  Right Rear Active
         </xs:appinfo>
         <xs:documentation>
            to fit in 4 bits
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:int">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="8"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="allOff"/>
               <xs:enumeration value="leftFront"/>
               <xs:enumeration value="leftRear"/>
               <xs:enumeration value="rightFront"/>
               <xs:enumeration value="rightRear"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
<xs:simpleType name=" BrakeAppliedStatus">
    <xs:list itemType="BrakeAppliedStatus-item"/>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: On vehicles with only 2 wheels, the left side values shall be used and the right side set to zero. Deployments may wish to define additional combinations such as "all on" here.

7.11 Data Element: DE_BrakeBoostApplied

Use: 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 even 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 re activation 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.

ASN.1 Representation:

```
BrakeBoostApplied ::= ENUMERATED {
    unavailable    (0), -- Vehicle not equipped with brake boost
                        -- or brake boost data is unavailable
    off            (1), -- Vehicle's brake boost is off
    on             (2)  -- Vehicle's brake boost is on (applied)
    }
    -- Encoded as a 2 bit value
```

XML Representation:

```
<xs:simpleType name=" BrakeBoostApplied" >
      <xs:annotation>
         <xs:appinfo>
            unavailable (0) -- Vehicle not equipped with brake boost
             -- or brake boost data is unavailable
            off (1) -- Vehicle&amp;apos;s brake boost is off
            on (2) -- Vehicle&amp;apos;s brake boost is on  (applied)
```

```
            </xs:appinfo>
            <xs:documentation>
               Encoded as a 2 bit value
            </xs:documentation>
         </xs:annotation>
         <xs:union>
            <xs:simpleType>
               <xs:restriction base="xs:unsignedInt">
                  <xs:minInclusive value="0"/>
                  <xs:maxInclusive value="2"/>
               </xs:restriction>
            </xs:simpleType>
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:enumeration value="unavailable"/>
                  <xs:enumeration value="off"/>
                  <xs:enumeration value="on"/>
               </xs:restriction>
            </xs:simpleType >
         </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

7.12 Data Element: DE_BumperHeightFront

Use: The DE_Bumper Height Front 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.

ASN.1 Representation:

```
BumperHeightFront ::= INTEGER (0..127) -- in units of 0.01 meters from ground surface.
```

XML Representation:

```
<xs:simpleType name=" BumperHeightFront" >
      <xs:annotation>
         <xs:documentation>
            in units of 0.01 meters from ground surface.
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedByte">
          <xs:maxInclusive value="127"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_BumperHeights	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.13 Data Element: DE_BumperHeightRear

Use: The DE_Bumper Height Rear 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.

ASN.1 Representation:

```
BumperHeightRear ::= INTEGER (0..127) -- in units of 0.01 meters from ground surface.
```

XML Representation:
```
<xs:simpleType name=" BumperHeightRear" >
       <xs:annotation>
          <xs:documentation>
             in units of 0.01 meters from ground surface.
          </xs:documentation>
       </xs:annotation>
       <xs:restriction base="xs:unsignedByte">
          <xs:maxInclusive value="127"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_BumperHeights	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.14 Data Element: DE_CodeWord

Use: The DE_CodeWord 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.

ASN.1 Representation:
```
CodeWord ::= OCTET STRING (SIZE(1..16))
   -- any octect string up to 16 bytes
```

XML Representation:
```
<xs:complexType name=" CodeWord" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             any octect string up to 16 bytes
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="CodeWord-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="CodeWord-string">
    <xs:restriction base="xs:base64Binary">
       <xs:minLength value="2"/>
       <xs:maxLength value="22"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_SignalRequest	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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7.15 Data Element: DE_CoefficientOfFriction

Use: Coefficient of Friction of an object, typical a wheel in contact with the ground. This DE is typically used in sets where the value of each wheel is provided in turn as a measure of relative local traction.

ASN.1 Representation:

```
CoefficientOfFriction ::= INTEGER (0..50)
   -- where 0 = 0.00 micro (frictonless)
   -- and 50 = 0.98 micro, in steps of 0.02
```

XML Representation:

```
<xs:simpleType name=" CoefficientOfFriction" >
       <xs:annotation>
          <xs:documentation>
             where 0 = 0.00 micro  (frictonless)
             and 50 = 0.98 micro,  in steps of 0.02
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedByte">
           <xs:maxInclusive value="50"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.16 Data Element: DE_ColorState

Use: An enumerated state representing what the color and flashing state of a signal light is (regardless of any directional indication or arrow that may also be associated with that light). Typically used in an array to represent signal lights.

ASN.1 Representation:

```
ColorState ::= ENUMERATED {
   dark             (0),  -- (B0000) Dark, lights inactive
   green            (1),  -- (B0001)
   green-flashing   (9),  -- (B1001)

   yellow           (2),  -- (B0010)
   yellow-flashing (10), -- (B1010)

   red              (4),  -- (B0100)
   red-flashing     (12)  -- (B1100)

   } -- a 4 bit encoded value
     -- note that above may be combined
     -- to create additonal patterns
```

XML Representation:

```
<xs:simpleType name=" ColorState" >
       <xs:annotation>
          <xs:appinfo>
             dark (0) -- (B0000)  Dark ,
             green (1) -- (B0001)
             green flashing (9) -- (B1001)
             yellow (2) -- (B0010)
             yellow flashing (10) -- (B1010)
             red (4) -- (B0100)
             red flashing (12) -- (B1100)
          </xs:appinfo>
          <xs:documentation>
```

```
            a 4 bit encoded value
            note that above may be combined
            to create additonal patterns
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="12"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="dark"/>
               <xs:enumeration value="green"/>
               <xs:enumeration value="green flashing"/>
               <xs:enumeration value="yellow"/>
               <xs:enumeration value="yellow flashing"/>
               <xs:enumeration value="red"/>
               <xs:enumeration value="red flashing"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: Used inside the SignalState data value for each direction supported. Note that because multiple lights can be illuminated at the same time under odd conditions, this is supported.

7.17 Data Element: DE_Count

Use: The DE_Count data element provides a count of items to follow in the message.

ASN.1 Representation:

```
Count ::= INTEGER (0..32)
```

XML Representation:

```
<xs:simpleType name=" Count" >
      <xs:restriction base="xs:unsignedByte">
        <xs:maxInclusive value="32"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 5 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_PathHistory	<ASN>	<XML>, and
MSG	MSG_ProbeDataManagement (PDM)	<ASN>	<XML>, and
MSG	MSG_ProbeVehicleData (PVD)	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.18 Data Element: DE_CrosswalkLaneAttributes

Use: The CrosswalkLaneAttributes data element relates the type of cross walk that is being described. The

term cross walk lane in this standard is generic and may include such items as a bicycle crossings and other non-motorized uses.

ASN.1 Representation:

```
CrosswalkLaneAttributes ::= ENUMERATED {
   noData                      (0),    -- ('0000000000000000'B)
   twoWayPath                  (1),    -- ('0000000000000001'B)
   pedestrianCrosswalk         (2),    -- ('0000000000000010'B)
   bikeLane                    (4),    -- ('0000000000000100'B)
   railRoadTrackPresent        (8),    -- ('0000000000001000'B)
   oneWayPathOfTravel          (16),   -- ('0000000000010000'B)
   pedestrianCrosswalkTypeA    (32),   -- ('0000000000100000'B)
   pedestrianCrosswalkTypeB    (64),   -- ('0000000001000000'B)
   pedestrianCrosswalkTypeC    (128)   -- ('0000000010000000'B)
   }
   -- MUTCD provides no real "types" to use here
```

XML Representation:

```
<xs:simpleType name=" CrosswalkLaneAttributes" >
      <xs:annotation>
         <xs:appinfo>
            noData (0) -- (&apos;0000000000000000&apos;B)
            twoWayPath (1) -- (&apos;0000000000000001&apos;B)
            pedestrianCrosswalk (2) -- (&apos;0000000000000010&apos;B)
            bikeLane (4) -- (&apos;0000000000000100&apos;B)
            railRoadTrackPresent (8) -- (&apos;0000000000001000&apos;B)
            oneWayPathOfTravel (16) -- (&apos;0000000000010000&apos;B)
            pedestrianCrosswalkTypeA (32) -- (&apos;0000000000100000&apos;B)
            pedestrianCrosswalkTypeB (64) -- (&apos;0000000001000000&apos;B)
            pedestrianCrosswalkTypeC (128) -- (&apos;0000000010000000&apos;B)
         </xs:appinfo>
         <xs:documentation>
            MUTCD provides no real &amp;quot;types&amp;quot; to use here
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="128"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="noData"/>
               <xs:enumeration value="twoWayPath"/>
               <xs:enumeration value="pedestrianCrosswalk"/>
               <xs:enumeration value="bikeLane"/>
               <xs:enumeration value="railRoadTrackPresent"/>
               <xs:enumeration value="oneWayPathOfTravel"/>
               <xs:enumeration value="pedestrianCrosswalkTypeA"/>
               <xs:enumeration value="pedestrianCrosswalkTypeB"/>
               <xs:enumeration value="pedestrianCrosswalkTypeC"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_CrosswalkLane	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.19 Data Element: DE_DDay

Use: The DSRC style day is a simple value consisting of integer values from zero to 31. The value of zero shall represent an unknown value.

ASN.1 Representation:
```
DDay ::= INTEGER (0..31)  -- units of days
```

XML Representation:
```
<xs:simpleType name=" DDay" >
       <xs:annotation>
          <xs:documentation>
             units of days
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedByte">
           <xs:maxInclusive value="31"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 5 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_DDate	<ASN>	<XML>, and
DF	DF_DDateTime	<ASN>	<XML>, and
DF	DF_DFullTime	<ASN>	<XML>, and
DF	DF_DMonthDay	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.20 Data Element: DE_DescriptiveName

Use: The DescriptiveName data concept is used in maps and intersections to provide an (optional) human readable name for the feature that follows. It is typically used only when debugging a data flow, as this information is not useful to the actual application at this time.

ASN.1 Representation:
```
DescriptiveName ::= IA5String (SIZE(1..63))
```

XML Representation:
```
<xs:simpleType name=" DescriptiveName" >
        <xs:restriction base="xs:string">
           <xs:minLength value="1"/>
           <xs:maxLength value="63"/>
        </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 9 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_Approach	<ASN>	<XML>, and
DF	DF_Intersection	<ASN>	<XML>, and
DF	DF_IntersectionState	<ASN>	<XML>, and
DF	DF_MovementState	<ASN>	<XML>, and
DF	DF_SignalControlZone	<ASN>	<XML>, and

DF	DF_VehicleIdent	<ASN>	<XML>, and
MSG	MSG_MapData (MAP)	<ASN>	<XML>, and
MSG	MSG_SignalPhaseAndTiming Message (SPAT)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.21 Data Element: DE_DHour

Use: 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.

ASN.1 Representation:
```
DHour ::= INTEGER (0..31) -- units of hours
```

XML Representation:
```
<xs:simpleType name=" DHour" >
      <xs:annotation>
         <xs:documentation>
            units of hours
         </xs:documentation>
      </xs:annotation>
      <xs:restriction base="xs:unsignedByte">
         <xs:maxInclusive value="31"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_DDateTime	<ASN>	<XML>, and
DF	DF_DFullTime	<ASN>	<XML>, and
DF	DF_DTime	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.22 Data Element: DE_DirectionOfUse

Use: The allowed direction of travel on a street lane or path described by shape points. The presumed (default) direction is outward, away from the initial set of points. However this data element can be used to overcome that and indicate a reverse direction or both directions as well as the original outward direction.

ASN.1 Representation:
```
DirectionOfUse ::= ENUMERATED {
   forward     (0), -- direction of travel follows node ordering
   reverse     (1), -- direction of travel is the reverse of node ordering
   both        (2), -- direction of travel allowed in both directions
   ...
   }
```

XML Representation:
```
<xs:simpleType name=" DirectionOfUse" >
      <xs:annotation>
         <xs:appinfo>
            forward (0) -- direction of travel follows node ordering
            reverse (1) -- direction of travel is the reverse of node ordering
            both (2) -- direction of travel allowed in both directions
         </xs:appinfo>
      </xs:annotation>
      <xs:union>
```

```
            <xs:simpleType>
               <xs:restriction base="xs:unsignedInt">
                  <xs:minInclusive value="0"/>
                  <xs:maxInclusive value="2"/>
               </xs:restriction>
            </xs:simpleType>
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:enumeration value="forward"/>
                  <xs:enumeration value="reverse"/>
                  <xs:enumeration value="both"/>
               </xs:restriction>
            </xs:simpleType >
         </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ShapePointSet	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.23 Data Element: DE_DMinute

Use: The DSRC style minute is a simple value consisting of integer values from zero to 59 representing the minutes within an hour. The value of 63 SHALL represent an unknown value, the range 60 to 62 is reserved.

ASN.1 Representation:

```
DMinute ::= INTEGER (0..63) -- units of minutes
```

XML Representation:

```
<xs:simpleType name=" DMinute" >
      <xs:annotation>
         <xs:documentation>
            units of minutes
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedByte">
          <xs:maxInclusive value="63"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_DDateTime	<ASN>	<XML>, and
DF	DF_DFullTime	<ASN>	<XML>, and
DF	DF_DTime	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.24 Data Element: DE_DMonth

Use: The DSRC style month is a simple value consisting of integer values from one to 12 representing the month within a year. The value of 15 SHALL represent an unknown value. The range 13 to 14 and the

value zero are all reserved.

ASN.1 Representation:

```
DMonth ::= INTEGER (0..15) -- units of months
```

XML Representation:

```
<xs:simpleType name=" DMonth" >
       <xs:annotation>
          <xs:documentation>
             units of months
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedByte">
          <xs:maxInclusive value="15"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 6 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_DDate	<ASN>	<XML>, and
DF	DF_DDateTime	<ASN>	<XML>, and
DF	DF_DFullTime	<ASN>	<XML>, and
DF	DF_DMonthDay	<ASN>	<XML>, and
DF	DF_DYearMonth	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.25 Data Element: DE_DOffset

Use: The DSRC style (time zone) offset is a simple value consisting of a signed integer representing an hour and minute value set from -14:00 to +14:00 representing all the worlds local time zones in units of minutes. The value of zero (00:00) may represent an unknown value. Note some time zones are do not align to hourly boundaries.

ASN.1 Representation:

```
DOffset ::= INTEGER (-840..840) -- units of minutes from UTC time
```

XML Representation:

```
<xs:simpleType name=" DOffset" >
       <xs:annotation>
          <xs:documentation>
             units of minutes from UTC time
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:short">
          <xs:minInclusive value="-840"/>
           <xs:maxInclusive value="840"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

7.26 Data Element: DE_DrivenLineOffset

Use: The DrivenLineOffset 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, independent of any width values. The units are a signed value with an LSB of 1 cm.

ASN.1 Representation:

```
DrivenLineOffset ::= INTEGER (-32767..32767)
   -- LSB units are 1 cm.
```

XML Representation:

```
<xs:simpleType name=" DrivenLineOffset" >
       <xs:annotation>
          <xs:documentation>
             LSB units are 1 cm.
          </xs:documentation>
       </xs:annotation>
       <xs:restriction base="xs:short">
          <xs:minInclusive value="-32767"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleComputedLane	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.27 Data Element: DE_DrivingWheelAngle

Use: The angle of the front (steering) wheel, expressed in a signed (to the right being positive) value with 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). A value of zero shall be sent when unavailable.

ASN.1 Representation:

```
DrivingWheelAngle ::= INTEGER (-127..127)
   -- LSB units of 0.3333 degrees.
   -- a range of 42.33 degrees each way
```

XML Representation:

```
<xs:simpleType name=" DrivingWheelAngle" >
       <xs:annotation>
          <xs:documentation>
             LSB units of 0.3333 degrees.
             a range of 42.33 degrees each way
          </xs:documentation>
       </xs:annotation>
       <xs:restriction base="xs:byte">
          <xs:minInclusive value="-127"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.28 Data Element: DE_DSecond

Use: The DSRC style second expressed in this data element is a simple value consisting of integer values

from zero to 60999 representing the milliseconds within a minute. A leap second is represented by the value range 60001 to 60999. The value of 65535 SHALL represent an unavailable value in the range of the minute, other values from 61000 to 65534 are reserved.

ASN.1 Representation:

```
DSecond ::= INTEGER (0..65535) -- units of miliseconds
```

XML Representation:

```
<xs:simpleType name=" DSecond" >
      <xs:annotation>
         <xs:documentation>
            units of miliseconds
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedShort"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 5 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_DDateTime	<ASN>	<XML>, and
DF	DF_DTime	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>, and
MSG	MSG_IntersectionCollisionAvoidance (ICA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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 BSM). 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. Here is a useful reference on this topic: http://tycho.usno navy.mil/leapsec html

7.29 Data Element: DE_DSignalSeconds

Use: The DSRC style of signal seconds is a simple value consisting of an integer value from zero to 30,000 representing a time value of from 0 to 300 seconds in 10 millisecond units from the moment the message is issued.. The other values SHALL represent an unknown value, and are reserved at this time.

ASN.1 Representation:

```
DSignalSeconds ::= INTEGER (0..30000) -- units of 0.01 seconds
```

XML Representation:

```
<xs:simpleType name=" DSignalSeconds" >
      <xs:annotation>
         <xs:documentation>
            units of 0.01 seconds
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="30000"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: An unknown or indeterminate value shall be set to zero.

7.30 Data Element: DE_DSRC_MessageID

Use: The DSRC Message ID is a data element used in each message to define which type of message follows from the message set defined by this Standard. This data element is always the first value inside the message and is used to tell the receiving application how to interpret the remaining bytes (i.e. what message structure has been used).

ASN.1 Representation:

```
DSRCmsgID ::= ENUMERATED {
   reserved                          (0),
   alaCarteMessage                   (1),  -- ACM
   basicSafetyMessage                (2),  -- BSM, heartbeat msg
   basicSafetyMessageVerbose         (3),  -- used for testing only
    commonSafetyRequest              (4),  -- CSR
   emergencyVehicleAlert             (5),  -- EVA
    intersectionCollisionAlert       (6),  -- ICA
   mapData                           (7),  -- MAP, GID, intersections
   nmeaCorrections                   (8),  -- NMEA
    probeDataManagement              (9),  -- PDM
   probeVehicleData                  (10), -- PVD
   roadSideAlert                     (11), -- RSA
   rtcmCorrections                   (12), -- RTCM
    signalPhaseAndTimingMessage      (13), -- SPAT
   signalRequestMessage              (14), -- SRM
   signalStatusMessage               (15), -- SSM
   travelerInformation               (16), -- TIM

   ... -- # LOCAL_CONTENT
   }
   -- values to 127 reserved for std use
   -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" DSRCmsgID" >
      <xs:annotation>
         <xs:appinfo>
            reserved (0)
            alaCarteMessage (1) -- ACM
            basicSafetyMessage (2) -- BSM ,
             basicSafetyMessageVerbose (3) -- used for testing only
             commonSafetyRequest (4) -- CSR
             emergencyVehicleAlert (5) -- EVA
             intersectionCollisionAlert (6) -- ICA
            mapData (7) -- MAP ,
            nmeaCorrections (8) -- NMEA
            probeDataManagement (9) -- PDM
            probeVehicleData (10) -- PVD
            roadSideAlert (11) -- RSA
            rtcmCorrections (12) -- RTCM
             signalPhaseAndTimingMessage (13) --  SPAT
             signalRequestMessage (14) -- SRM
             signalStatusMessage (15) -- SSM
             travelerInformation (16) -- TIM
         </xs:appinfo>
         <xs:documentation>
            values to 127 reserved for std use
            values 128 to 255 reserved for local use
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
             <xs:restriction base="xs:unsignedInt">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="16"/>
            </xs:restriction>
```

```
            </xs:simpleType>
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:enumeration value="reserved"/>
                  <xs:enumeration value="alaCarteMessage"/>
                  <xs:enumeration value="basicSafetyMessage"/>
                  <xs:enumeration value="basicSafetyMessageVerbose"/>
                  <xs:enumeration value="commonSafetyRequest"/>
                  <xs:enumeration value="emergencyVehicleAlert"/>
                  <xs:enumeration value="intersectionCollisionAlert"/>
                  <xs:enumeration value="mapData"/>
                  <xs:enumeration value="nmeaCorrections"/>
                  <xs:enumeration value="probeDataManagement"/>
                 <xs:enumeration value="probeVehicleData"/>
                  <xs:enumeration value="roadSideAlert"/>
                  <xs:enumeration value="rtcmCorrections"/>
                  <xs:enumeration value="signalPhaseAndTimingMessage"/>
                 <xs:enumeration value="signalRequestMessage"/>
                  <xs:enumeration value="signalStatusMessage"/>
                  <xs:enumeration value="travelerInformation"/>
               </xs:restriction>
            </xs:simpleType >
            <xs:simpleType>
               <xs:restriction base="local:DSRCmsgID" />
            </xs:simpleType>
         </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 17 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_A_la_Carte (ACM)	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage (BSM)	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>, and
MSG	MSG_CommonSafetyRequest (CSR)	<ASN>	<XML>, and
MSG	MSG_EmergencyVehicleAlert (EVA)	<ASN>	<XML>, and
MSG	MSG_IntersectionCollisionAvoidance (ICA)	<ASN>	<XML>, and
MSG	MSG_MapData (MAP)	<ASN>	<XML>, and
MSG	MSG_NMEA_Corrections (NMEA)	<ASN>	<XML>, and
MSG	MSG_ProbeDataManagement (PDM)	<ASN>	<XML>, and
MSG	MSG_ProbeVehicleData (PVD)	<ASN>	<XML>, and
MSG	MSG_RoadSideAlert (RSA)	<ASN>	<XML>, and
MSG	MSG_RTCM_Corrections (RTCM)	<ASN>	<XML>, and
MSG	MSG_SignalPhaseAndTiming Message (SPAT)	<ASN>	<XML>, and
MSG	MSG_SignalRequestMessage (SRM)	<ASN>	<XML>, and
MSG	MSG_SignalStatusMessage (SSM)	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note: The three letter abbreviations shown in the ASN comments are sometimes used as

shorthand terms for the subject messages in the documentation.

7.31 Data Element: DE_DYear

Use: 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. The value of zero SHALL represent an unknown value.

ASN.1 Representation:
```
DYear ::= INTEGER (0..9999) -- units of years
```

XML Representation:
```
<xs:simpleType name=" DYear" >
      <xs:annotation>
         <xs:documentation>
            units of years
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="9999"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 6 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_DDate	<ASN>	<XML>, and
DF	DF_DDateTime	<ASN>	<XML>, and
DF	DF_DFullTime	<ASN>	<XML>, and
DF	DF_DYearMonth	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.32 Data Element: DE_ElevationConfidence

Use: This DE is used to provide the confidence interval of the 95% confidence level for the currently reported value of DE_Elevation, taking into account the current calibration and precision of the sensor(s) used to measure and/or calculate the value. This data element is only to provide the listener with information on the limitations of the sensing system; not to support any type of automatic error correction or to imply a guaranteed maximum error. This data element should not be used for fault detection or diagnosis, but if a vehicle is able to detect a fault, the confidence interval should be increased accordingly.

The frame of references and axis of rotation used shall be accordance with that defined in SAE J670, Issued 1976-07 and its successors. Note the definitions provided in Figure 1 (Tire Axis System) and Figure 2 (Directional Control Axis Systems).

ASN.1 Representation:
```
ElevationConfidence ::= ENUMERATED {
    unavailable (0),   -- B'0000   Not Equipped or unavailable
    elev-500-00 (1),   -- B'0001   (500 m)
    elev-200-00 (2),   -- B'0010   (200 m)
    elev-100-00 (3),   -- B'0011   (100 m)
    elev-050-00 (4),   -- B'0100   (50 m)
    elev-020-00 (5),   -- B'0101   (20 m)
    elev-010-00 (6),   -- B'0110   (10 m)
    elev-005-00 (7),   -- B'0111   (5 m)
    elev-002-00 (8),   -- B'1000   (2 m)
```

```
    elev-001-00 (9),  -- B'1001  (1 m)
    elev-000-50 (10), -- B'1010  (50 cm)
    elev-000-20 (11), -- B'1011  (20 cm)
    elev-000-10 (12), -- B'1100  (10 cm)
    elev-000-05 (13), -- B'1101  (5 cm)
    elev-000-02 (14), -- B'1110  (2 cm)
    elev-000-01 (15)  -- B'1111  (1 cm)
    }
    -- Encoded as a 4 bit value
```

XML Representation:

```
<xs:simpleType name=" ElevationConfidence" >
      <xs:annotation>
         <xs:appinfo>
            unavailable (0) -- B&apos;0000  Not Equipped or unavailable
            elev 500 00 (1) -- B&apos;0001   (500 m)
            elev 200 00 (2) -- B&apos;0010   (200 m)
            elev 100 00 (3) -- B&apos;0011   (100 m)
            elev 050 00 (4) -- B&apos;0100   (50 m)
            elev 020 00 (5) -- B&apos;0101   (20 m)
            elev 010 00 (6) -- B&apos;0110   (10 m)
            elev 005 00 (7) -- B&apos;0111   (5 m)
            elev 002 00 (8) -- B&apos;1000   (2 m)
            elev 001 00 (9) -- B&apos;1001   (1 m)
            elev 000 50 (10) -- B&apos;1010   (50 cm)
            elev 000 20 (11) -- B&apos;1011   (20 cm)
            elev 000 10 (12) -- B&apos;1100   (10 cm)
            elev 000 05 (13) -- B&apos;1101   (5 cm)
            elev 000 02 (14) -- B&apos;1110   (2 cm)
            elev 000 01 (15) -- B&apos;1111   (1 cm)
         </xs:appinfo>
         <xs:documentation>
            Encoded as a 4 bit value
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="15"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unavailable"/>
               <xs:enumeration value="elev 500 00"/>
               <xs:enumeration value="elev 200 00"/>
               <xs:enumeration value="elev 100 00"/>
               <xs:enumeration value="elev 050 00"/>
               <xs:enumeration value="elev 020 00"/>
               <xs:enumeration value="elev 010 00"/>
               <xs:enumeration value="elev 005 00"/>
               <xs:enumeration value="elev 002 00"/>
               <xs:enumeration value="elev 001 00"/>
               <xs:enumeration value="elev 000 50"/>
               <xs:enumeration value="elev 000 20"/>
               <xs:enumeration value="elev 000 10"/>
               <xs:enumeration value="elev 000 05"/>
               <xs:enumeration value="elev 000 02"/>
               <xs:enumeration value="elev 000 01"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

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7.33 Data Element: DE_Elevation

Use: The Elevation data element represents the geographic position above or below the reference ellipsoid (typically WSG-84). The 16-bit number has a resolution of 1 decimeter and represents an asymmetric range of positive and negative values. The encoding is as follows: the range 0x0000 to 0xEFFF (0 to 61439 decimal) are positive numbers representing elevations from 0 to +6143.9 meters, i.e. above the reference ellipsoid. The range 0xF001 to 0xFFFF are negative numbers representing elevations from -409.5 meters to -0.1 meters, i.e. below the reference ellipsoid. An elevation higher than +6143.9 meters is represented 0xEFFF. An elevation lower than -409.5 meters is represented 0xF001. If the sending device does not know its elevation it shall encode the Elevation data element with 0xF000.

Examples of this encoding are: the elevation 0 meters is encoded as 0x0000. The elevation -0.1 meters is encoded as 0xFFFF. The elevation +100.0 meters is encoded as 0x03E8.

ASN.1 Representation:

```
Elevation ::= OCTET STRING (SIZE(2))
   -- 1 decimeter LSB (10 cm)
   -- Encode elevations from 0 to 6143.9 meters
   -- above the reference ellipsoid as 0x0000 to 0xEFFF.
   -- Encode elevations from -409.5 to -0.1 meters,
   -- i.e. below the reference ellipsoid, as 0xF001 to 0xFFFF
   -- unknown as 0xF000
```

XML Representation:

```
<xs:complexType name=" Elevation" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             1 decimeter LSB  (10 cm)
             Encode elevations from 0 to 6143.9 meters
             above the reference ellipsoid as 0x0000 to 0xEFFF.
             Encode elevations from -409.5 to -0.1 meters,
             i.e. below the reference ellipsoid,  as 0xF001 to 0xFFFF
             unknown as 0xF000
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="Elevation-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="Elevation-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="3"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_FullPositionVector	<ASN>	<XML>, and
DF	DF_Position3D	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: The Elevation shall be taken from the spatial center of the vehicle, when a vehicle is being

measured.

7.34 Data Element: DE_EmergencyDetails

Use: The EmergencyDetails data element combines several bit level items into a single word for efficient transmission.

ASN.1 Representation:

```
EmergencyDetails  ::=  INTEGER  (0..63)
   -- First two bit (MSB set to zero.
   -- Combining these 3 items in the remaning 6 bits
   -- sirenUse          SirenInUse
   -- lightsUse         LightbarInUse
   -- multi             MultiVehicleReponse
```

XML Representation:

```
<xs:simpleType name=" EmergencyDetails" >
       <xs:annotation>
          <xs:documentation>
              First two bit   (MSB set to zero.
              Combining these 3 items in the remaning 6 bits
             sirenUse          SirenInUse
             lightsUse         LightbarInUse
             multi             MultiVehicleReponse
           </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedByte">
           <xs:maxInclusive value="63"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_EmergencyVehicleAlert(EVA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.35 Data Element: DE_EventFlags

Use: The Event Flags 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. The Event Flag 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 in any Event Flag data element it sends. The presence of the Event Flag 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 the Event Flag 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 pass the line without coming to a full stop before reaching it.
- ABS: system activated exceeding 100 mSec in length and active
- Traction Control: system activated exceeding 100 mSec in length and active

- Stability Control: system activated exceeding 100 mSec in length and active
- Hazardous Materials The vehicle 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 has (or is) decelerated at a rate of greater than 0.4g
- Lights Changed: The status of the external lighting of the vehicle has changed recently (the new state of the lights is presented in another element).
- Wipers Changed: The status of wipers (font or rear) of the vehicle has changed recently (the new state of the wipers is presented in another element).
- Flat tire: The vehicle has determined that at least one tire has run flat.
- Disabled Vehicle: Any vehicle that considers itself disabled.
- Air Bag Deployment: At least one airbag has been deployed.

ASN.1 Representation:

```
EventFlags ::= INTEGER (0..8192)
-- With bits as defined:
   eventHazardLights                EventFlags ::= 1
   eventStopLineViolation           EventFlags ::= 2 -- Intersection Violation
   eventABSactivated                EventFlags ::= 4
   eventTractionControlLoss         EventFlags ::= 8
    eventStabilityControlactivated  EventFlags ::= 16
   eventHazardousMaterials          EventFlags ::= 32
   eventEmergencyResponse           EventFlags ::= 64
   eventHardBraking                 EventFlags ::= 128
   eventLightsChanged               EventFlags ::= 256
   eventWipersChanged               EventFlags ::= 512
   eventFlatTire                    EventFlags ::= 1024
    eventDisabledVehicle            EventFlags ::= 2048
   eventAirBagDeployment            EventFlags ::= 4096
```

XML Representation:

```
<xs:simpleType name=" EventFlags" >
      <xs:annotation>
         <xs:documentation>
            With bits as defined:
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="8192"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleSafetyExtension	<ASN>	<XML>, and
MSG	MSG_IntersectionCollisionAvoidance (ICA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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.

7.36 Data Element: DE_Extent

Use: The spatial distance over which this message applies and should be presented to the driver. Under certain conditions some messages may never be shown to the driver of a vehicle if they are short in duration and other conflicting needs supercede the display until such time as the subject message is no longer relevant.

ASN.1 Representation:

```
Extent ::= ENUMERATED {
     useInstantlyOnly    (0),
     useFor3meters       (1),
     useFor10meters      (2),
     useFor50meters      (3),
     useFor100meters     (4),
     useFor500meters     (5),
     useFor1000meters    (6),
     useFor5000meters    (7),
     useFor10000meters   (8),
     useFor50000meters   (9),
     useFor100000meters  (10),
     forever             (127)  -- very wide area
     }
     -- encode as a single byte
```

XML Representation:

```
<xs:simpleType name=" Extent" >
      <xs:annotation>
          <xs:appinfo>
             useInstantlyOnly (0)
             useFor3meters (1)
             useFor10meters (2)
             useFor50meters (3)
             useFor100meters (4)
             useFor500meters (5)
             useFor1000meters (6)
             useFor5000meters (7)
             useFor10000meters (8)
             useFor50000meters (9)
             useFor100000meters (10)
             forever (127) -- very wide area
          </xs:appinfo>
          <xs:documentation>
            encode as a single byte
          </xs:documentation>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
              <xs:restriction base="xs:unsignedInt">
                 <xs:minInclusive value="0"/>
                 <xs:maxInclusive value="127"/>
              </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
              <xs:restriction base="xs:string">
                 <xs:enumeration value="useInstantlyOnly"/>
                 <xs:enumeration value="useFor3meters"/>
                 <xs:enumeration  value="useFor10meters"/>
                 <xs:enumeration value="useFor50meters"/>
                 <xs:enumeration value="useFor100meters"/>
                 <xs:enumeration value="useFor500meters"/>
                 <xs:enumeration value="useFor1000meters"/>
                 <xs:enumeration value="useFor5000meters"/>
                 <xs:enumeration value="useFor10000meters"/>
                 <xs:enumeration value="useFor50000meters"/>
                 <xs:enumeration value="useFor100000meters"/>
                 <xs:enumeration value="forever"/>
              </xs:restriction>
          </xs:simpleType >
```

```
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ValidRegion	<ASN>	<XML>, and
MSG	MSG_RoadSideAlert (RSA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.37 Data Element: DE_ExteriorLights

Use: The status of various exterior lights encoded in a bit string which can be used to relate the current vehicle settings.

The "Vehicle Exterior Lights" Probe Data Element provides the status of all exterior lights on the vehicle. As currently defined, these are: parking lights, headlights (*lo* and *hi* beam, automatic light control), fog lights, daytime running lights, turn signals (right / left) and hazard signals. Should the need for additional types of light be needed, a new data element will be added.

ASN.1 Representation:

```
ExteriorLights ::= INTEGER (0..256)
-- With bits as defined:
   allLightsOff                ExteriorLights ::= 0
                               -- B'0000-0000
   lowBeamHeadlightsOn         ExteriorLights ::= 1
                               -- B'0000-0001
   highBeamHeadlightsOn        ExteriorLights ::= 2
                               -- B'0000-0010
   leftTurnSignalOn            ExteriorLights ::= 4
                               -- B'0000-0100
   rightTurnSignalOn           ExteriorLights ::= 8
                               -- B'0000-1000
   hazardSignalOn              ExteriorLights ::= 12
                               -- B'0000-1100
   automaticLightControlOn     ExteriorLights ::= 16
                               -- B'0001-0000
   daytimeRunningLightsOn      ExteriorLights ::= 32
                               -- B'0010-0000
   fogLightOn                  ExteriorLights ::= 64
                               -- B'0100-0000
   parkingLightsOn             ExteriorLights ::= 128
                               -- B'1000-0000
```

XML Representation:

```
<xs:simpleType name=" ExteriorLights" >
      <xs:annotation>
         <xs:documentation>
            With bits as defined:
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="256"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.38 Data Element: DE_FurtherInfoID

Use: This data element provides a link number to other messages (described here and in other message set standards) which relate to the same event. Use zero when unkown or not present.

ASN.1 Representation:

```
FurtherInfoID ::= OCTET STRING (SIZE(2))
   -- a link to any other incident
   -- information data that may be available
   -- in the normal ATIS incident description
   -- or other messages
   -- two value bytes in length
```

XML Representation:

```
<xs:complexType name=" FurtherInfoID" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             a link to any other incident
             information data that may be available
             in the normal ATIS incident description
             or other messages
             two value bytes in length
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="FurtherInfoID-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="FurtherInfoID-string">
    <xs:restriction base="xs:base64Binary">
       <xs:length value="3"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_RoadSideAlert (RSA)	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Some message sets allow a request of other relevant messages by use of this ID, some others do not. Some messages do not yet support this ID 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.

7.39 Data Element: DE_GPSstatus

Use: The DE_GPSstatus data element is used to relate the current state 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.

ASN.1 Representation:

```
GPSstatus ::= BIT STRING {
   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 base station
   aPDOPofUnder5              (4), -- A dilution of precision greater then 5
   inViewOfUnder5             (5), -- Less then 5 satellites in view
   localCorrectionsPresent    (6),
   networkCorrectionsPresent  (7)
   } -- (SIZE(1))
```

XML Representation:

```
<xs:simpleType name="GPSstatus-item" >
      <xs:annotation>
         <xs:appinfo>
            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 base station
            aPDOPofUnder5 (4) -- A dilution of precision greater then 5
            inViewOfUnder5 (5) -- Less then 5 satellites in view
             localCorrectionsPresent (6)
             networkCorrectionsPresent (7)
         </xs:appinfo>
         <xs:documentation>
            (SIZE (1) )
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:int">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="7"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unavailable"/>
               <xs:enumeration value="isHealthy"/>
              <xs:enumeration value="isMonitored"/>
               <xs:enumeration value="baseStationType"/>
               <xs:enumeration value="aPDOPofUnder5"/>
               <xs:enumeration value="inViewOfUnder5"/>
               <xs:enumeration value="localCorrectionsPresent"/>
               <xs:enumeration value="networkCorrectionsPresent"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
<xs:simpleType name=" GPSstatus">
    <xs:list itemType="GPSstatus-item"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_PathHistory	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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.

7.40 Data Element: DE_HeadingConfidence

Use: This DE is used to provide the confidence interval of the 95% confidence level for the currently reported value of DE_Heading, taking into account the current calibration and precision of the sensor(s) used to measure and/or calculate the value. This data element is only to provide the listener with information on the limitations of the sensing system; not to support any type of automatic error correction or to imply a guaranteed maximum error. This data element should not be used for fault detection or diagnosis, but if a vehicle is able to detect a fault, the confidence interval should be increased accordingly.

The frame of references and axis of rotation used shall be in accordance with that defined in SAE J670, Issued 1976-07 and its successors. Note the definitions provided in Figure 1 (Tire Axis System) and Figure 2 (Directional Control Axis Systems).

ASN.1 Representation:

```
HeadingConfidence  ::= ENUMERATED {
    unavailable (0), -- B'000   Not Equipped or unavailable
    prec45deg   (1), -- B'001   45    degrees
    prec10deg   (2), -- B'010   10    degrees
    prec05deg   (3), -- B'011   5     degrees
    prec01deg   (4), -- B'100   1     degrees
    prec0-1deg  (5), -- B'101   0.1   degrees
   prec0-05deg (6), -- B'110   0.05 degrees
    prec0-01deg (7)  -- B'111   0.01 degrees
    }
    -- Encoded as a 3 bit value
```

XML Representation:

```
<xs:simpleType name=" HeadingConfidence" >
      <xs:annotation>
         <xs:appinfo>
            unavailable (0) -- B&apos;000   Not Equipped or unavailable
            prec45deg (1) -- B&apos;001   45    degrees
            prec10deg (2) -- B&apos;010   10    degrees
            prec05deg (3) -- B&apos;011   5     degrees
            prec01deg (4) -- B&apos;100   1     degrees
            prec0 1deg (5) -- B&apos;101   0.1   degrees
            prec0 05deg (6) -- B&apos;110   0.05 degrees
            prec0 01deg (7) -- B&apos;111   0.01 degrees
         </xs:appinfo>
         <xs:documentation>
            Encoded as a 3 bit value
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="7"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unavailable"/>
               <xs:enumeration value="prec45deg"/>
               <xs:enumeration value="prec10deg"/>
               <xs:enumeration value="prec05deg"/>
               <xs:enumeration value="prec01deg"/>
               <xs:enumeration value="prec0 1deg"/>
               <xs:enumeration value="prec0 05deg"/>
               <xs:enumeration value="prec0 01deg"/>
            </xs:restriction>
         </xs:simpleType >
```

```
      </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

7.41 Data Element: DE_Heading

Use: The current heading of the sending device, expressed in unsigned units of 0.0125 degrees from North (such that 28799 such degrees represent 359.9875 degrees). North shall be defined as the axis defined by the WSG-84 coordinate system and its reference ellipsoid. Headings "to the east" are defined as the positive direction. A 2 byte value when sent, a value of 28800 shall be used when unavailable. When sent by a vehicle, this element indicates the orientation of the front of the vehicle.

ASN.1 Representation:

```
Heading ::= INTEGER (0..28800)
   -- LSB of 0.0125 degrees
   -- A range of 0 to 359.9875 degrees
```

XML Representation:

```
<xs:simpleType name=" Heading" >
      <xs:annotation>
         <xs:documentation>
            LSB of 0.0125 degrees
            A range of 0 to 359.9875 degrees
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="28800"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_FullPositionVector	<ASN>	<XML>, and
DF	DF_Intersection	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that other one byte heading data elements are found in other parts of ITS.

7.42 Data Element: DE_HeadingSlice

Use: A DE 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 East and due West. A 2 byte value.

ASN.1 Representation:

```
HeadingSlice ::= OCTET STRING (SIZE(2))
   -- Each bit 22.5 degree starting from
   -- North and moving Eastward (clockwise)

   --  Define global enums for this entry
   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
```

XML Representation:

```
<xs:complexType name=" HeadingSlice" >
    <xs:simpleContent>
      <xs:annotation>
         <xs:documentation>
            Each bit 22.5 degree starting from
            North and moving Eastward  (clockwise)
            Define global enums for this entry
         </xs:documentation>
       </xs:annotation>
       <xs:extension base="HeadingSlice-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
         </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="HeadingSlice-string">
    <xs:restriction  base="xs:base64Binary">
      <xs:length value="3"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 5 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_RoadSignID	<ASN>	<XML>, and
DF	DF_ValidRegion	<ASN>	<XML>, and
MSG	MSG_ProbeDataManagement (PDM)	<ASN>	<XML>, and
MSG	MSG_RoadSideAlert (RSA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: See also the heading DE used to define a specific single heading value found in other parts of the DSRC message set.

7.43 Data Element: DE_Intersection Status Object

Use: The Intersection Status Object contains Advanced Traffic Controller (ATC) status information that may be sent to local OBUs as part of the SPAT process.

ASN.1 Representation:

```
IntersectionStatusObject ::= OCTET STRING (SIZE(1))
   -- with bits set as follows Bit #:
   -- 0    Manual Control is enabled.  Timing reported is per
   --      programmed values, etc but person at cabinet can
   --      manually request that certain intervals are terminated
   --      early (e.g. green).
   -- 1    Stop Time is activated and all counting/timing has stopped.
   -- 2    Intersection is in Conflict Flash.
   -- 3    Preempt is Active
   -- 4    Transit Signal Priority (TSP) is Active
   -- 5    Reserved
   -- 6    Reserved
   -- 7    Reserved as zero
```

XML Representation:

```
<xs:complexType name=" IntersectionStatusObject" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             with bits set as follows Bit #:
             0    Manual Control is enabled.  Timing reported is per
             programmed values,   etc but person at cabinet can
              manually request that certain intervals are terminated
             early  (e.g. green) .
             1    Stop Time is activated and all counting/timing has stopped.
             2    Intersection is in Conflict Flash.
             3    Preempt is Active
             4    Transit Signal  Priority  (TSP)  is Active
             5    Reserved
             6    Reserved
             7    Reserved as zero
          </xs:documentation>
       </xs:annotation>
        <xs:extension base="IntersectionStatusObject-string" >
           <xs:attribute name="EncodingType" use="required">
             <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
             </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="IntersectionStatusObject-string">
    <xs:restriction base="xs:base64Binary">
       <xs:length value="2"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_Intersection	<ASN>	<XML>, and
DF	DF_IntersectionState	<ASN>	<XML>, and
MSG	MSG_SignalStatusMessage (SSM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: All zero indicates normal operating mode.

7.44 Data Element: DE_IntersectionID

Use: The IntersectionID is used to globally and uniquely define an intersection within a country or region in a 32 bit field. Assignment rules for this value are established elsewhere and may use regional assignment schemas that vary.

ASN.1 Representation:

```
IntersectionID ::= OCTET STRING (SIZE(2..4))
   -- note that often only the lower 16 bits of this value
   -- will be sent as the operational region (state etc) will
   -- be known and not sent each time
```

XML Representation:

```
<xs:complexType name=" IntersectionID" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             note that often only the lower 16 bits of this value
             will be sent as the operational region  (state etc)  will
             be known and not sent each time
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="IntersectionID-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="IntersectionID-string">
    <xs:restriction base="xs:base64Binary">
       <xs:minLength value="3"/>
       <xs:maxLength value="6"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 6 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_Intersection	<ASN>	<XML>, and
DF	DF_IntersectionState	<ASN>	<XML>, and
DF	DF_SignalRequest	<ASN>	<XML>, and
MSG	MSG_IntersectionCollisionAvoidance (ICA)	<ASN>	<XML>, and
MSG	MSG_SignalStatusMessage (SSM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Values with the first three bytes set as zero are reserved for use as reference IntersectionIDs (intersection which may be reused in other places by providing an ID and an anchor point to locate them).

7.45 Data Element: DE_J1939-71-Axle Location

Use: 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.

ASN.1 Representation:
```
AxleLocation ::= INTEGER (0..127)
```

XML Representation:
```
<xs:simpleType name=" AxleLocation" >
       <xs:restriction base="xs:unsignedByte">
          <xs:maxInclusive value="127"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.46 Data Element: DE_J1939-71-Axle Weight

Use: A data element reused from the SAE J1939 standard and to be encoded as: 0.5kg/bit, 0deg offset Range: 0 - 32,127.5kg.

ASN.1 Representation:
```
AxleWeight ::= INTEGER (0..65535)
```

XML Representation:
```
<xs:simpleType name=" AxleWeight" >
       <xs:restriction base="xs:unsignedShort"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.47 Data Element: DE_J1939-71-Cargo Weight

Use: A data element reused from the SAE J1939 standard and encoded as: 2kg/bit, 0deg offset Range: 0 - 128,510kg.

ASN.1 Representation:
```
CargoWeight ::= INTEGER (0..65535)
```

XML Representation:
```
<xs:simpleType name=" CargoWeight" >
       <xs:restriction base="xs:unsignedShort"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.48 Data Element: DE_J1939-71-Drive Axle Lift Air Pressure

Use: A data element reused from the SAE J1939 standard and encoded as: Units of kPa/bit, 0 offset, 0-1000kPa.

ASN.1 Representation:
```
DriveAxleLiftAirPressure ::= INTEGER (0..1000)
```

XML Representation:
```
<xs:simpleType name=" DriveAxleLiftAirPressure" >
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="1000"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.49 Data Element: DE_J1939-71-Drive Axle Location

Use: 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. 256 states/8 bit, 0 offset, Range: 0-255.

ASN.1 Representation:
```
DriveAxleLocation ::= INTEGER (0..255)
```

XML Representation:
```
<xs:simpleType name=" DriveAxleLocation" >
       <xs:restriction base="xs:unsignedByte"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.50 Data Element: DE_J1939-71-Drive Axle Lube Pressure

Use: A data element reused from the SAE J1939 standard and encoded units of: 4 kPa/bit, 0 offset, 0-1000kPa.

ASN.1 Representation:
```
DriveAxleLubePressure ::= INTEGER (0..1000)
```

XML Representation:
```
<xs:simpleType name=" DriveAxleLubePressure" >
      <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="1000"/>
       </xs:restriction>
```

```
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.51 Data Element: DE_J1939-71-Drive Axle Temperature

Use: A data element reused from the SAE J1939 standard and encoded as: 1 deg C/bit, -40 deg C/bit offset -40 - 210 deg C.

ASN.1 Representation:

```
DriveAxleTemperature ::= INTEGER (-40..210)
```

XML Representation:

```
<xs:simpleType name=" DriveAxleTemperature" >
       <xs:restriction base="xs:short">
         <xs:minInclusive value="-40"/>
          <xs:maxInclusive value="210"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.52 Data Element: DE_J1939-71-Steering Axle Lube Pressure

Use: A data element reused from the SAE J1939 standard and encoded as: 4 kPa/bit, 0 offset, 0-1000kPa.

ASN.1 Representation:

```
SteeringAxleLubePressure ::= INTEGER (0..255)
```

XML Representation:

```
<xs:simpleType name=" SteeringAxleLubePressure" >
       <xs:restriction base="xs:unsignedByte"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.53 Data Element: DE_J1939-71-Steering Axle Temperature

Use: A data element reused from the SAE J1939 standard and encoded as: 1 deg C/bit, -40 deg C/bit offset -40 - 210 deg C.

ASN.1 Representation:

```
SteeringAxleTemperature ::= INTEGER (0..255)
```

XML Representation:
```
<xs:simpleType name=" SteeringAxleTemperature" >
       <xs:restriction base="xs:unsignedByte"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.54 Data Element: DE_J1939-71-Tire Leakage Rate

Use: A data element reused from the SAE J1939 standard and encoded as: 0.1 Pa/s per bit, 0 offset, Range: 0 Pa/s - 6425.5 Pa/s.

ASN.1 Representation:
```
TireLeakageRate ::= INTEGER (0..65535)
```

XML Representation:
```
<xs:simpleType name=" TireLeakageRate" >
      <xs:restriction base="xs:unsignedShort"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.55 Data Element: DE_J1939-71-Tire Location

Use: 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. 256 states/8 bit, 0 offset, Range: 0-255.

ASN.1 Representation:
```
TireLocation ::= INTEGER (0..255)
```

XML Representation:
```
<xs:simpleType name=" TireLocation" >
       <xs:restriction base="xs:unsignedByte"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.56 Data Element: DE_J1939-71-Tire Pressure Threshold Detection

Use: A measure of the relative tire pressure observed. Encoded as per the value set used in SAE J1939.

ASN.1 Representation:

```
TirePressureThresholdDetection  ::=  ENUMERATED  {
   noData                  (0),   --  B'000'
   overPressure            (1),   --  B'001'
   noWarningPressure       (2),   --  B'010'
   underPressure           (3),   --  B'011'
   extremeUnderPressure    (4),   --  B'100'
   undefined               (5),   --  B'101'
   errorIndicator          (6),   --  B'110'
   notAvailable            (7),   --  B'111'
   ... --  #  LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:simpleType name=" TirePressureThresholdDetection" >
      <xs:annotation>
         <xs:appinfo>
            noData (0) -- B&apos;000&apos;
            overPressure (1) -- B&apos;001&apos;
            noWarningPressure (2) -- B&apos;010&apos;
            underPressure (3) -- B&apos;011&apos;
            extremeUnderPressure (4) -- B&apos;100&apos;
            undefined (5) -- B&apos;101&apos;
            errorIndicator (6) -- B&apos;110&apos;
            notAvailable (7) -- B&apos;111&apos;
         </xs:appinfo>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="7"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="noData"/>
               <xs:enumeration value="overPressure"/>
               <xs:enumeration value="noWarningPressure"/>
               <xs:enumeration value="underPressure"/>
               <xs:enumeration value="extremeUnderPressure"/>
               <xs:enumeration value="undefined"/>
               <xs:enumeration value="errorIndicator"/>
               <xs:enumeration value="notAvailable"/>
            </xs:restriction>
         </xs:simpleType >
         <xs:simpleType>
            <xs:restriction base="local:TirePressureThresholdDetection" />
         </xs:simpleType>
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.57 Data Element: DE_J1939-71-Tire Pressure

Use: A data element reused from the SAE J1939 standard and encoded as: 4 kPa/bit, 0 offset, 0-1000kPa.

ASN.1 Representation:

```
TirePressure  ::=  INTEGER  (0..1000)
```

XML Representation:
```
<xs:simpleType name=" TirePressure" >
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="1000"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.58 Data Element: DE_J1939-71-Tire Temp

Use: A data element reused from the SAE J1939 standard and encoded as: .03125 deg C/bit, -273 deg C offset, Range: -273 - 1735 deg C.

ASN.1 Representation:
```
TireTemp ::= INTEGER (0..65535)
```

XML Representation:
```
<xs:simpleType name=" TireTemp" >
       <xs:restriction base="xs:unsignedShort"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.59 Data Element: DE_J1939-71-Trailer Weight

Use: A data element reused from the SAE J1939 standard and encoded as: 2kg/bit, 0deg offset Range: 0 - 128,510kg.

ASN.1 Representation:
```
TrailerWeight ::= INTEGER (0..65535)
```

XML Representation:
```
<xs:simpleType name=" TrailerWeight" >
       <xs:restriction base="xs:unsignedShort"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: The term "weight" is used in J1939, while the term "mass" is used in J2735.

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7.60 Data Element: DE_J1939-71-Wheel End Elect. Fault

Use: A data element reused from the SAE J1939 standard and encoded as defined in that standard.

ASN.1 Representation:

```
WheelEndElectFault ::= BIT STRING {
   bitOne       (1),
   bitTwo       (2),
   bitThree     (3),
   bitFour      (4)
   }
```

XML Representation:

```
<xs:simpleType name="WheelEndElectFault-item" >
       <xs:annotation>
          <xs:appinfo>
             bitOne (1)
             bitTwo (2)
             bitThree (3)
             bitFour (4)
          </xs:appinfo>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
             <xs:restriction base="xs:int">
                <xs:minInclusive value="1"/>
                <xs:maxInclusive value="4"/>
             </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
             <xs:restriction base="xs:string">
                <xs:enumeration value="bitOne"/>
                <xs:enumeration value="bitTwo"/>
                <xs:enumeration value="bitThree"/>
                <xs:enumeration value="bitFour"/>
             </xs:restriction>
          </xs:simpleType >
       </xs:union>
</xs:simpleType>
<xs:simpleType name=" WheelEndElectFault">
    <xs:list itemType="WheelEndElectFault-item"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.61 Data Element: DE_J1939-71-Wheel Sensor Status

Use: A data element reused from the SAE J1939 standard and encoded as: 00:Off, 01:On, 10: Not defined, 11: Not supported.

ASN.1 Representation:

```
WheelSensorStatus  ::=  ENUMERATED  {
     off            (0),
     on             (1),
     notDefined     (2),
     notSupoprted   (3)
     }
```

XML Representation:

```
<xs:simpleType name=" WheelSensorStatus" >
```

```
        <xs:annotation>
           <xs:appinfo>
              off (0)
              on (1)
              notDefined (2)
              notSupoprted (3)
           </xs:appinfo>
        </xs:annotation>
        <xs:union>
           <xs:simpleType>
              <xs:restriction base="xs:unsignedInt">
                 <xs:minInclusive value="0"/>
                 <xs:maxInclusive value="3"/>
              </xs:restriction>
           </xs:simpleType>
           <xs:simpleType>
              <xs:restriction base="xs:string">
                 <xs:enumeration value="off"/>
                 <xs:enumeration value="on"/>
                 <xs:enumeration value="notDefined"/>
                 <xs:enumeration value="notSupoprted"/>
              </xs:restriction>
           </xs:simpleType >
        </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_J1939-Data Items	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.62 Data Element: DE_LaneCount

Use: The DE_LaneCount data element provides a count of the lanes.

ASN.1 Representation:

```
LaneCount ::= INTEGER (0..255) -- the number of lanes to follow
```

XML Representation:

```
<xs:simpleType name=" LaneCount" >
        <xs:annotation>
           <xs:documentation>
              the number of lanes to follow
           </xs:documentation>
        </xs:annotation>
         <xs:restriction base="xs:unsignedByte"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_MovementState	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.63 Data Element: DE_LaneManeuverCode

Use: The LaneManeuverCode data element is used to describe the specific use of a single lane from the point of view of the lane description that contains it. In the use in the "connects to" case this means the

way in which the subject lane is used by the lane that is being described. For example, a given lane may represent the lane that a vehicle would enter when making a "left turn" from its current lane. More than one lane may be the "left turn lane" so the use of these values among the set of lanes is not exclusive. However, every lane can be only of one type at a time (from the perspective of the lane description that contains it).

ASN.1 Representation:

```
LaneManeuverCode ::= ENUMERATED {
   unknown          (0),  -- used for N.A. as well
   uTurn            (1),
   leftTurn         (2),
   rightTurn        (3),
   straightAhead    (4),
   softLeftTurn     (5),
   softRightTurn    (6),
   ...
   }
   -- values to 127 reserved for std use
   -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" LaneManeuverCode" >
      <xs:annotation>
         <xs:appinfo>
            unknown (0) -- used for N.A. as well
            uTurn (1)
            leftTurn (2)
            rightTurn (3)
            straightAhead (4)
            softLeftTurn (5)
            softRightTurn (6)
         </xs:appinfo>
         <xs:documentation>
            values to 127 reserved for std use
            values 128 to 255 reserved for local use
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
             <xs:restriction base="xs:unsignedInt">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="6"/>
             </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
             <xs:restriction base="xs:string">
                <xs:enumeration value="unknown"/>
                <xs:enumeration value="uTurn"/>
                <xs:enumeration value="leftTurn"/>
                <xs:enumeration value="rightTurn"/>
                <xs:enumeration value="straightAhead"/>
                <xs:enumeration value="softLeftTurn"/>
                <xs:enumeration value="softRightTurn"/>
             </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: Note: We reserve the upper bits for any other indications to be defined in the future, such as enter a freeway or entering a private drive. Treated as an octet byte when used in the packed octets of the "Connects To" data frame (no BER tagging is present in this small blob).

7.64 Data Element: DE_LaneNumber

Use: The LaneNumber data element conveys a unique index value for a lane used to refer to that lane by other objects in the intersection map data structure. Lanes may be ingress (inbound traffic) or egress (outbound traffic) in nature, as well as barriers and other types of specialty lanes. All lanes are numbered. The LaneNumber, in conjunction with the intersection ID, forms a regionally unique way to address a specific lane in that intersection.

ASN.1 Representation:

```
LaneNumber ::= OCTET STRING (SIZE(1))
```

XML Representation:

```
<xs:complexType name=" LaneNumber" >
    <xs:simpleContent>
       <xs:extension base="LaneNumber-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="LaneNumber-string">
   <xs:restriction base="xs:base64Binary">
      <xs:length value="2"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 9 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_BarrierLane	<ASN>	<XML>, and
DF	DF_CrosswalkLane	<ASN>	<XML>, and
DF	DF_SignalControlZone	<ASN>	<XML>, and
DF	DF_SignalRequest	<ASN>	<XML>, and
DF	DF_SpecialLane	<ASN>	<XML>, and
DF	DF_VehicleComputedLane	<ASN>	<XML>, and
DF	DF_VehicleReferenceLane	<ASN>	<XML>, and
MSG	MSG_IntersectionCollisionAvoidance (ICA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: If a globally unique lane number is needed, this can be obtained by combining the complete intersection ID with the lane number.

7.65 Data Element: DE_LaneSet

Use: The LaneSet data element is a sequence of one or more octets, where each octet represents one of the lanes in an intersection.

ASN.1 Representation:

```
LaneSet ::= OCTET STRING (SIZE(1..127))
    -- each byte encoded as a: LaneNumber,
    -- the collection of lanes, by num,
```

```
    -- to which some state data applies
```

XML Representation:

```
<xs:complexType name=" LaneSet" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             each byte encoded as a:  LaneNumber,
             the collection of lanes,   by num,
             to which some state data applies
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="LaneSet-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="LaneSet-string">
    <xs:restriction base="xs:base64Binary">
       <xs:minLength value="2"/>
       <xs:maxLength value="170"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_MovementState	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.66 Data Element: DE_LaneWidth

Use: The LaneWidth data concept conveys the width of a lane in LSB units of 1 cm. Maximum value would be a lane of over 327 meters.

ASN.1 Representation:

```
LaneWidth ::= INTEGER (0..32767) -- units of 1 cm
```

XML Representation:

```
<xs:simpleType name=" LaneWidth" >
       <xs:annotation>
          <xs:documentation>
             units of 1 cm
          </xs:documentation>
       </xs:annotation>
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="32767"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 11 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ApproachesObject	<ASN>	<XML>, and
DF	DF_BarrierLane	<ASN>	<XML>, and

DF	DF_CrosswalkLane	<ASN>	<XML>, and
DF	DF_Intersection	<ASN>	<XML>, and
DF	DF_ShapePointSet	<ASN>	<XML>, and
DF	DF_SignalControlZone	<ASN>	<XML>, and
DF	DF_SpecialLane	<ASN>	<XML>, and
DF	DF_VehicleComputedLane	<ASN>	<XML>, and
DF	DF_VehicleReferenceLane	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that one half the lane width is used to find the "edge" of the lane, as measured from its center, described by the offsets found in its node list.

7.67 Data Element: DE_Latitude

Use: The geographic latitude of an object, expressed in 1/10th integer microdegrees, as a 32 bit value and with reference to the horizontal datum then in use. The value 900000001 shall be used when unavailable

ASN.1 Representation:

```
Latitude ::= INTEGER (-900000000..900000001)
   -- LSB = 1/10 micro degree
   -- Providing a range of plus-minus 90 degrees
```

XML Representation:

```
<xs:simpleType name=" Latitude" >
      <xs:annotation>
         <xs:documentation>
            LSB = 1/10 micro degree
            Providing a range of plus-minus 90 degrees
         </xs:documentation>
      </xs:annotation>
      <xs:restriction base="xs:int">
         <xs:minInclusive value="-900000000"/>
         <xs:maxInclusive value="900000001"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_FullPositionVector	<ASN>	<XML>, and
DF	DF_Position3D	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.68 Data Element: DE_LayerID

Use: The LayerID is a data concept used to uniquely identity the layer of a geographic map fragment such as an intersection. Note that the layer type is used simply as a means to express a layer within a transmitted message, it has no value as a unique or permanent naming system for the map object (such as an intersection or any of its component parts).

ASN.1 Representation:
```
LayerID ::= INTEGER (0..100)
```

XML Representation:
```
<xs:simpleType name=" LayerID" >
       <xs:restriction base="xs:unsignedByte">
          <xs:maxInclusive value="100"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_MapData (MAP)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.69 Data Element: DE_LayerType

Use: The LayerType is a data concept used to uniquely identity the type of information to be found in a layer of a geographic map fragment such as an intersection.

ASN.1 Representation:
```
LayerType ::= ENUMERATED {
     none                  (0),
     mixedContent          (1), -- two or more of the below types
     generalMapData        (2),
     intersectionData      (3),
     curveData             (4),
     roadwaySectionData    (5),
     parkingAreaData       (6),
     sharedLaneData        (7),
     ... -- # LOCAL_CONTENT
     }
     -- values to 127 reserved for std use
     -- values 128 to 255 reserved for local use
```

XML Representation:
```
<xs:simpleType name=" LayerType" >
       <xs:annotation>
          <xs:appinfo>
             none (0)
             mixedContent (1) -- two or more of the below types
             generalMapData (2)
             intersectionData (3)
             curveData (4)
             roadwaySectionData (5)
             parkingAreaData (6)
             sharedLaneData (7)
          </xs:appinfo>
          <xs:documentation>
             values to 127 reserved for std use
             values 128 to 255 reserved for local use
          </xs:documentation>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
             <xs:restriction base="xs:unsignedInt">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="7"/>
             </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
             <xs:restriction base="xs:string">
                <xs:enumeration value="none"/>
```

```
                <xs:enumeration value="mixedContent"/>
                <xs:enumeration value="generalMapData"/>
                <xs:enumeration value="intersectionData"/>
                <xs:enumeration value="curveData"/>
                <xs:enumeration value="roadwaySectionData"/>
                <xs:enumeration value="parkingAreaData"/>
                <xs:enumeration value="sharedLaneData"/>
            </xs:restriction>
        </xs:simpleType >
        <xs:simpleType>
            <xs:restriction base="local:LayerType" />
        </xs:simpleType>
    </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_MapData (MAP)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.70 Data Element: DE_LightbarInUse

Use: 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.

ASN.1 Representation:

```
LightbarInUse ::= ENUMERATED {
     unavailable          (0),  -- Not Equipped or unavailable
     notInUse             (1),  -- none active
     inUse                (2),
     sirenInUse           (3),
     yellowCautionLights  (4),
     schoolBusLights      (5),
     arrowSignsActive     (6),
     slowMovingVehicle    (7),
     freqStops            (8),
     reserved             (9)   -- for future use
     }
```

XML Representation:

```
<xs:simpleType name=" LightbarInUse" >
      <xs:annotation>
         <xs:appinfo>
            unavailable (0) -- Not Equipped or unavailable
            notInUse (1) -- none active
            inUse (2)
            sirenInUse (3)
            yellowCautionLights (4)
            schoolBusLights (5)
            arrowSignsActive (6)
            slowMovingVehicle (7)
            freqStops (8)
            reserved (9) -- for future use
         </xs:appinfo>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="9"/>
```

```
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unavailable"/>
              <xs:enumeration value="notInUse"/>
               <xs:enumeration value="inUse"/>
               <xs:enumeration value="sirenInUse"/>
               <xs:enumeration value="yellowCautionLights"/>
               <xs:enumeration value="schoolBusLights"/>
              <xs:enumeration value="arrowSignsActive"/>
               <xs:enumeration value="slowMovingVehicle"/>
               <xs:enumeration value="freqStops"/>
               <xs:enumeration value="reserved"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: See also the entry for ExteriorLights.

7.71 Data Element: DE_Longitude

Use: The geographic longitude of an object, expressed in 1/10th integer microdegrees, as a 32 bit value and with reference to the horizontal datum then in use. The value 1800000001 shall be used when unavailable.

ASN.1 Representation:

```
Longitude ::= INTEGER (-1800000000..1800000001)
   -- LSB = 1/10 micro degree
   -- Providing a range of plus-minus 180 degrees
```

XML Representation:

```
<xs:simpleType name=" Longitude" >
      <xs:annotation>
         <xs:documentation>
            LSB = 1/10 micro degree
            Providing a range of plus-minus 180 degrees
         </xs:documentation>
      </xs:annotation>
      <xs:restriction base="xs:int">
         <xs:minInclusive value="-1800000000"/>
          <xs:maxInclusive value="1800000001"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_FullPositionVector	<ASN>	<XML>, and
DF	DF_Position3D	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.72 Data Element: DE_MAYDAY_Location_quality_code

Use: A value representing the "goodness" of the position estimate (accuracy). The element is used to convey the relative quality of a GPS generated location. This quality value is enumerated as shown, as follows below.

ASN.1 Representation:

```
Location-quality ::= ENUMERATED {
     loc-qual-bt1m        (0), -- quality better than 1 meter
     loc-qual-bt5m        (1), -- quality better than 5 meters
     loc-qual-bt12m       (2), -- quality better than 12.5 meters
     loc-qual-bt50m       (3), -- quality better than 50 meters
     loc-qual-bt125m      (4), -- quality better than 125 meters
     loc-qual-bt500m      (5), -- quality better than 500 meters
     loc-qual-bt1250m     (6), -- quality better than 1250 meters
     loc-qual-unknown     (7)  -- quality value unknown
     } -- 3 bits, appends with loc-tech to make one octet (0..7)
```

XML Representation:

```
<xs:simpleType name=" Location-quality" >
      <xs:annotation>
         <xs:appinfo>
           loc qual bt1m (0) -- quality better than 1 meter
            loc qual bt5m (1) -- quality better than 5 meters
            loc qual bt12m (2) -- quality better than 12.5 meters
            loc qual bt50m (3) -- quality better than 50 meters
           loc qual bt125m (4) -- quality better than 125 meters
            loc qual bt500m (5) -- quality better than 500 meters
            loc qual bt1250m (6) -- quality better than 1250 meters
            loc qual unknown (7) -- quality value unknown
         </xs:appinfo>
         <xs:documentation>
            3 bits,  appends with loc-tech to make one octet  (0..7)
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="7"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="loc qual bt1m"/>
               <xs:enumeration value="loc qual bt5m"/>
               <xs:enumeration value="loc qual bt12m"/>
               <xs:enumeration value="loc qual bt50m"/>
               <xs:enumeration value="loc qual bt125m"/>
              <xs:enumeration value="loc qual bt500m"/>
               <xs:enumeration value="loc qual bt1250m"/>
               <xs:enumeration value="loc qual unknown"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: This element was originally defined in J2313. From Section 8.35 "Location-Quality." This element is used by the IEEE IM effort relating to the accuracy of location information.

7.73 Data Element: DE_MAYDAY_Location_tech_code

Use: The technology used to determine the position of the vehicle. This element is used to convey what type of technology was used to determine the position (other elements it is used with in messages). The nav-system flag in the sender flag word shall be set to reflect the device technologies available.

ASN.1 Representation:

```
Location-tech ::= ENUMERATED {
     loc-tech-unknown     (0), -- technology type unknown
     loc-tech-GPS         (1), -- GPS technology only
     loc-tech-DGPS        (2), -- differential GPS (DGPS) technology
     loc-tech-drGPS       (3), -- dead reckoning system w/GPS
     loc-tech-drDGPS      (4), -- dead reckoning system w/DGPS
     loc-tech-dr          (5), -- dead reckoning only
     loc-tech-nav         (6), -- autonomous navigation system on-board
     ...,
     loc-tech-fault       (31) -- feature is not working
     }    -- (0..31) 5 bits, appends with loc-quality to make one octet
```

XML Representation:

```
<xs:simpleType name=" Location-tech" >
      <xs:annotation>
         <xs:appinfo>
            loc tech unknown (0) -- technology type unknown
            loc tech GPS (1) -- GPS technology only
            loc tech DGPS (2) -- differential GPS  (DGPS)  technology
            loc tech drGPS (3) -- dead reckoning system w/GPS
            loc tech drDGPS (4) -- dead reckoning system w/DGPS
            loc tech dr (5) -- dead reckoning only
            loc tech nav (6) -- autonomous navigation system on-board
            loc tech fault (31) -- feature is not working
         </xs:appinfo>
         <xs:documentation>
            (0..31)  5 bits,  appends with loc-quality to make one octet
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
              <xs:minInclusive value="0"/>
               <xs:maxInclusive value="31"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="loc tech unknown"/>
               <xs:enumeration value="loc tech GPS"/>
               <xs:enumeration value="loc tech DGPS"/>
               <xs:enumeration value="loc tech drGPS"/>
               <xs:enumeration value="loc tech drDGPS"/>
               <xs:enumeration value="loc tech dr"/>
               <xs:enumeration value="loc tech nav"/>
               <xs:enumeration value="loc tech fault"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: This element was originally defined in J2313. From Section 8.15 "Location-Tech."

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7.74 Data Element: DE_MinuteOfTheYear

Use: The DE_MinuteOfTheYear is used to set the value of the current minute within the current year (used to establish start and end times) for sending messages to travelers.

ASN.1 Representation:
```
MinuteOfTheYear ::= INTEGER (0..525960)
```

XML Representation:
```
<xs:simpleType name=" MinuteOfTheYear" >
       <xs:restriction base="xs:unsignedInt">
          <xs:maxInclusive value="525960"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.75 Data Element: DE_MinutesDuration

Use: The duration, in units of whole minutes, that a object persists for. A value of 32000 means that the object persists forever. The range 0..32000 provide for about 22.2 days of maximum duration.

ASN.1 Representation:
```
MinutesDuration ::= INTEGER (0..32000) -- units of minutes
```

XML Representation:
```
<xs:simpleType name=" MinutesDuration" >
       <xs:annotation>
          <xs:documentation>
             units of minutes
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="32000"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note also the DE_Extent element used for spatial duration.

7.76 Data Element: DE_MsgCount

Use: The MsgCount data element is used to provide a sequence number within a stream of messages with the same DSRCmsgID 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 DSRCmsgID, or if the sender has changed identity (e.g. by changing its TemporaryID) since sending the most recent message with that DSRCmsgID. Two further use cases exist when the sender has not changed identity: When the rest of the message content to be sent changes, the MsgCount shall be set equal to one greater than the value used in the most recent message sent with the same DSRCmsgID When the message content has not changed, the

MsgCount is not changed. For this element the value after 127 is zero.

The receipt of a non-sequential MsgCount value (from the same sending device and message type) implies that one or more messages from that sending device may have been lost, unless MsgCount has been reinitialized due to an identity change.

ASN.1 Representation:

```
MsgCount ::= INTEGER (0..127)
```

XML Representation:

```
<xs:simpleType name=" MsgCount" >
       <xs:restriction base="xs:unsignedByte">
          <xs:maxInclusive value="127"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 9 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>, and
MSG	MSG_CommonSafetyRequest (CSR)	<ASN>	<XML>, and
MSG	MSG_IntersectionCollisionAvoidance (ICA)	<ASN>	<XML>, and
MSG	MSG_MapData (MAP)	<ASN>	<XML>, and
MSG	MSG_RoadSideAlert (RSA)	<ASN>	<XML>, and
MSG	MSG_RTCM_Corrections (RTCM)	<ASN>	<XML>, and
MSG	MSG_SignalRequestMessage (SRM)	<ASN>	<XML>, and
MSG	MSG_SignalStatusMessage (SSM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: In usage, some devices change their Temporary ID frequently, to prevent identity tracking, while others do not. A change in Temporary ID data element value (which also changes the message contents in which it appears) implies that the MsgCount may also change value.

If a sender is composing a message with new content with a given DSRCmsgID, and the TemporaryID 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 with a given DSRCmsgID, and the TemporaryID has changed since it sent the previous message, the sender may set the MsgCount element 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 with the same DSRCmsgID, and less than 10 seconds have elapsed since it sent the previous message with that DSRCmsgID, the sender will use the same MsgCount as sent in the previous message.

If a sender is composing a message with the same content as the most recent message with the same DSRCmsgID, and at least 10 seconds have elapsed since it sent the previous message with that DSRCmsgID, the sender may set the MsgCount 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 MsgCount element, it shall maintain a separate MsgCount state for each message type so that the MsgCount value in a given message identifies its place in the stream of that message type. The MsgCount 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.

7.77 Data Element: DE_MsgCRC

Use: 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.

ASN.1 Representation:

```
MsgCRC ::= OCTET STRING (SIZE(2)) -- created with the CRC-CCITT polynomial
```

XML Representation:

```
<xs:complexType name=" MsgCRC" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             created with the CRC-CCITT polynomial
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="MsgCRC-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="MsgCRC-string">
    <xs:restriction base="xs:base64Binary">
       <xs:length value="3"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 7 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_RoadSignID	<ASN>	<XML>, and
MSG	MSG_A_la_Carte (ACM)	<ASN>	<XML>, and
MSG	MSG_EmergencyVehicleAlert(EVA)	<ASN>	<XML>, and
MSG	MSG_MapData (MAP)	<ASN>	<XML>, and
MSG	MSG_RoadSideAlert (RSA)	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.78 Data Element: DE_MultiVehicleResponse

Use: A data element which is set if the vehicle transmitting believes that more than one vehicle (regardless of the dispatch or command and control organization of those vehicles or their agency) are currently in-route or involved in the response to the event. When received in a message by another vehicle OBU, this

data element indicates to other vehicles that additional response vehicles may be converging to the same location and that additional caution is warranted.

Used to indicate that more that one vehicle is responding and traveling in a closely aligned fashion (one after the other in a loose platoon formation). This DE is intended to be used with the DSRC public safety vehicle operating in the area use case.

ASN.1 Representation:

```
MultiVehicleResponse ::= ENUMERATED {
      unavailable    (0), -- Not Equipped or unavailable
      singleVehicle  (1),
      multiVehicle   (2),
      reserved       (3)  -- for future use
      }
```

XML Representation:

```
<xs:simpleType name=" MultiVehicleResponse" >
       <xs:annotation>
          <xs:appinfo>
             unavailable (0) -- Not Equipped or unavailable
             singleVehicle (1)
             multiVehicle (2)
             reserved (3) -- for future use
          </xs:appinfo>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
              <xs:restriction base="xs:unsignedInt">
                 <xs:minInclusive value="0"/>
                 <xs:maxInclusive value="3"/>
              </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
              <xs:restriction base="xs:string">
                 <xs:enumeration value="unavailable"/>
                 <xs:enumeration value="singleVehicle"/>
                 <xs:enumeration value="multiVehicle"/>
                 <xs:enumeration value="reserved"/>
              </xs:restriction>
          </xs:simpleType >
       </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

7.79 Data Element: DE_MUTCDCode

Use: The DE_MUTCDCode data element is used to defined what basic MUTCD type a sign expression falls into.

ASN.1 Representation:

```
MUTCDCode ::= ENUMERATED {
   none             (0), -- non-MUTCD information
   regulatory       (1), -- "R" Regulatory signs
   warning          (2), -- "W" warning signs
   maintenance      (3), -- "M" Maintenance and construction
   motoristService  (4), -- Motorist Services
   guide            (5), -- "G" Guide signs
   rec              (6), -- Recreation and Cultural Interest
   ... -- # LOCAL_CONTENT
   }
     -- values to 127 reserved for std use
     -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" MUTCDCode" >
      <xs:annotation>
         <xs:appinfo>
            none (0) -- non-MUTCD information
            regulatory (1) -- &quot;R&quot; Regulatory signs
            warning (2) -- &quot;W&quot; warning signs
            maintenance (3) -- &quot;M&quot; Maintenance and construction
            motoristService (4) -- Motorist Services
            guide (5) -- &quot;G&quot; Guide signs
            rec (6) -- Recreation and Cultural Interest
         </xs:appinfo>
         <xs:documentation>
            values to 127 reserved for std use
            values 128 to 255 reserved for local use
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="6"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="none"/>
               <xs:enumeration value="regulatory"/>
               <xs:enumeration value="warning"/>
               <xs:enumeration value="maintenance"/>
               <xs:enumeration value="motoristService"/>
               <xs:enumeration value="guide"/>
               <xs:enumeration value="rec"/>
            </xs:restriction>
         </xs:simpleType >
         <xs:simpleType>
            <xs:restriction base="local:MUTCDCode" />
         </xs:simpleType>
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_RoadSignID	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: If sent, a value of zero shall be used (for "generic sign") general ITIS codes not meeting a MUTCD definition.

7.80 Data Element: DE_NMEA_MsgType

Use: The NMEA-MsgType provides the--- value defined in the 0183 NMEA standards for each message.

ASN.1 Representation:

```
NMEA-MsgType ::= INTEGER (0..32767)
```

XML Representation:

```
<xs:simpleType name=" NMEA-MsgType" >
      <xs:restriction base="xs:unsignedShort">
         <xs:maxInclusive value="32767"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_NMEA_Corrections (NMEA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.81 Data Element: DE_NMEA_Payload

Use: The NMEA Payload element contains the stream of bytes in the actual NEMA 0183 message that is being sent.

ASN.1 Representation:

```
NMEA-Payload ::= OCTET STRING (SIZE(1..1023))
```

XML Representation:

```
<xs:complexType name=" NMEA-Payload" >
    <xs:simpleContent>
       <xs:extension base="NMEA-Payload-string" >
          <xs:attribute name="EncodingType" use="required">
           <xs:simpleType>
              <xs:restriction base="xs:NMTOKEN">
                 <xs:enumeration value="base64Binary"/>
              </xs:restriction>
           </xs:simpleType>
         </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="NMEA-Payload-string">
    <xs:restriction base="xs:base64Binary">
       <xs:minLength value="2"/>
       <xs:maxLength value="1364"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_NMEA_Corrections (NMEA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.82 Data Element: DE_NMEA_Revision

Use: The specific revision 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.

ASN.1 Representation:

```
NMEA-Revision ::= ENUMERATED {
     unknown        (0),
     reserved       (1),
     rev1           (10),
     rev2           (20),
     rev3           (30),
     rev4           (40),
     rev5           (50),
     ... -- # LOCAL_CONTENT
     }
     -- values to 127 reserved for std use
```

```
    -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" NMEA-Revision" >
      <xs:annotation>
         <xs:appinfo>
            unknown (0)
            reserved (1)
            rev1 (10)
            rev2 (20)
            rev3 (30)
            rev4 (40)
            rev5 (50)
         </xs:appinfo>
         <xs:documentation>
            values to 127 reserved for std use
            values 128 to 255 reserved for local use
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive  value="50"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unknown"/>
               <xs:enumeration value="reserved"/>
               <xs:enumeration value="rev1"/>
               <xs:enumeration value="rev2"/>
               <xs:enumeration value="rev3"/>
               <xs:enumeration value="rev4"/>
               <xs:enumeration value="rev5"/>
            </xs:restriction>
         </xs:simpleType >
         <xs:simpleType>
            <xs:restriction base="local:NMEA-Revision" />
         </xs:simpleType>
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_NMEA_Corrections (NMEA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.83 Data Element: DE_NTCIPVehicleclass,

Use: The DE_NTCIP Vehicle class 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 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 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.

ASN.1 Representation:

```
NTCIPVehicleclass ::= OCTET STRING (SIZE(1))
   -- With bits set as per NTCIP values
   -- Priority Request Vehicle Class Type
   -- in the upper nibble
   -- Priority Request Vehicle Class Level
   -- in the lower nibble
```

XML Representation:

```
<xs:complexType name=" NTCIPVehicleclass" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             With bits set as per NTCIP values
             Priority Request Vehicle Class Type
             in the upper nibble
             Priority Request Vehicle Class Level
             in the lower nibble
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="NTCIPVehicleclass-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="NTCIPVehicleclass-string">
    <xs:restriction base="xs:base64Binary">
       <xs:length value="2"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_SignalRequest	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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.

7.84 Data Element: DE_ObjectCount

Use: The DE_ObjectCount provides a count of various types of objects.

ASN.1 Representation:

```
ObjectCount ::= INTEGER (0..6000) -- a count of objects
```

XML Representation:

```
<xs:simpleType name=" ObjectCount" >
       <xs:annotation>
          <xs:documentation>
             a count of objects
          </xs:documentation>
```


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```
        </xs:annotation>
        <xs:restriction base="xs:unsignedShort">
           <xs:maxInclusive value="6000"/>
        </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_MovementState	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.85 Data Element: DE_ObstacleDirection

Use: As a companion data element to Obstacle Distance, this data element draws from the output of a forward sensing system to report the obstacle direction from the vehicle detecting and reporting the obstacle. The data is expressed in degrees as azimuth relative to forward direction of vehicle.

ASN.1 Representation:

```
ObstacleDirection ::=  Heading -- Use the header DE for this unless it proves different.
```

XML Representation:

```
<xs:simpleType name=" ObstacleDirection" >
        <xs:annotation>
           <xs:documentation>
              Use the header DE for this unless it proves different.
           </xs:documentation>
        </xs:annotation>
        <xs:restriction base =" Heading"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.86 Data Element: DE_ObstacleDistance

Use: This data element draws from the output of a forward sensing system to report the presence of an obstacle and its measured distance from the vehicle 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.

ASN.1 Representation:

```
ObstacleDistance ::= INTEGER (0..32767) -- LSB units of meters
```

XML Representation:

```
<xs:simpleType name=" ObstacleDistance" >
        <xs:annotation>
           <xs:documentation>
              LSB units of meters
           </xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:unsignedShort">
           <xs:maxInclusive value="32767"/>
        </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.87 Data Element: DE_PayloadData

Use: A stream of octets to be exchanged.

ASN.1 Representation:
```
PayloadData ::= OCTET STRING (SIZE(1..2048))
```

XML Representation:
```
<xs:complexType name=" PayloadData" >
    <xs:simpleContent>
       <xs:extension base="PayloadData-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="PayloadData-string">
    <xs:restriction base="xs:base64Binary">
       <xs:minLength value="2"/>
       <xs:maxLength value="2731"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

7.88 Data Element: DE_Payload

Use: A data element to convey bulk information as a stream of bytes.

ASN.1 Representation:
```
Payload ::= OCTET STRING (SIZE(1..64))
```

XML Representation:
```
<xs:complexType name=" Payload" >
    <xs:simpleContent>
       <xs:extension base="Payload-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="Payload-string">
    <xs:restriction base="xs:base64Binary">
      <xs:minLength value="2"/>
```

```
      <xs:maxLength value="86"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

7.89 Data Element: DE_PedestrianDetect

Use: A data element indicating the (possible) presence of one or more pedestrians or other objects in the walk area, independent of the technology used to determine this.

ASN.1 Representation:

```
PedestrianDetect ::= ENUMERATED {
   none        (0), -- (B00000001)
   maybe       (1), -- (B00000010)
   one         (2), -- (B00000100)
   some        (3), --  (B00001000) Indicates more than one
   ...
   } -- one byte
```

XML Representation:

```
<xs:simpleType name=" PedestrianDetect" >
      <xs:annotation>
         <xs:appinfo>
            none (0) -- (B00000001)
            maybe (1) -- (B00000010)
            one (2) -- (B00000100)
            some (3) -- (B00001000)  Indicates more than one
         </xs:appinfo>
         <xs:documentation>
            one byte
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="3"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="none"/>
               <xs:enumeration value="maybe"/>
               <xs:enumeration value="one"/>
               <xs:enumeration value="some"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_MovementState	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.90 Data Element: DE_PedestrianSignalState

Use: A data element indicating either the **current** or the **next** signal state of a particular known pedestrian

lane (depending on usage context). Used in the SPAT message. The data element is a 8-bit encoded string, allowing multiple values to be indicated.

ASN.1 Representation:

```
PedestrianSignalState  ::=  ENUMERATED {
    unavailable (0), -- Not Equipped or unavailable
    stop        (1), -- (B00000001) do not walk
    caution     (2), -- (B00000010) flashing dont walk sign
    walk        (3), -- (B00000100) walk active
    ...
    } -- one byte
```

XML Representation:

```
<xs:simpleType name=" PedestrianSignalState" >
       <xs:annotation>
          <xs:appinfo>
             unavailable (0) -- Not Equipped or unavailable
             stop (1) -- (B00000001)  do not walk
             caution (2) -- (B00000010)  flashing dont walk sign
             walk (3) -- (B00000100)  walk active
          </xs:appinfo>
          <xs:documentation>
             one byte
          </xs:documentation>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
              <xs:restriction base="xs:unsignedInt">
                 <xs:minInclusive value="0"/>
                 <xs:maxInclusive value="3"/>
              </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
              <xs:restriction base="xs:string">
                 <xs:enumeration value="unavailable"/>
                 <xs:enumeration value="stop"/>
                <xs:enumeration value="caution"/>
                 <xs:enumeration value="walk"/>
              </xs:restriction>
          </xs:simpleType >
       </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_MovementState	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.91 Data Element: DE_PositionConfidence

Use: This DE is used to provide the confidence interval of the 95% confidence level for the currently reported value of entries such as the DE_Position entries, taking into account the current calibration and precision of the sensor(s) used to measure and/or calculate the value. It is used in the horizontal plane. This data element is only to provide the listener with information on the limitations of the sensing system; not to support any type of automatic error correction or to imply a guaranteed maximum error. This data element should not be used for fault detection or diagnosis, but if a vehicle is able to detect a fault, the confidence interval should be increased accordingly.

The frame of references and axis of rotation used shall be in accordance with that defined in SAE J670, Issued 1976-07 and its successors. Note the definitions provided in Figure 1 (Tire Axis System) and Figure 2 (Directional Control Axis Systems).

ASN.1 Representation:

```
PositionConfidence ::= ENUMERATED {
    unavailable (0),   -- B'0000   Not Equipped or unavailable
    a500m    (1), -- B'0001   500m   or about 5 * 10 ^ -3 decimal degrees
    a200m    (2), -- B'0010   200m   or about 2 * 10 ^ -3 decimal degrees
    a100m    (3), -- B'0011   100m   or about 1 * 10 ^ -3 decimal degrees
    a50m     (4), -- B'0100   50m    or about 5 * 10 ^ -4 decimal degrees
    a20m     (5), -- B'0101   20m    or about 2 * 10 ^ -4 decimal degrees
    a10m     (6), -- B'0110   10m    or about 1 * 10 ^ -4 decimal degrees
    a5m      (7), -- B'0111   5m     or about 5 * 10 ^ -5 decimal degrees
    a2m      (8), -- B'1000   2m     or about 2 * 10 ^ -5 decimal degrees
    a1m      (9), -- B'1001   1m     or about 1 * 10 ^ -5 decimal degrees
    a50cm   (10), -- B'1010   0.50m  or about 5 * 10 ^ -6 decimal degrees
    a20cm   (11), -- B'1011   0.20m  or about 2 * 10 ^ -6 decimal degrees
    a10cm   (12), -- B'1100   0.10m  or about 1 * 10 ^ -6 decimal degrees
    a5cm    (13), -- B'1101   0.05m  or about 5 * 10 ^ -7 decimal degrees
    a2cm    (14), -- B'1110   0.02m  or about 2 * 10 ^ -7 decimal degrees
    a1cm    (15)  -- B'1111   0.01m  or about 1 * 10 ^ -7 decimal degrees
    }
    -- Encoded as a 4 bit value
```

XML Representation:

```
<xs:simpleType name=" PositionConfidence" >
      <xs:annotation>
         <xs:appinfo>
            unavailable (0) -- B&amp;apos;0000   Not Equipped or unavailable
            a500m (1) -- B&amp;apos;0001   500m   or about 5 * 10 ^ -3 decimal degrees
            a200m (2) -- B&amp;apos;0010   200m   or about 2 * 10 ^ -3 decimal degrees
            a100m (3) -- B&amp;apos;0011   100m   or about 1 * 10 ^ -3 decimal degrees
            a50m (4) -- B&amp;apos;0100   50m    or about 5 * 10 ^ -4 decimal degrees
            a20m (5) -- B&amp;apos;0101   20m    or about 2 * 10 ^ -4 decimal degrees
            a10m (6) -- B&amp;apos;0110   10m    or about 1 * 10 ^ -4 decimal degrees
            a5m (7) -- B&amp;apos;0111   5m     or about 5 * 10 ^ -5 decimal degrees
            a2m (8) -- B&amp;apos;1000   2m     or about 2 * 10 ^ -5 decimal degrees
            a1m (9) -- B&amp;apos;1001   1m     or about 1 * 10 ^ -5 decimal degrees
            a50cm (10) -- B&amp;apos;1010   0.50m or about 5 * 10 ^ -6 decimal degrees
            a20cm (11) -- B&amp;apos;1011   0.20m or about 2 * 10 ^ -6 decimal degrees
            a10cm (12) -- B&amp;apos;1100   0.10m or about 1 * 10 ^ -6 decimal degrees
            a5cm (13) -- B&amp;apos;1101   0.05m or about 5 * 10 ^ -7 decimal degrees
            a2cm (14) -- B&amp;apos;1110   0.02m or about 2 * 10 ^ -7 decimal degrees
            a1cm (15) -- B&amp;apos;1111   0.01m or about 1 * 10 ^ -7 decimal degrees
         </xs:appinfo>
         <xs:documentation>
            Encoded as a 4 bit value
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
              <xs:maxInclusive value="15"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unavailable"/>
               <xs:enumeration value="a500m"/>
               <xs:enumeration value="a200m"/>
               <xs:enumeration value="a100m"/>
               <xs:enumeration value="a50m"/>
               <xs:enumeration value="a20m"/>
               <xs:enumeration value="a10m"/>
              <xs:enumeration value="a5m"/>
               <xs:enumeration value="a2m"/>
               <xs:enumeration value="a1m"/>
               <xs:enumeration value="a50cm"/>
               <xs:enumeration value="a20cm"/>
               <xs:enumeration value="a10cm"/>
               <xs:enumeration value="a5cm"/>
```

```
                <xs:enumeration value="a2cm"/>
                <xs:enumeration value="a1cm"/>
             </xs:restriction>
          </xs:simpleType >
       </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: Observe that the relationships between degrees of latitude or longitude and the distances given are for the general area of North America. These values will, of course, change with the exact position of the user on the face of the earth.

7.92 Data Element: DE_PreemptState

Use: The PreemptState data element is used to relate the current preemption state of a signal system. Note that this data element follows the values and definitions of the *preemptState* object of NTCIP 1202 v2.19f as its starting point and adds values of 0 and 10.

ASN.1 Representation:

```
PreemptState ::= ENUMERATED {
   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
    ackowledgedButOverridden (10), -- Ackowledged but Over-ridden
   ... -- # LOCAL_CONTENT
   }
   -- To use 4 bits,
   -- typically packed with other items in a BYTE
```

XML Representation:

```
<xs:simpleType name=" PreemptState" >
      <xs:annotation>
         <xs:appinfo>
            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
              ackowledgedButOverridden (10) -- Ackowledged but Over-ridden
         </xs:appinfo>
         <xs:documentation>
            To use 4 bits,
            typically packed with other items in a INTEGER  (-128..127)
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="10"/>
            </xs:restriction>
```

```
            </xs:simpleType>
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:enumeration value="none"/>
                  <xs:enumeration value="other"/>
                  <xs:enumeration value="notActive"/>
                  <xs:enumeration value="notActiveWithCall"/>
                  <xs:enumeration value="entryStarted"/>
                  <xs:enumeration value="trackService"/>
                  <xs:enumeration value="dwell"/>
                  <xs:enumeration value="linkActive"/>
                  <xs:enumeration value="existStarted"/>
                  <xs:enumeration value="maximumPresence"/>
                  <xs:enumeration value="ackowledgedButOverridden"/>
               </xs:restriction>
            </xs:simpleType >
            <xs:simpleType>
               <xs:restriction base="local:PreemptState" />
            </xs:simpleType>
         </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: Used in the *SignalState* definition (a complex octet encoding).

7.93 Data Element: DE_Priority

Use: A priority for the alert message, giving urgency of this message. A relative degree of merit compared with other similar messages for this type (not other message being sent by the device, nor a priority of display urgency at the receiver).

At this time, the lower five bits are reserved and shall be set to zero. This effectively reduces the number of priority levels to eight. The value of all zeros shall be used for "routine" messages such as roadside signage where not displaying the message to the driver is of only modest impact. The value 111xxxxx shall be the highest level of priority and shall be consider the most important level. When choices of display order or transmission order are considered, messages with this level of priority shall be given precedence. The remaining 6 levels shall be used as determined by local conventions.

ASN.1 Representation:

```
Priority ::= OCTET STRING (SIZE(1))
    -- Follow definition notes on setting these bits
```

XML Representation:

```
<xs:complexType name=" Priority" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             Follow definition notes on setting these bits
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="Priority-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="Priority-string">
   <xs:restriction base="xs:base64Binary">
```

```
      <xs:length value="2"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_RoadSideAlert (RSA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that a well chosen roadway with a set of priority schemes chosen to be very well managed can be thrown into chaos when an incident event occurs in it and when emergency response equipment enters the transmission zone during the response to the event. Local agreements on practices, including roadside unit (RSU) placement, will be needed to insure correct operation.

7.94 Data Element: DE_PriorityState

Use: The PriorityState data element is used to relate the current priority state of a signal system. TSP stands for Transit Signal Priority, a term used in NTCIP and in TCIP. Note that this data element follows the values defined in the *tspInputStatus* object defined in the NYC ASTC2 traffic controller effort.

ASN.1 Representation:

```
PriorityState ::= ENUMERATED {
    noneActive          (0), -- No signal priority (same as value = 1)
    none                (1), -- TSP None
    requested           (2), -- TSP Requested
    active              (3), -- TSP Active
     activeButIhibitd   (4), -- TSP Reservice (active but inhibited)
    seccess             (5), -- TSP Success
    removed             (6), -- TSP Removed
    clearFail           (7), -- TSP Clear Fail
    detectFail          (8), -- TSP Detect Fail
     detectClear        (9), -- TSP Detect Clear
    abort              (10), -- TSP Abort (needed to remain on-line)
    delayTiming        (11), -- TSP Delay Timing
    extendTiming       (12), -- TSP Extend Timing
     preemptOverride   (13), -- TSP Preempt Over-ride
     adaptiveOverride  (14), -- TSP Adaptive Over-ride
    reserved           (15),
    ... -- # LOCAL_CONTENT
    }
    -- To use 4 bits,
    -- typically packed with other items in a BYTE
```

XML Representation:

```
<xs:simpleType name=" PriorityState" >
       <xs:annotation>
          <xs:appinfo>
             noneActive (0) -- No signal priority  (same as value = 1)
             none (1) -- TSP None
             requested (2) -- TSP Requested
             active (3) -- TSP Active
              activeButIhibitd (4) -- TSP Reservice  (active but inhibited)
             seccess (5) -- TSP Success
             removed (6) -- TSP Removed
             clearFail (7) -- TSP Clear Fail
             detectFail (8) -- TSP Detect Fail
             detectClear (9) -- TSP Detect Clear
             abort (10) -- TSP Abort  (needed to remain on-line)
             delayTiming (11) -- TSP Delay Timing
             extendTiming (12) -- TSP Extend Timing
             preemptOverride (13) -- TSP Preempt Over-ride
             adaptiveOverride (14) -- TSP Adaptive Over-ride
```

```
            reserved (15)
         </xs:appinfo>
         <xs:documentation>
            To use 4 bits,
            typically packed with other items in a INTEGER  (-128..127)
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="15"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="noneActive"/>
              <xs:enumeration value="none"/>
               <xs:enumeration value="requested"/>
               <xs:enumeration value="active"/>
               <xs:enumeration value="activeButIhibitd"/>
               <xs:enumeration value="seccess"/>
              <xs:enumeration value="removed"/>
               <xs:enumeration value="clearFail"/>
               <xs:enumeration value="detectFail"/>
               <xs:enumeration value="detectClear"/>
               <xs:enumeration value="abort"/>
              <xs:enumeration value="delayTiming"/>
               <xs:enumeration value="extendTiming"/>
               <xs:enumeration value="preemptOverride"/>
               <xs:enumeration value="adaptiveOverride"/>
               <xs:enumeration value="reserved"/>
            </xs:restriction>
         </xs:simpleType >
         <xs:simpleType>
            <xs:restriction base="local:PriorityState" />
         </xs:simpleType>
      </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: Used in the *SignalState* definition (a complex octet encoding).

7.95 Data Element: DE_ProbeSegmentNumber

Use: The PSN enables users to identify vehicle trajectory for a limited amount of time or over a limited distance. It is randomly generated by a vehicle every 120 seconds or 1km, whichever comes last. The interval between PSN changes is a random number of seconds between 0 and 10s or a random distance between 0 and 200m, whichever comes last. When sending messages containing 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 will not contain a PSN.

ASN.1 Representation:

```
ProbeSegmentNumber ::= INTEGER (0..32767)
   -- value determined by local device
   -- as per standard
```

XML Representation:

```
<xs:simpleType name=" ProbeSegmentNumber" >
```

```
      <xs:annotation>
         <xs:documentation>
            value determined by local device
            as per standard
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="32767"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_ProbeVehicleData (PVD)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.96 Data Element: DE_RainSensor

Use: A general sensor of rain intensity which requires further interpretation by the OEM for precise semantic meaning.

The "Rain Sensor" Probe Data Element is intended to inform Probe Data Users as to how hard it was raining/snowing in the area the vehicle was traveling at the time the Probe Data snapshot was taken. The value of the Rain Sensor data element ranges from 0-7, with 0 indicating "No Rain/Snow", 1 indicating "Light Mist", and 7 indicating "Heavy Downpour". This information could be sent to vehicles approaching the area to warn drives of raining/snowing conditions ahead or it could provide Traffic Operation Centers with locations most likely in need of a snowplow.

ASN.1 Representation:

```
RainSensor ::= ENUMERATED {
     none                (0),
     lightMist           (1),
     heavyMist           (2),
      lightRainOrDrizzle (3),
     rain                (4),
     moderateRain        (5),
     heavyRain           (6),
     heavyDownpour       (7)
     }
```

XML Representation:

```
<xs:simpleType name=" RainSensor" >
      <xs:annotation>
         <xs:appinfo>
            none (0)
            lightMist (1)
            heavyMist (2)
             lightRainOrDrizzle (3)
            rain (4)
            moderateRain (5)
            heavyRain (6)
            heavyDownpour (7)
         </xs:appinfo>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
             <xs:restriction base="xs:unsignedInt">
                <xs:minInclusive value="0"/>
                 <xs:maxInclusive value="7"/>
             </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
```

```
            <xs:restriction base="xs:string">
               <xs:enumeration value="none"/>
              <xs:enumeration value="lightMist"/>
               <xs:enumeration value="heavyMist"/>
               <xs:enumeration value="lightRainOrDrizzle"/>
               <xs:enumeration value="rain"/>
               <xs:enumeration value="moderateRain"/>
              <xs:enumeration value="heavyRain"/>
               <xs:enumeration value="heavyDownpour"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: It is recommended that Automotive Manufacturers divide the range of their Rain Sensors into 8 resistance ranges corresponding to the above scale. For Example: a sensor that has a resistance range from 12K Ohms (Max Rain Fall) to 250 Ohms (No Rain Fall) will have the following resistance value ranges:

0=250 to 1749 Ohms

1=1750 to 3249 Ohms

2=3250 to 4749 Ohms

3=4750 to 6249 Ohms

4=6250 to 7749 Ohms

5=7750 to 9249 Ohms

6=9250 to 10749 Ohms

7= 10501 to 12000 Ohms

7.97 Data Element: DE_RequestedItem

Use: The Requested Item data element is used to specify what item (or items) is being requested in a CommonSafetyRequest message sent to other vehicles. The requested item may be broadcast by other vehicles in the Part II content of the BSM or the *a la carte* message that they transmit.

ASN.1 Representation:

```
RequestedItem ::= ENUMERATED {
   reserved       (0),
   itemA          (1),
        -- consisting of 2 elements:
        -- lights           ExteriorLights
        -- lightBar         LightbarInUse

   itemB          (2),
        -- consisting of:
        -- wipers   a SEQUENCE

   itemC          (3),
        -- consisting of:
        -- brakeStatus   BrakeSystemStatus

   itemD          (4),
        -- consisting of 2 elements:
```

```
        -- brakePressure    BrakeAppliedPressure
        -- roadFriction     CoefficientOfFriction

    itemE          (5),
        -- consisting of 4 elements:
        -- sunData          SunSensor
        -- rainData         RainSensor
        -- airTemp          AmbientAirTemperature
        -- airPres          AmbientAirPressure

    itemF          (6),
        -- consisting of:
        -- steering   a SEQUENCE

    itemG          (7),
        -- consisting of:
        -- accelSets a SEQUENCE

    itemH          (8),
        -- consisting of:
        -- object a SEQUENCE


    itemI          (9),
        -- consisting of:
        -- fullPos          FullPositionVector

    itemJ          (10),
        -- consisting of:
        -- position2D       Position2D

    itemK          (11),
        -- consisting of:
        -- position3D       Position3D

    itemL          (12),
        -- consisting of 2 elements:
        -- speedHeadC       SpeedandHeadingConfidence
        -- speedC           SpeedConfidence

    itemM          (13),
        -- consisting of:
        -- vehicleData a SEQUENCE

    itemN          (14),
        -- consisting of:
        -- vehicleIdent    VehicleIdent

    itemO          (15),
        -- consisting of:
        -- weatherReport a SEQUENCE

    itemP          (16),
        -- consisting of:
        -- breadcrumbs     VehicleMotionTrail

    itemQ          (17),
        -- consisting of:
        -- gpsStatus       GPSstatus

    ... -- # LOCAL_CONTENT OPTIONAL,
    }
    -- values to 127 reserved for std use
    -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" RequestedItem" >
      <xs:annotation>
        <xs:appinfo>
```


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```
        reserved (0)
        itemA (1) -- consisting of 2 elements:
         -- lights            ExteriorLights
         -- lightBar          LightbarInUse
        itemB (2) -- consisting of:
         -- wipers  a SEQUENCE
        itemC (3) -- consisting of:
         -- brakeStatus    BrakeSystemStatus
        itemD (4) -- consisting of 2 elements:
         -- brakePressure     BrakeAppliedPressure
         -- roadFriction      CoefficientOfFriction
        itemE (5) -- consisting of 4 elements:
         -- sunData           SunSensor
         -- rainData          RainSensor
         -- airTemp           AmbientAirTemperature
         -- airPres           AmbientAirPressure
        itemF (6) -- consisting of:
         -- steering  a SEQUENCE
        itemG (7) -- consisting of:
         -- accelSets a SEQUENCE
        itemH (8) -- consisting of:
         -- object a SEQUENCE
        itemI (9) -- consisting of:
         -- fullPos           FullPositionVector
        itemJ (10) -- consisting of:
         -- position2D       Position2D
        itemK (11) -- consisting of:
         -- position3D        Position3D
        itemL (12) -- consisting of 2 elements:
         -- speedHeadC        SpeedandHeadingConfidence
         -- speedC            SpeedConfidence
        itemM (13) -- consisting of:
         -- vehicleData  a SEQUENCE
        itemN (14) -- consisting of:
         -- vehicleIdent     VehicleIdent
        itemO (15) -- consisting of:
         -- weatherReport a SEQUENCE
        itemP (16) -- consisting of:
         -- breadcrumbs      VehicleMotionTrail
        itemQ (17) -- consisting of:
         -- gpsStatus        GPSstatus
    </xs:appinfo>
    <xs:documentation>
       values to 127 reserved for std use
       values 128 to 255 reserved for local use
    </xs:documentation>
 </xs:annotation>
 <xs:union>
    <xs:simpleType>
       <xs:restriction base="xs:unsignedInt">
          <xs:minInclusive value="0"/>
          <xs:maxInclusive value="17"/>
       </xs:restriction>
    </xs:simpleType>
    <xs:simpleType>
       <xs:restriction base="xs:string">
          <xs:enumeration value="reserved"/>
          <xs:enumeration value="itemA"/>
          <xs:enumeration value="itemB"/>
          <xs:enumeration value="itemC"/>
          <xs:enumeration value="itemD"/>
          <xs:enumeration value="itemE"/>
          <xs:enumeration value="itemF"/>
          <xs:enumeration value="itemG"/>
          <xs:enumeration value="itemH"/>
          <xs:enumeration value="itemI"/>
          <xs:enumeration value="itemJ"/>
          <xs:enumeration value="itemK"/>
          <xs:enumeration value="itemL"/>
```

```
                <xs:enumeration value="itemM"/>
                <xs:enumeration value="itemN"/>
                <xs:enumeration value="itemO"/>
                <xs:enumeration value="itemP"/>
                <xs:enumeration value="itemQ"/>
              </xs:restriction>
            </xs:simpleType >
            <xs:simpleType>
               <xs:restriction base="local:RequestedItem" />
            </xs:simpleType>
         </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_CommonSafetyRequest (CSR)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.98 Data Element: DE_ResponseType

Use: The response type which this vehicle is engaged in at the time an alerting message is being sent. At this time only emergency and non-emergency are defined; however other types of operational modes are expected to be added.

The type of response which a public safety, or other type of vehicle, is engaged in when transmitting emergency alerts. Intended to be used as part of the DSRC safety message for public safety vehicles operating in the area.

ASN.1 Representation:

```
ResponseType ::= ENUMERATED {
   notInUseOrNotEquipped       (0),
   emergency                   (1),
   nonEmergency                (2),
   pursuit                     (3)
   -- all others Future Use
   }
   -- values to 127 reserved for std use
   -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" ResponseType" >
      <xs:annotation>
         <xs:appinfo>
            notInUseOrNotEquipped (0)
           emergency (1)
           nonEmergency (2)
           pursuit (3) -- all others Future Use
         </xs:appinfo>
         <xs:documentation>
            values to 127 reserved for std use
            values 128 to 255 reserved for local use
        </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="3"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="notInUseOrNotEquipped"/>
```

```
                <xs:enumeration value="emergency"/>
                <xs:enumeration value="nonEmergency"/>
                <xs:enumeration value="pursuit"/>
            </xs:restriction>
        </xs:simpleType >
    </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_EmergencyVehicleAlert(EVA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: There are remaining issues with this data element, and changes may occur after serious review by a number of different agency types. For example, codes (such as NEMSIS codes) are not really uniform and understood (even within a single service); the urgency of a "code 3" run is different in different parts of the world. The common element here is what action the receiving driver is supposed to do (nothing, follow flagman, be alert, pull over, etc.). See also some of the "mandatory" ITIS advice codes like this. For some applications, some slow speed maneuvering type codes are likely added in future editions (moving a fire truck or tow truck around an incident scene, for example).

7.99 Data Element: DE_RTCM_ID

Use: The RTCM-MsgType 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 the RTCM for the latest list of these assignments and uses.

ASN.1 Representation:

```
RTCM-ID ::= INTEGER (0..32767)
```

XML Representation:

```
<xs:simpleType name=" RTCM-ID" >
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="32767"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_RTCMmsg	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.100 Data Element: DE_RTCM_Payload

Use: The RTCM_Payload element contains the stream of bytes in the actual RTCM message that is being sent.

ASN.1 Representation:

```
RTCM-Payload ::= OCTET STRING (SIZE(1..1023))
```

XML Representation:

```
<xs:complexType name=" RTCM-Payload" >
```

```
    <xs:simpleContent>
       <xs:extension base="RTCM-Payload-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="RTCM-Payload-string">
    <xs:restriction base="xs:base64Binary">
       <xs:minLength value="2"/>
       <xs:maxLength value="1364"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

DF DF_RTCMmsg <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

7.101 Data Element: DE_RTCM_Revision

Use: 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.

ASN.1 Representation:

```
RTCM-Revision ::= ENUMERATED {
      unknown        (0),
      reserved       (1),
      rtcmCMR        (2),
      rtcmCMR-Plus   (3),
      rtcmSAPOS      (4),
      rtcmSAPOS-Adv  (5),
      rtcmRTCA       (6),
      rtcmRAW        (7),
      rtcmRINEX      (8),
      rtcmSP3        (9),
      rtcmBINEX      (10),
      rtcmRev2-x     (19), -- Used when specific rev is not known
      rtcmRev2-0     (20),
      rtcmRev2-1     (21),
      rtcmRev2-3     (23), -- Std 10402.3
      rtcmRev3-0     (30),
      rtcmRev3-1     (31), -- Std 10403.1
      ... -- # LOCAL_CONTENT
      }
      -- values to 127 reserved for std use
      -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" RTCM-Revision" >
       <xs:annotation>
          <xs:appinfo>
             unknown (0)
             reserved (1)
             rtcmCMR (2)
             rtcmCMR Plus (3)
             rtcmSAPOS (4)
```


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```
            rtcmSAPOS Adv (5)
            rtcmRTCA (6)
            rtcmRAW (7)
            rtcmRINEX (8)
            rtcmSP3 (9)
            rtcmBINEX (10)
            rtcmRev2 x (19) -- Used when specific rev is not known
            rtcmRev2 0 (20)
            rtcmRev2 1 (21)
            rtcmRev2 3 (23) -- Std 10402.3
            rtcmRev3 0 (30)
            rtcmRev3 1 (31) -- Std 10403.1
         </xs:appinfo>
         <xs:documentation>
            values to 127 reserved for std use
            values 128 to 255 reserved for local use
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="31"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unknown"/>
               <xs:enumeration value="reserved"/>
               <xs:enumeration value="rtcmCMR"/>
               <xs:enumeration value="rtcmCMR Plus"/>
               <xs:enumeration value="rtcmSAPOS"/>
               <xs:enumeration value="rtcmSAPOS Adv"/>
               <xs:enumeration value="rtcmRTCA"/>
               <xs:enumeration value="rtcmRAW"/>
               <xs:enumeration value="rtcmRINEX"/>
               <xs:enumeration value="rtcmSP3"/>
               <xs:enumeration value="rtcmBINEX"/>
               <xs:enumeration value="rtcmRev2 x"/>
               <xs:enumeration value="rtcmRev2 0"/>
               <xs:enumeration value="rtcmRev2 1"/>
               <xs:enumeration value="rtcmRev2 3"/>
               <xs:enumeration value="rtcmRev3 0"/>
               <xs:enumeration value="rtcmRev3 1"/>
            </xs:restriction>
         </xs:simpleType >
         <xs:simpleType>
            <xs:restriction base="local:RTCM-Revision" />
         </xs:simpleType>
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_RTCMmsg	<ASN>	<XML>, and
MSG	MSG_RTCM_Corrections (RTCM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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.

7.102 Data Element: DE_SignalLightState

Use: A data element indicating the **current** (or the next) signal state of all lights pertaining to a particular known lane or movement (set of lanes). Encoded as per the table below. Used in the SPAT frame. The data element 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.

Signal Phase Indications Encoding

	Green	Yellow	Red	Flashing
Ball	0x00000001	0x00000002	0x00000004	0x00000008
Left Arrow	0x00000010	0x00000020	0x00000040	0x00000080
Right Arrow	0x00000100	0x00000200	0x00000400	0x00000800
Straight Arrow	0x00001000	0x00002000	0x00004000	0x00008000
Soft Left Arrow	0x00010000	0x00020000	0x00040000	0x00080000
Soft Right Arrow	0x00100000	0x00200000	0x00400000	0x00800000
U-Turn Arrow	0x01000000	0x02000000	0x04000000	0x08000000

* Note: DARK = 0x00000000

The Signal Light State value is built by ORing the various bitmasks together for that approach.

Examples: Solid Green Ball = 0x00000001, transmitted as 0x01

Flashing Green Ball = 0x00000009, transmitted as 0x09

Solid Red Ball with Green Right Arrow = 0x00000104, transmitted as 0x0104

ASN.1 Representation:

```
SignalLightState ::= INTEGER (0..536870912)
  -- The above bit ranges map to each type of direction
  -- using the bits defined by the above table of the standard.
```

XML Representation:

```
<xs:simpleType name=" SignalLightState" >
      <xs:annotation>
         <xs:documentation>
            The above bit ranges map to each type of direction
            using the bits defined by the above table of the standard.
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedInt">
          <xs:maxInclusive value="536870912"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

DF DF_MovementState <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: 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 "yellow" phase (when 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. Pedestrian lanes also have two such signal states, one for the period of the walk time and one for the warning time at the end of walk. Pedestrian lanes should use the "ball" entry in the table above unless an arrow is indicated.

7.103 Data Element: DE_SignalReqScheme

Use: The SignalReqScheme data element is used in a *priority* or *preempt* request frame to select which preempt or priority controller sequence is to be activated. The data element has either a priority value or a preemption value, depending on the setting of the 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.

ASN.1 Representation:

```
SignalReqScheme ::= OCTET STRING (SIZE(1))
    -- 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 prempt,
    -- while the value of 0 is reserved.

   -- lower nibble:  Strategy #:
    -- Range is 0..15 and is used to specify a desired
    -- strategy (if available).
    -- Currently no strategies are defined and this
    -- should be zero.
```

XML Representation:

```
<xs:complexType name=" SignalReqScheme" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             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 prempt,
             while the value of 0 is reserved.
             lower nibble:  Strategy #:
             Range is 0..15 and is used to specify a desired
             strategy  (if available) .
             Currently no strategies are defined and this
             should be zero.
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="SignalReqScheme-string" >
          <xs:attribute  name="EncodingType"  use="required">
             <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
             </xs:simpleType>
```

```
        </xs:attribute>
      </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="SignalReqScheme-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="2"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_SignalControlZone	<ASN>	<XML>, and
DF	DF_SignalRequest	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: In use, the the vehicle must determine which preempt number or priority number to request by analyzing its location relative to the map layer information.

7.104 Data Element: DE_SignalState

Use: The SignalState data element is used to reflect the current general state of the signal system in question. This is how *preemption* and *priority* states are acknowledged, and in this case a single signal system (and intersection) may have multiple states to relate. This data element is typically used as part of the SPAT message.

ASN.1 Representation:

```
SignalState ::= OCTET STRING (SIZE(1))
    -- 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 sequences

    -- Bits 6~4 The preempt or priority value that is
    -- being described.

    -- Bits 3~0 the state bits, indicating either a
    -- preemption or a priority use as follows:

    -- If a preemption: to follow the
    -- preemptState object of NTCIP 1202 v2.19f
    -- See PreemptState for bit definitions.

    -- If a prioirty to follow the
    -- tspInputStatus object utilized in the
    -- NYC ASTC2 traffic controller
    -- See PriorityState for bit definitions
```

XML Representation:

```
<xs:complexType name=" SignalState" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             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 sequences
             Bits 6~4 The preempt or priority value that is
             being described.
             Bits 3~0 the state bits,  indicating either a
             preemption or a priority use as follows:
```

```
            If a preemption: to follow the
            preemptState object of NTCIP 1202 v2.19f
            See  PreemptState for bit definitions.
            If a prioirty to follow the
            tspInputStatus object utilized in the
            NYC ASTC2 traffic controller
            See  PriorityState for bit definitions
         </xs:documentation>
      </xs:annotation>
      <xs:extension base="SignalState-string" >
         <xs:attribute name="EncodingType" use="required">
           <xs:simpleType>
              <xs:restriction base="xs:NMTOKEN">
                 <xs:enumeration value="base64Binary"/>
              </xs:restriction>
           </xs:simpleType>
         </xs:attribute>
      </xs:extension>
   </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="SignalState-string">
   <xs:restriction base="xs:base64Binary">
      <xs:length value="2"/>
   </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_IntersectionState	<ASN>	<XML>, and
MSG	MSG_SignalStatusMessage (SSM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Note that in use this object is enclosed in an outer sequence which identifies if it is describing a preemption or a priority use.

7.105 Data Element: DE_SignPrority

Use: The relative importance of the sign, a scale from zero (least important) to seven (most important).

ASN.1 Representation:

```
SignPrority ::= INTEGER (0..7)
   -- 0 as least, 7 as most
```

XML Representation:

```
<xs:simpleType name=" SignPrority" >
      <xs:annotation>
        <xs:documentation>
           0 as least,  7 as most
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedByte">
         <xs:maxInclusive value="7"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

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In addition, this item may be used by data structures in other ITS standards.

7.106 Data Element: DE_SirenInUse

Use: A data element which is set if any sort of audible alarm is being emitted from the vehicle. This includes various common sirens as well as backup up beepers and other slow speed maneuvering alerts.

Used to reflect any type or style of audio alerting when a vehicle is progressing and transmitting DSRC messages to others about its path. Intended to be used as part of the DSRC safety message for public safety vehicles operating in the area.

ASN.1 Representation:

```
SirenInUse ::= ENUMERATED {
     unavailable    (0), -- Not Equipped or unavailable
     notInUse       (1),
     inUse          (2),
     reserved       (3)  -- for future use
     }
```

XML Representation:

```
<xs:simpleType name=" SirenInUse" >
       <xs:annotation>
          <xs:appinfo>
             unavailable (0) -- Not Equipped or unavailable
             notInUse (1)
             inUse (2)
             reserved (3) -- for future use
          </xs:appinfo>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
              <xs:restriction base="xs:unsignedInt">
                 <xs:minInclusive value="0"/>
                 <xs:maxInclusive value="3"/>
              </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
              <xs:restriction base="xs:string">
                 <xs:enumeration value="unavailable"/>
                 <xs:enumeration value="notInUse"/>
                 <xs:enumeration value="inUse"/>
                <xs:enumeration value="reserved"/>
              </xs:restriction>
          </xs:simpleType >
       </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

7.107 Data Element: DE_SpecialLaneAttributes

Use: The SpecialLaneAttributes 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.

ASN.1 Representation:

```
SpecialLaneAttributes ::= ENUMERATED {
   noData                    (0), -- ('0000000000000000'B)
   egressPath                (1), -- ('0000000000000001'B)
       -- a two-way path or an outbound path is described
   railRoadTrack             (2), -- ('0000000000000010'B)
```

```
    transitOnlyLane            (4), -- ('0000000000000100'B)
    hovLane                    (8), --  ('0000000000001000'B)
    busOnly                   (16), -- ('0000000000010000'B)
    vehiclesEntering          (32), -- ('0000000000100000'B)
    vehiclesLeaving           (64), -- ('0000000001000000'B)
    reserved                 (128)  -- ('0000000010000000'B)
    } -- 1 byte
```

XML Representation:

```
<xs:simpleType name=" SpecialLaneAttributes" >
      <xs:annotation>
         <xs:appinfo>
            noData (0) -- (&apos;0000000000000000&apos;B)
            egressPath (1) -- (&apos;0000000000000001&apos;B)
             -- a two-way path or an outbound path is described
            railRoadTrack (2) -- (&apos;0000000000000010&apos;B)
            transitOnlyLane (4) -- (&apos;0000000000000100&apos;B)
            hovLane (8) -- (&apos;0000000000001000&apos;B)
            busOnly (16) -- (&apos;0000000000010000&apos;B)
            vehiclesEntering (32) -- (&apos;0000000000100000&apos;B)
            vehiclesLeaving (64) -- (&apos;0000000001000000&apos;B)
            reserved (128) -- (&apos;0000000010000000&apos;B)
         </xs:appinfo>
         <xs:documentation>
            1 byte
          </xs:documentation>
      </xs:annotation>
       <xs:union>
          <xs:simpleType>
             <xs:restriction base="xs:unsignedInt">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="128"/>
             </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
             <xs:restriction base="xs:string">
                <xs:enumeration value="noData"/>
                <xs:enumeration value="egressPath"/>
                <xs:enumeration value="railRoadTrack"/>
               <xs:enumeration value="transitOnlyLane"/>
                <xs:enumeration value="hovLane"/>
                <xs:enumeration value="busOnly"/>
                <xs:enumeration value="vehiclesEntering"/>
                <xs:enumeration value="vehiclesLeaving"/>
              <xs:enumeration value="reserved"/>
             </xs:restriction>
          </xs:simpleType >
       </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_SpecialLane	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.108 Data Element: DE_SpecialSignalState

Use: A data element indicating the **current** signal state of a particular known special lane type (such as a train). Used in the the SPAT frame.

ASN.1 Representation:

```
SpecialSignalState  ::=  ENUMERATED  {
   unknown     (0),
```

```
    notInUse    (1), -- (B0001) default state, empty, not in use
    arriving    (2), -- (B0010) track-lane about to be occupied
    present     (3), -- (B0100) track-lane is occupied with vehicle
    departing   (4), -- (B1000) track-lane about to be empty
    ...
    } -- one byte
```

XML Representation:

```
<xs:simpleType name=" SpecialSignalState" >
      <xs:annotation>
         <xs:appinfo>
            unknown (0)
            notInUse (1) -- (B0001)  default state ,
            arriving (2) -- (B0010)  track-lane about to be occupied
            present (3) -- (B0100)  track-lane is occupied with vehicle
            departing (4) -- (B1000)  track-lane about to be empty
         </xs:appinfo>
         <xs:documentation>
            one byte
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="4"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
              <xs:enumeration value="unknown"/>
               <xs:enumeration value="notInUse"/>
               <xs:enumeration value="arriving"/>
               <xs:enumeration value="present"/>
               <xs:enumeration value="departing"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_MovementState	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.109 Data Element: DE_SpeedConfidence

Use: This DE is used to provide the confidence interval of the 95% confidence level for the currently reported value of DE_Speed, taking into account the current calibration and precision of the sensor(s) used to measure and/or calculate the value. This data element is only to provide the listener with information on the limitations of the sensing system; not to support any type of automatic error correction or to imply a guaranteed maximum error. This data element should not be used for fault detection or diagnosis, but if a vehicle is able to detect a fault, the confidence interval should be increased accordingly.

The frame of references and axis of rotation used shall be accordance with that defined in SAE J670, Issued 1976-07 and its successors. Note the definitions provided in Figure 1 (Tire Axis System) and Figure 2 (Directional Control Axis Systems).

ASN.1 Representation:

```
SpeedConfidence ::= ENUMERATED {
    unavailable (0), -- B'000  Not Equipped or unavailable
    prec100ms   (1), -- B'001  100  meters / sec
```

```
    prec10ms     (2), -- B'010  10    meters / sec
    prec5ms      (3), -- B'011  5     meters / sec
    prec1ms      (4), -- B'100  1     meters / sec
    prec0-1ms    (5), -- B'101  0.1   meters / sec
    prec0-05ms   (6), -- B'110  0.05  meters / sec
    prec0-01ms   (7)  -- B'111  0.01  meters / sec
    }
    -- Encoded as a 3 bit value
```

XML Representation:

```
<xs:simpleType name=" SpeedConfidence" >
      <xs:annotation>
         <xs:appinfo>
            unavailable (0) -- B&apos;000  Not Equipped or unavailable
            prec100ms (1) -- B&apos;001  100  meters / sec
            prec10ms (2) -- B&apos;010  10   meters / sec
            prec5ms  (3) -- B&apos;011  5    meters / sec
            prec1ms  (4) -- B&apos;100  1    meters / sec
            prec0 1ms (5) -- B&apos;101  0.1  meters / sec
            prec0 05ms (6) -- B&apos;110  0.05 meters / sec
            prec0 01ms (7) -- B&apos;111  0.01 meters / sec
         </xs:appinfo>
         <xs:documentation>
            Encoded as a 3 bit value
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="7"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unavailable"/>
               <xs:enumeration value="prec100ms"/>
               <xs:enumeration value="prec10ms"/>
               <xs:enumeration value="prec5ms"/>
               <xs:enumeration value="prec1ms"/>
               <xs:enumeration value="prec0 1ms"/>
               <xs:enumeration value="prec0 05ms"/>
               <xs:enumeration value="prec0 01ms"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.110 Data Element: DE_Speed

Use: This data element represents the vehicle 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. A value of 8191 shall be used when the speed is unavailable.

ASN.1 Representation:

```
Speed ::= INTEGER (0..8191) -- Units of 0.02 m/s
          -- The value 8191 indicates that
          -- speed is unavailable
```

XML Representation:

```
<xs:simpleType name=" Speed" >
      <xs:annotation>
         <xs:documentation>
            Units of 0.02 m/s
            The value 8191 indicates that
            speed is unavailable
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="8191"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

7.111 Data Element: DE_StabilityControlStatus

Use: This data element reflects the current state of the stability control system status. The "Stability Control Status" 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, or in an Active state.

ASN.1 Representation:

```
StabilityControlStatus ::= ENUMERATED {
    unavailable (0), -- B'00  Not Equipped with SC
                     -- or SC status is unavailable
    off         (1), -- B'01  Off
    on          (2)  -- B'10  On or active (engaged)
    }
    -- Encoded as a 2 bit value
```

XML Representation:

```
<xs:simpleType name=" StabilityControlStatus" >
      <xs:annotation>
         <xs:appinfo>
            unavailable (0) -- B&amp;apos;00  Not Equipped with SC
             -- or SC status is unavailable
            off (1) -- B&amp;apos;01  Off
            on (2) -- B&amp;apos;10  On or active  (engaged)
         </xs:appinfo>
         <xs:documentation>
            Encoded as a 2 bit value
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
             <xs:restriction base="xs:unsignedInt">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="2"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
             <xs:restriction base="xs:string">
                <xs:enumeration value="unavailable"/>
                <xs:enumeration value="off"/>
                <xs:enumeration value="on"/>
             </xs:restriction>
         </xs:simpleType >
```

```
      </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The value for notEquipped shall be used when data is not available.

7.112 Data Element: DE_StateConfidence

Use: The StateConfidence data element is used to relate additional data about the confidence of the current movement phase and its estimated time values.

ASN.1 Representation:

```
StateConfidence ::= ENUMERATED {
   unKnownEstimate         (0),
   minTime                 (1),
   maxTime                 (2),
   timeLikeklyToChange     (3),
   ... -- # LOCAL_CONTENT
   }
     -- values to 127 reserved for std use
     -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" StateConfidence" >
      <xs:annotation>
         <xs:appinfo>
            unKnownEstimate (0)
            minTime (1)
            maxTime (2)
             timeLikeklyToChange (3)
         </xs:appinfo>
         <xs:documentation>
            values to 127 reserved for std use
            values 128 to 255 reserved for local use
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
             <xs:restriction base="xs:unsignedInt">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="3"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
             <xs:restriction base="xs:string">
                <xs:enumeration value="unKnownEstimate"/>
                <xs:enumeration value="minTime"/>
                <xs:enumeration value="maxTime"/>
                 <xs:enumeration value="timeLikeklyToChange"/>
             </xs:restriction>
         </xs:simpleType >
         <xs:simpleType>
             <xs:restriction base="local:StateConfidence" />
         </xs:simpleType>
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

DF DF_MovementState <ASN> <XML>.

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In addition, this item may be used by data structures in other ITS standards.

7.113 Data Element: DE_SteeringWheelAngleConfidence

Use: This DE is used to provide the confidence interval of the 95% confidence level for the currently reported value of DE_SteeringWheelAngle, taking into account the current calibration and precision of the sensor(s) used to measure and/or calculate the value. This data element is only to provide the listener with information on the limitations of the sensing system; not to support any type of automatic error correction or to imply a guaranteed maximum error. This data element should not be used for fault detection or diagnosis, but if a vehicle is able to detect a fault, the confidence interval should be increased accordingly.

The frame of references and axis of rotation used shall be accordance with that defined in SAE J670, Issued 1976-07 and its successors. Note the definitions provided in Figure 1 (Tire Axis System) and Figure 2 (Directional Control Axis Systems).

ASN.1 Representation:

```
SteeringWheelAngleConfidence  ::=  ENUMERATED  {
    unavailable  (0), -- B'00   Not Equipped with Wheel angle
                      -- or Wheel angle status is unavailable
    prec2deg     (1), -- B'01   2 degrees
    prec1deg     (2), -- B'10   1 degree
    prec0-02deg  (3)   -- B'11   0.02 degrees
    }
    -- Encoded as a 2 bit value
```

XML Representation:

```
<xs:simpleType name=" SteeringWheelAngleConfidence" >
      <xs:annotation>
         <xs:appinfo>
            unavailable (0) -- B&apos;00   Not Equipped with Wheel angle
            -- or Wheel angle status is unavailable
            prec2deg (1) -- B&apos;01   2 degrees
            prec1deg (2) -- B&apos;10   1 degree
            prec0 02deg (3) -- B&apos;11   0.02 degrees
         </xs:appinfo>
         <xs:documentation>
            Encoded as a 2 bit value
          </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="3"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unavailable"/>
                <xs:enumeration value="prec2deg"/>
                <xs:enumeration value="prec1deg"/>
                <xs:enumeration value="prec0 02deg"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 4 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AccelSteerYawRateConfidence	<ASN>	<XML>, and
DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ConfidenceSet	<ASN>	<XML>, and

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DF DF_VehicleStatus <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

7.114 Data Element: DE_SteeringWheelAngleRateOfChange

Use: The rate of change of the angle of the steering wheel, expressed in signed units of 3 degrees/second over a range of 381degrees in either direction. To the right being positive. Values beyond this range shall use the last value (-127 or +127).

ASN.1 Representation:

```
SteeringWheelAngleRateOfChange ::= INTEGER (-127..127)
   -- LSB is 3 degrees per second
```

XML Representation:

```
<xs:simpleType name=" SteeringWheelAngleRateOfChange" >
       <xs:annotation>
          <xs:documentation>
             LSB is 3 degrees per second
          </xs:documentation>
       </xs:annotation>
       <xs:restriction base="xs:byte">
          <xs:minInclusive value="-127"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF DF_AllInclusive <ASN> <XML>, and

DF DF_VehicleStatus <ASN> <XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: This element may be used by road maintenance operations to determine presence of an obstruction or pothole in the roadway.

7.115 Data Element: DE_SteeringWheelAngle

Use: 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.

ASN.1 Representation:

```
SteeringWheelAngle ::= OCTET STRING (SIZE(1))
    -- LSB units of 1.5 degrees.
    -- a range of -189 to +189 degrees
    -- 0x01 = 00 = +1.5 deg
    -- 0x81 = -126 = -189 deg and beyond
    -- 0x7E = +126 = +189 deg and beyond
    -- 0x7F = +127 to be used for unavailable
```

XML Representation:

```
<xs:complexType name=" SteeringWheelAngle" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             LSB units of 1.5 degrees.
             a range of -189 to +189 degrees
             0x01 = 00 = +1.5 deg
             0x81 = -126 = -189 deg and beyond
             0x7E = +126 = +189 deg and beyond
             0x7F = +127 to be used for unavailable
          </xs:documentation>
       </xs:annotation>
```

```
        <xs:extension base="SteeringWheelAngle-string" >
           <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
            </xs:simpleType>
           </xs:attribute>
        </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="SteeringWheelAngle-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="2"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.116 Data Element: DE_SunSensor

Use: The "Sun Sensor" Probe Data Element is intended to inform Probe Data Users as to the level of Sun Light in the area the vehicle was traveling at the time the Probe Data snapshot was taken. The value of the Sun Sensor data element ranges from 0-7, with 0 indicating "Complete Darkness", 1 indicating "Minimal Sun Light", and 7 indicating "Maximum Sun Light". This information could be sent to vehicles approaching the area to tell drivers to be prepared for sunny/clouding conditions ahead or a Weather Server for monitoring weather conditions in the area.

ASN.1 Representation:

```
SunSensor ::= INTEGER (0..1000)
   -- units of watts / m2
```

XML Representation:

```
<xs:simpleType name=" SunSensor" >
       <xs:annotation>
          <xs:documentation>
             units of watts / m2
          </xs:documentation>
       </xs:annotation>
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="1000"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: It is recommended that Automotive Manufacturers divide the range of their Sun Sensors into 8 resistance ranges corresponding to the above scale. For Example: a sensor that has a resistance range from 12K Ohms (No Light) to 250 Ohms (Max Light) will have the following resistance value ranges:

- # 0= 10501 to 12000 Ohms
- # 1=9250 to 10749 Ohms
- # 2=7750 to 9249 Ohms
- # 3=6250 to 7749 Ohms
- # 4=4750 to 6249 Ohms
- # 5=3250 to 4749 Ohms
- # 6=1750 to 3249 Ohms
- # 7=250 to 1749 Ohms

7.117 Data Element: DE_TemporaryID

Use: This is the 4 byte random device identifier, called the temporary ID. In essence, this value for a mobile OBU device (unlike a typical wireless or wired 802 device) will periodically change 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.

ASN.1 Representation:

```
TemporaryID ::= OCTET STRING (SIZE(4)) -- a 4 byte string array
```

XML Representation:

```
<xs:complexType name=" TemporaryID" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             a 4 byte string array
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="TemporaryID-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:NMTOKEN">
                   <xs:enumeration value="base64Binary"/>
                </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="TemporaryID-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="6"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 6 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleIdent	<ASN>	<XML>, and
MSG	MSG_BasicSafetyMessage_Verbose	<ASN>	<XML>, and
MSG	MSG_CommonSafetyRequest (CSR)	<ASN>	<XML>, and
MSG	MSG_EmergencyVehicleAlert (EVA)	<ASN>	<XML>, and
MSG	MSG_IntersectionCollisionAvoidance (ICA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.118 Data Element: DE_TerminationDistance

Use: Provides a Distance-to-Live type of time-out. Allows users to provide the distance driven until the probe management process ceases and the default condition is applied.

ASN.1 Representation:
```
TermDistance ::= INTEGER (1..30000)    -- units in meters
```

XML Representation:
```
<xs:simpleType name=" TermDistance" >
       <xs:annotation>
          <xs:documentation>
             units in meters
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedShort">
           <xs:minInclusive value="1"/>
           <xs:maxInclusive value="30000"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_ProbeDataManagement (PDM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.119 Data Element: DE_TerminationTime

Use: Provides a Time-to-Live type of time-out. Allows users to provide the number of seconds at which time the probe management process ceases and the default condition is applied.

ASN.1 Representation:
```
TermTime ::= INTEGER (1..1800) -- units of sec
```

XML Representation:
```
<xs:simpleType name=" TermTime" >
       <xs:annotation>
          <xs:documentation>
             units of sec
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedShort">
           <xs:minInclusive value="1"/>
           <xs:maxInclusive value="1800"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_ProbeDataManagement (PDM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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7.120 Data Element: DE_ThrottleConfidence

Use: This DE is used to provide the confidence interval of the 95% confidence level for the currently reported value of DE_Throttle, taking into account the current calibration and precision of the sensor(s) used to measure and/or calculate the value. This data element is only to provide the listener with information on the limitations of the sensing system; not to support any type of automatic error correction or to imply a guaranteed maximum error. This data element should not be used for fault detection or diagnosis, but if a vehicle is able to detect a fault, the confidence interval should be increased accordingly. If a fault that triggers the MIL is of a nature to render throttle performance unreliable, then ThrottleConfidence should be represented as "notEquipped."

ASN.1 Representation:

```
ThrottleConfidence  ::=  ENUMERATED  {
    unavailable      (0), -- B'00   Not Equipped or unavailable
    prec10percent    (1), -- B'01   10   percent Confidence level
    prec1percent     (2), -- B'10   1    percent Confidence level
    prec0-5percent   (3)  -- B'11   0.5  percent Confidence level
    }
    -- Encoded as a 2 bit value
```

XML Representation:

```
<xs:simpleType name=" ThrottleConfidence" >
       <xs:annotation>
          <xs:appinfo>
             unavailable (0) -- B&amp;apos;00   Not Equipped or unavailable
             prec10percent (1) -- B&amp;apos;01   10   percent Confidence level
             prec1percent (2) -- B&amp;apos;10   1    percent Confidence level
             prec0 5percent (3) -- B&amp;apos;11   0.5 percent Confidence level
          </xs:appinfo>
          <xs:documentation>
             Encoded as a 2 bit value
          </xs:documentation>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
              <xs:restriction base="xs:unsignedInt">
                 <xs:minInclusive value="0"/>
                 <xs:maxInclusive value="3"/>
              </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
              <xs:restriction base="xs:string">
                 <xs:enumeration value="unavailable"/>
                 <xs:enumeration value="prec10percent"/>
                 <xs:enumeration value="prec1percent"/>
                 <xs:enumeration value="prec0 5percent"/>
              </xs:restriction>
          </xs:simpleType >
       </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ConfidenceSet	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.121 Data Element: DE_ThrottlePosition

Use: The position of the throttle in the vehicle, expressed in units of 0.5 percent of range of travel, unsigned.

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ASN.1 Representation:

```
ThrottlePosition ::= INTEGER (0..200) -- LSB units are 0.5 percent
```

XML Representation:

```
<xs:simpleType name=" ThrottlePosition" >
      <xs:annotation>
        <xs:documentation>
          LSB units are 0.5 percent
        </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedByte">
         <xs:maxInclusive value="200"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.122 Data Element: DE_TimeConfidence

Use: This DE is used to provide the confidence interval of the 95% confidence level for the currently reported value of time, taking into account the current calibration and precision of the sensor(s) used to measure and/or calculate the value. This data element is only to provide the listener with information on the limitations of the sensing system; not to support any type of automatic error correction or to imply a guaranteed maximum error. This data element should not be used for fault detection or diagnosis, but if a vehicle is able to detect a fault, the confidence interval should be increased accordingly.

ASN.1 Representation:

```
TimeConfidence ::= ENUMERATED {
   unavailable              (0), -- Not Equipped or unavailable
   time-100-000             (1), -- Better then  100 Seconds
   time-050-000             (2), -- Better then  50 Seconds
   time-020-000             (3), -- Better then  20 Seconds
   time-010-000             (4), -- Better then  10 Seconds
   time-002-000             (5), -- Better then  2 Seconds
   time-001-000             (6), -- Better then  1 Second
   time-000-500             (7), -- Better then  0.5 Seconds
   time-000-200             (8), -- Better then  0.2 Seconds
   time-000-100             (9), -- Better then  0.1 Seconds
   time-000-050            (10), -- Better then  0.05 Seconds
   time-000-020            (11), -- Better then  0.02 Seconds
   time-000-010            (12), -- Better then  0.01 Seconds
   time-000-005            (13), -- Better then  0.005 Seconds
   time-000-002            (14), -- Better then  0.002 Seconds
   time-000-001            (15), -- Better then  0.001 Seconds
                                 -- Better then one milisecond
   time-000-000-5          (16), -- Better then  0.000,5 Seconds
   time-000-000-2          (17), -- Better then  0.000,2 Seconds
   time-000-000-1          (18), -- Better then  0.000,1 Seconds
   time-000-000-05         (19), -- Better then  0.000,05 Seconds
   time-000-000-02         (20), -- Better then  0.000,02 Seconds
   time-000-000-01         (21), -- Better then  0.000,01 Seconds
   time-000-000-005        (22), -- Better then  0.000,005 Seconds
   time-000-000-002        (23), -- Better then  0.000,002 Seconds
   time-000-000-001        (24), -- Better then  0.000,001 Seconds
                                 -- Better then one micro second
   time-000-000-000-5      (25), -- Better then  0.000,000,5 Seconds
   time-000-000-000-2      (26), -- Better then  0.000,000,2 Seconds
   time-000-000-000-1      (27), -- Better then  0.000,000,1 Seconds
   time-000-000-000-05     (28), -- Better then  0.000,000,05 Seconds
```

```
    time-000-000-000-02      (29), -- Better then   0.000,000,02 Seconds
    time-000-000-000-01      (30), -- Better then   0.000,000,01 Seconds
    time-000-000-000-005     (31), -- Better then   0.000,000,005 Seconds
    time-000-000-000-002     (32), -- Better then   0.000,000,002 Seconds
    time-000-000-000-001     (33), -- Better then   0.000,000,001 Seconds
                                   -- Better then one nano second
    time-000-000-000-000-5   (34), -- Better then   0.000,000,000,5 Seconds
    time-000-000-000-000-2   (35), -- Better then   0.000,000,000,2 Seconds
    time-000-000-000-000-1   (36), -- Better then   0.000,000,000,1 Seconds
    time-000-000-000-000-05 (37), -- Better then   0.000,000,000,05 Seconds
    time-000-000-000-000-02 (38), -- Better then   0.000,000,000,02 Seconds
    time-000-000-000-000-01 (39)  -- Better then   0.000,000,000,01 Seconds
    }
```

XML Representation:

```
<xs:simpleType name=" TimeConfidence" >
       <xs:annotation>
          <xs:appinfo>
             unavailable (0) -- Not Equipped or unavailable
             time 100 000 (1) -- Better then  100 Seconds
             time 050 000 (2) -- Better then  50 Seconds
             time 020 000 (3) -- Better then  20 Seconds
             time 010 000 (4) -- Better then  10 Seconds
             time 002 000 (5) -- Better then  2 Seconds
             time 001 000 (6) -- Better then  1 Second
             time 000 500 (7) -- Better then  0.5 Seconds
             time 000 200 (8) -- Better then  0.2 Seconds
             time 000 100 (9) -- Better then  0.1 Seconds
             time 000 050 (10) -- Better then  0.05 Seconds
             time 000 020 (11) -- Better then  0.02 Seconds
             time 000 010 (12) -- Better then  0.01 Seconds
             time 000 005 (13) -- Better then  0.005 Seconds
             time 000 002 (14) -- Better then  0.002 Seconds
             time 000 001 (15) -- Better then  0.001 Seconds
              -- Better then one milisecond
             time 000 000 5 (16) -- Better then  0.000 ,
             time 000 000 2 (17) -- Better then  0.000 ,
             time 000 000 1 (18) -- Better then  0.000 ,
             time 000 000 05 (19) -- Better then  0.000 ,
             time 000 000 02 (20) -- Better then  0.000 ,
             time 000 000 01 (21) -- Better then  0.000 ,
             time 000 000 005 (22) -- Better then  0.000 ,
             time 000 000 002 (23) -- Better then  0.000 ,
             time 000 000 001 (24) -- Better then  0.000 ,
              -- Better then one micro second
             time 000 000 000 5 (25) -- Better then  0.000 ,
             time 000 000 000 2 (26) -- Better then  0.000 ,
             time 000 000 000 1 (27) -- Better then  0.000 ,
             time 000 000 000 05 (28) -- Better then  0.000 ,
             time 000 000 000 02 (29) -- Better then  0.000 ,
             time 000 000 000 01 (30) -- Better then  0.000 ,
             time 000 000 000 005 (31) -- Better then  0.000 ,
             time 000 000 000 002 (32) -- Better then  0.000 ,
             time 000 000 000 001 (33) -- Better then  0.000 ,
              -- Better then one nano second
             time 000 000 000 000 5 (34) -- Better then  0.000 ,
             time 000 000 000 000 2 (35) -- Better then  0.000 ,
             time 000 000 000 000 1 (36) -- Better then  0.000 ,
             time 000 000 000 000 05 (37) -- Better then  0.000 ,
             time 000 000 000 000 02 (38) -- Better then  0.000 ,
             time 000 000 000 000 01 (39) -- Better then  0.000 , 000 , 000 , 01 Seconds
          </xs:appinfo>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
              <xs:restriction base="xs:unsignedInt">
                 <xs:minInclusive value="0"/>
                 <xs:maxInclusive value="39"/>
              </xs:restriction>
```

```
            </xs:simpleType>
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:enumeration value="unavailable"/>
                    <xs:enumeration value="time 100 000"/>
                    <xs:enumeration value="time 050 000"/>
                    <xs:enumeration value="time 020 000"/>
                    <xs:enumeration value="time 010 000"/>
                    <xs:enumeration value="time 002 000"/>
                    <xs:enumeration value="time 001 000"/>
                    <xs:enumeration value="time 000 500"/>
                    <xs:enumeration value="time 000 200"/>
                    <xs:enumeration value="time 000 100"/>
                    <xs:enumeration value="time 000 050"/>
                    <xs:enumeration value="time 000 020"/>
                    <xs:enumeration value="time 000 010"/>
                    <xs:enumeration value="time 000 005"/>
                    <xs:enumeration value="time 000 002"/>
                    <xs:enumeration value="time 000 001"/>
                    <xs:enumeration value="time 000 000 5"/>
                    <xs:enumeration value="time 000 000 2"/>
                    <xs:enumeration value="time 000 000 1"/>
                    <xs:enumeration value="time 000 000 05"/>
                    <xs:enumeration value="time 000 000 02"/>
                    <xs:enumeration value="time 000 000 01"/>
                    <xs:enumeration value="time 000 000 005"/>
                    <xs:enumeration value="time 000 000 002"/>
                    <xs:enumeration value="time 000 000 001"/>
                    <xs:enumeration value="time 000 000 000 5"/>
                    <xs:enumeration value="time 000 000 000 2"/>
                    <xs:enumeration value="time 000 000 000 1"/>
                    <xs:enumeration value="time 000 000 000 05"/>
                    <xs:enumeration value="time 000 000 000 02"/>
                    <xs:enumeration value="time 000 000 000 01"/>
                    <xs:enumeration value="time 000 000 000 005"/>
                    <xs:enumeration value="time 000 000 000 002"/>
                    <xs:enumeration value="time 000 000 000 001"/>
                    <xs:enumeration value="time 000 000 000 000 5"/>
                    <xs:enumeration value="time 000 000 000 000 2"/>
                    <xs:enumeration value="time 000 000 000 000 1"/>
                    <xs:enumeration value="time 000 000 000 000 05"/>
                    <xs:enumeration value="time 000 000 000 000 02"/>
                    <xs:enumeration value="time 000 000 000 000 01"/>
                </xs:restriction>
            </xs:simpleType >
        </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ConfidenceSet	<ASN>	<XML>, and
DF	DF_FullPositionVector	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.123 Data Element: DE_TimeMark

Use: The TimeMark data element is used to relate the moment in local UTC based time when a signal phase is predicted to change, with a precision of 1/10 of a second. A range of 2 full minutes seconds 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. A value of zero

is taken to mean no time remaining (or less then 0.1 seconds). When there is a need to send a value greater then the range allowed by the data element, the value 12001 shall be sent and shall be interpreted to indicate an indefinite future time value. When the value to be used in undefined or unknown a value of 12002 shall be sent.

ASN.1 Representation:

```
TimeMark ::= INTEGER (0..12002)
   -- In units of 1/10th second from local UTC time
   -- A range of 0~600 for even minutes, 601~1200 for odd minutes
   -- 12001 to indicate indefinite time
   -- 12002 to be used when value undefined or unknown
```

XML Representation:

```
<xs:simpleType name=" TimeMark" >
       <xs:annotation>
          <xs:documentation>
             In units of 1/10th second from local UTC time
             A range of 0~600 for even minutes,  601~1200 for odd minutes
             12001 to indicate indefinite time
             12002 to be used when value undefined or unknown
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedShort">
           <xs:maxInclusive value="12002"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_IntersectionState	<ASN>	<XML>, and
DF	DF_MovementState	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.124 Data Element: DE_TractionControlState

Use: The DE_TractionControlState data element reflects the status of the vehicle traction 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.

ASN.1 Representation:

```
TractionControlState ::= ENUMERATED {
    unavailable (0), -- B'00  Not Equipped with tracton control
                     -- or tracton control status is unavailable
   off          (1), -- B'01  tracton control is Off
   on           (2), -- B'10  tracton control is On (but not Engaged)
   engaged      (3)  -- B'11  tracton control is Engaged
   }
   -- Encoded as a 2 bit value
```

XML Representation:

```
<xs:simpleType name=" TractionControlState" >
       <xs:annotation>
          <xs:appinfo>
             unavailable (0) -- B&amp;apos;00  Not Equipped with tracton control
              -- or tracton control status is unavailable
             off (1) -- B&amp;apos;01  tracton control is Off
             on (2) -- B&amp;apos;10  tracton control is On  (but not Engaged)
             engaged (3) -- B&amp;apos;11  tracton control is Engaged
          </xs:appinfo>
```

```
            <xs:documentation>
               Encoded as a 2 bit value
            </xs:documentation>
         </xs:annotation>
         <xs:union>
            <xs:simpleType>
               <xs:restriction base="xs:unsignedInt">
                  <xs:minInclusive value="0"/>
                  <xs:maxInclusive value="3"/>
               </xs:restriction>
            </xs:simpleType>
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:enumeration value="unavailable"/>
                  <xs:enumeration value="off"/>
                  <xs:enumeration value="on"/>
                  <xs:enumeration value="engaged"/>
               </xs:restriction>
            </xs:simpleType >
         </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The value for notEquipped shall be used when data is not available.

7.125 Data Element: DE_TransitPreEmptionRequest

Use: The TransitPreEmptionRequest data element will be used to enumerate various types of preemption events.

ASN.1 Representation:

```
TransitPreEmptionRequest ::= ENUMERATED {
      typeOne         (0),
      typeTwo         (1),
      typeThree       (2),
      typeFour        (3),
      ... -- # LOCAL_CONTENT
      }
      -- values to 127 reserved for std use
      -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" TransitPreEmptionRequest" >
       <xs:annotation>
          <xs:appinfo>
             typeOne (0)
             typeTwo (1)
             typeThree (2)
             typeFour (3)
          </xs:appinfo>
          <xs:documentation>
             values to 127 reserved for std use
             values 128 to 255 reserved for local use
          </xs:documentation>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
             <xs:restriction base="xs:unsignedInt">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="3"/>
             </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
             <xs:restriction base="xs:string">
```

```
                <xs:enumeration value="typeOne"/>
                <xs:enumeration value="typeTwo"/>
                <xs:enumeration value="typeThree"/>
                <xs:enumeration value="typeFour"/>
             </xs:restriction>
          </xs:simpleType >
          <xs:simpleType>
             <xs:restriction base="local:TransitPreEmptionRequest" />
          </xs:simpleType>
       </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

7.126 Data Element: DE_TransitStatus

Use: The TransitStatus 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 becomes part of the input processing for how that system will respond to the request.

ASN.1 Representation:

```
TransitStatus ::= BIT STRING {
    none          (0), -- nothing is active
    anADAuse      (1), -- an ADA access is in progress (wheelchairs, kneling, etc.)
    aBikeLoad     (2), -- loading of a bicyle is in progress
    doorOpen      (3), -- a vehicle door is open for passenger access
    occM          (4),
    occL          (5)
    -- bits four and five are used to relate the
    -- the relative occupancy of the vehicle, with
    -- 00  as least full and 11 indicating a
    -- close-to or full conditon
    } (SIZE(6))
```

XML Representation:

```
<xs:simpleType name="TransitStatus-item" >
       <xs:annotation>
          <xs:appinfo>
             none (0) -- nothing is active
             anADAuse (1) -- an ADA access is in progress  (wheelchairs ,
             aBikeLoad (2) -- loading of a bicyle is in progress
             doorOpen (3) -- a vehicle door is open for passenger access
             occM (4)
             occL (5) -- bits four and five are used to relate the
              -- the relative occupancy of the vehicle ,  with
              -- 00  as least full and 11 indicating a
              -- close-to or full conditon
          </xs:appinfo>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
             <xs:restriction base="xs:int">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="5"/>
             </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
             <xs:restriction base="xs:string">
                <xs:enumeration value="none"/>
                <xs:enumeration value="anADAuse"/>
                <xs:enumeration value="aBikeLoad"/>
                <xs:enumeration value="doorOpen"/>
                <xs:enumeration value="occM"/>
                <xs:enumeration value="occL"/>
             </xs:restriction>
```

```
        </xs:simpleType >
      </xs:union>
</xs:simpleType>
<xs:simpleType name=" TransitStatus">
    <xs:list itemType="TransitStatus-item"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_SignalRequestMessage (SRM)	<ASN>	<XML>, and
MSG	MSG_SignalStatusMessage (SSM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Most of these values are used to detect that the transit vehicle in 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.

7.127 Data Element: DE_TransmissionState

Use: The DE_TransmissionState data element is used to provide the current state of the vehicle transmission. It is typically combined with a speed value to represent the vehicle rate of speed. When used with non-equipped vehicles the value "unavailable" shall be sent.

ASN.1 Representation:

```
TransmissionState  ::= ENUMERATED {
   neutral          (0), -- Neutral, speed relative to the vehicle alignment
   park             (1), -- Park, speed relative the to vehicle alignment
   forwardGears     (2), -- Forward gears, speed relative the to vehicle alignment
   reverseGears     (3), -- Reverse gears, speed relative the to vehicle alignment
   reserved1        (4),
   reserved2        (5),
   reserved3        (6),
   unavailable      (7), -- not-equipped or unavailable value,
                         -- speed relative to the vehicle alignment

   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:simpleType name=" TransmissionState" >
      <xs:annotation>
         <xs:appinfo>
            neutral (0) -- Neutral ,
            park (1) -- Park ,
            forwardGears (2) -- Forward gears ,
            reverseGears (3) -- Reverse gears ,
            reserved1 (4)
            reserved2 (5)
            reserved3 (6)
            unavailable (7) -- not-equipped or unavailable value ,
             -- speed relative to the vehicle alignment
         </xs:appinfo>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
             <xs:restriction base="xs:unsignedInt">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="7"/>
             </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
```

```
                <xs:enumeration value="neutral"/>
                <xs:enumeration value="park"/>
                <xs:enumeration value="forwardGears"/>
                <xs:enumeration value="reverseGears"/>
                <xs:enumeration value="reserved1"/>
                <xs:enumeration value="reserved2"/>
                <xs:enumeration value="reserved3"/>
                <xs:enumeration value="unavailable"/>
            </xs:restriction>
        </xs:simpleType >
        <xs:simpleType>
            <xs:restriction base="local:TransmissionState" />
        </xs:simpleType>
    </xs:union>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

7.128 Data Element: DE_TransmitInterval

Use: Defines time interval between actions or events. (defines the interval between transmissions of probe messages.)

ASN.1 Representation:

```
TxTime ::= INTEGER (1..20)    -- units of seconds
```

XML Representation:

```
<xs:simpleType name=" TxTime" >
    <xs:annotation>
        <xs:documentation>
            units of seconds
        </xs:documentation>
    </xs:annotation>
    <xs:restriction base="xs:unsignedByte">
        <xs:minInclusive value="1"/>
        <xs:maxInclusive value="20"/>
    </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_ProbeDataManagement (PDM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.129 Data Element: DE_TravelerInfoType

Use: The traveler information DE (the type of message if you prefer) to follow in the rest of the message frame structure, used in the traveler information message, which may contain several such structures.

ASN.1 Representation:

```
TravelerInfoType ::= ENUMERATED {
    unknown             (0),
    advisory            (1),
    roadSignage         (2),
    commercialSignage   (3),
    ... -- # LOCAL_CONTENT
    }
    -- values to 127 reserved for std use
    -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" TravelerInfoType" >
      <xs:annotation>
         <xs:appinfo>
            unknown (0)
            advisory (1)
            roadSignage (2)
            commercialSignage (3)
         </xs:appinfo>
         <xs:documentation>
            values to 127 reserved for std use
            values 128 to 255 reserved for local use
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="3"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unknown"/>
               <xs:enumeration value="advisory"/>
               <xs:enumeration value="roadSignage"/>
               <xs:enumeration value="commercialSignage"/>
            </xs:restriction>
         </xs:simpleType >
         <xs:simpleType>
            <xs:restriction base="local:TravelerInfoType" />
         </xs:simpleType>
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.130 Data Element: DE_UniqueMSG_ID

Use: A message link value used to connect to other supporting messages in other formats.

ASN.1 Representation:

```
UniqueMSGID ::= OCTET STRING (SIZE(9))
```

XML Representation:

```
<xs:complexType name=" UniqueMSGID" >
    <xs:simpleContent>
       <xs:extension base="UniqueMSGID-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="UniqueMSGID-string">
    <xs:restriction base="xs:base64Binary">
```

```
      <xs:length value="12"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.131 Data Element: DE_URL_Base

Use: A valid internet style URI / URL in the form of a text string which will form the base of a compound string which, when combined with the 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. The very last letter of the string may be used to differentiate multiple URL-Base values in a single system. This allows for a total of up to 26+10= 36 such base addresses to exist. This last letter is then used to differentiate which base a given short value is to be used with (a matching first letter in the URL-Short value is also used). These letters are stripped from both the base and short data elements before combining to create the final URL/URI value.

ASN.1 Representation:

```
URL-Base ::= IA5String (SIZE(1..45))
```

XML Representation:

```
<xs:simpleType name=" URL-Base" >
      <xs:restriction base="xs:string">
        <xs:minLength value="1"/>
        <xs:maxLength value="45"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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.

7.132 Data Element: DE_URL_Link

Use: A valid internet style URI / URL in the form of a text string which will link to the designated resource.

ASN.1 Representation:

```
URL-Link ::= IA5String (SIZE(1..255))
```

XML Representation:

```
<xs:simpleType name=" URL-Link" >
      <xs:restriction base="xs:anyURI">
        <xs:minLength value="1"/>
        <xs:maxLength value="255"/>
      </xs:restriction>
</xs:simpleType>
```


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Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

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.

7.133 Data Element: DE_URL_Short

Use: 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 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 URL-Base values in a single system is to b 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.

ASN.1 Representation:

```
URL-Short ::= IA5String (SIZE(1..15))
```

XML Representation:

```
<xs:simpleType name=" URL-Short" >
       <xs:restriction base="xs:string">
          <xs:minLength value="1"/>
         <xs:maxLength value="15"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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.

7.134 Data Element: DE_VehicleHeight

Use: The height of the vehicle, measured from the ground to the highest surface, excluding any antenna(s), and expressed in units of 5 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.

ASN.1 Representation:

```
VehicleHeight ::= INTEGER (0..127)
    -- the height of the vehicle
    -- LSB units of 5 cm, range to 6.35 meters
```

XML Representation:

```
<xs:simpleType name=" VehicleHeight" >
       <xs:annotation>
          <xs:documentation>
             the height of the vehicle
             LSB units of 5 cm,  range to 6.35 meters
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedByte">
          <xs:maxInclusive value="127"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.135 Data Element: DE_VehicleLaneAttributes

Use: The VehicleLaneAttributes 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.

ASN.1 Representation:

```
VehicleLaneAttributes  ::=  INTEGER  (0..65535)
-- 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 "TWLTL" (two way left turn lane)
     maneuverBikeLane          VehicleLaneAttributes ::= 32768
                               -- ('1000000000000000'B)
```

XML Representation:

```
<xs:simpleType name=" VehicleLaneAttributes" >
       <xs:annotation>
          <xs:documentation>
             With bits as defined:
          </xs:documentation>
       </xs:annotation>
        <xs:restriction base="xs:unsignedShort"/>
</xs:simpleType>
```


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Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleComputedLane	<ASN>	<XML>, and
DF	DF_VehicleReferenceLane	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: If the VehicleLaneAttributes 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).

7.136 Data Element: DE_VehicleLength

Use: The length of the vehicle measured from the edge of the front bumper to the edge of rear bumper expressed in centimeters, unsigned. Note that this is a 14 bit value and it is combined with a 10 bit value (DE_VehicleWidth) to form a 3 byte data frame. When sent alone it shall occupy 2 bytes. The value zero shall be sent when data is unavailable.

ASN.1 Representation:
```
VehicleLength ::= INTEGER (0..16383) -- LSB units are 1 cm
```

XML Representation:
```
<xs:simpleType name=" VehicleLength" >
      <xs:annotation>
         <xs:documentation>
            LSB units are 1 cm
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="16383"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleSize	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.137 Data Element: DE_VehicleMass

Use: The mass of the vehicle. With an LSB of 50 kg, this produces a max range of 6350kg (about 14,000 lbs). Mass should reflect current gross mass of vehicle and contents if known, otherwise an average laden value should be established. In cases where the mass is greater then 6350 Kg then the value of 127 shall be used.

ASN.1 Representation:
```
VehicleMass ::= INTEGER (1..127) -- mass with an LSB of 50 Kg
```

XML Representation:
```
<xs:simpleType name=" VehicleMass" >
      <xs:annotation>
         <xs:documentation>
            mass with an LSB of 50 Kg
         </xs:documentation>
```

```
      </xs:annotation>
       <xs:restriction base="xs:unsignedByte">
          <xs:minInclusive value="1"/>
          <xs:maxInclusive value="127"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>, and
MSG	MSG_EmergencyVehicleAlert(EVA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.138 Data Element: DE_VehicleRequestStatus

Use: The VehicleRequestStatus 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 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.

ASN.1 Representation:

```
VehicleRequestStatus  ::=  OCTET STRING (SIZE(1))
  -- With bits set as follows:
  -- Bit 7 (MSB)  Brakes-on, see notes for use
  -- Bit 6 Emergency Use or operation
  -- Bit 5 Lights in use (see also the light bar element)
  -- Bits 5~0
  -- when a priority, map the values of
  -- LightbarInUse to the lower 4 bits
  -- and set the 5th bit to zero
  -- when a preemption, map the values of
  -- TransistStatus to the lower 5 bits
```

XML Representation:

```
<xs:complexType name=" VehicleRequestStatus" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             With bits set as follows:
             Bit 7  (MSB)   Brakes-on,  see notes for use
             Bit 6 Emergency Use or operation
             Bit 5 Lights in use  (see also the light bar element)
             Bits 5~0
             when a priority,  map the values of
              LightbarInUse to the lower 4 bits
             and set the 5th bit to zero
             when a preemption,  map the values of
             TransistStatus to the lower 5 bits
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="VehicleRequestStatus-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
```

```
<xs:simpleType name="VehicleRequestStatus-string">
    <xs:restriction base="xs:base64Binary">
      <xs:length value="2"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_SignalRequestMessage (SRM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

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.

7.139 Data Element: DE_VehicleStatusDeviceTypeTag

Use: The VehicleStatusDeviceTypeTag element is an enumeration of every possible value which can be found in the VehicleStatusDeviceType data frame. It is used to denote that value (and hence also the length) of the data which follows it.

ASN.1 Representation:

```
VehicleStatusDeviceTypeTag ::= ENUMERATED {
   unknown              (0),
   lights               (1),  -- Exterior Lights
   wipers               (2),  -- Wipers
   brakes               (3),  -- Brake Applied
   stab                 (4),  -- Stability Control
   trac                 (5),  -- Traction Control
   abs                  (6),  -- Anti-Lock Brakes
   sunS                 (7),  -- Sun Sensor
   rainS                (8),  -- Rain Sensor
   airTemp              (9),  -- Air Temperature
   steering             (10),
   vertAccelThres       (11), -- Wheel that Exceeded the
   vertAccel            (12), -- Vertical g Force Value
   hozAccelLong         (13), -- Longitudinal Acceleration
   hozAccelLat          (14), -- Lateral Acceleration
   hozAccelCon          (15), --  Acceleration Confidence
   accel4way            (16),
   confidenceSet        (17),
   obDist               (18), -- Obstacle Distance
   obDirect             (19), -- Obstacle Direction
   yaw                  (20), -- Yaw Rate
   yawRateCon           (21), -- Yaw Rate Confidence
   dateTime             (22), -- complete time
   fullPos              (23), -- complete set of time and
                              -- position, speed, heading
   position2D           (24), -- lat, long
   position3D           (25), -- lat, long, elevation
   vehicle              (26), -- height, mass, type
   speedHeadC           (27),
   speedC               (28),

   ... -- # LOCAL_CONTENT
   }
   -- values to 127 reserved for std use
   -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" VehicleStatusDeviceTypeTag" >
```

```
<xs:annotation>
   <xs:appinfo>
      unknown (0)
      lights (1) -- Exterior Lights
      wipers (2) -- Wipers
      brakes (3) -- Brake Applied
      stab (4) -- Stability Control
      trac (5) -- Traction Control
      abs (6) -- Anti-Lock Brakes
      sunS (7) -- Sun Sensor
      rainS (8) -- Rain Sensor
      airTemp (9) -- Air Temperature
      steering (10)
      vertAccelThres (11) -- Wheel that Exceeded the
      vertAccel (12) -- Vertical g Force Value
      hozAccelLong (13) -- Longitudinal  Acceleration
      hozAccelLat (14) -- Lateral  Acceleration
      hozAccelCon (15) --  Acceleration Confidence
      accel4way (16)
      confidenceSet (17)
      obDist (18) -- Obstacle Distance
      obDirect (19) -- Obstacle Direction
      yaw (20) -- Yaw Rate
      yawRateCon (21) -- Yaw Rate Confidence
      dateTime (22) -- complete time
      fullPos (23) -- complete set of time and
       -- position ,  speed ,  heading
      position2D (24) -- lat ,
      position3D (25) -- lat ,
      vehicle (26) -- height ,
      speedHeadC (27)
      speedC (28)
   </xs:appinfo>
   <xs:documentation>
      values to 127 reserved for std use
      values 128 to 255 reserved for local use
   </xs:documentation>
</xs:annotation>
<xs:union>
   <xs:simpleType>
      <xs:restriction base="xs:unsignedInt">
         <xs:minInclusive value="0"/>
         <xs:maxInclusive value="28"/>
      </xs:restriction>
   </xs:simpleType>
   <xs:simpleType>
      <xs:restriction base="xs:string">
         <xs:enumeration value="unknown"/>
         <xs:enumeration value="lights"/>
         <xs:enumeration value="wipers"/>
        <xs:enumeration value="brakes"/>
         <xs:enumeration value="stab"/>
         <xs:enumeration value="trac"/>
         <xs:enumeration value="abs"/>
         <xs:enumeration value="sunS"/>
         <xs:enumeration value="rainS"/>
         <xs:enumeration value="airTemp"/>
         <xs:enumeration value="steering"/>
         <xs:enumeration value="vertAccelThres"/>
         <xs:enumeration value="vertAccel"/>
         <xs:enumeration value="hozAccelLong"/>
         <xs:enumeration value="hozAccelLat"/>
         <xs:enumeration value="hozAccelCon"/>
         <xs:enumeration value="accel4way"/>
         <xs:enumeration value="confidenceSet"/>
        <xs:enumeration value="obDist"/>
         <xs:enumeration value="obDirect"/>
         <xs:enumeration value="yaw"/>
         <xs:enumeration value="yawRateCon"/>
```

```
                <xs:enumeration value="dateTime"/>
                <xs:enumeration value="fullPos"/>
                <xs:enumeration value="position2D"/>
                <xs:enumeration value="position3D"/>
                <xs:enumeration value="vehicle"/>
                <xs:enumeration value="speedHeadC"/>
                <xs:enumeration value="speedC"/>
             </xs:restriction>
          </xs:simpleType >
          <xs:simpleType>
             <xs:restriction base="local:VehicleStatusDeviceTypeTag" />
          </xs:simpleType>
       </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatusRequest	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.140 Data Element: DE_VehicleType

Use: The type (classification) of the vehicle in DSRC terms of overall size.

ASN.1 Representation:

```
VehicleType ::= ENUMERATED {
   none                 (0),  -- Not Equipped, Not known or unavailable
   unknown              (1),  -- Does not fit any other category
   special              (2),  -- Special use
   moto                 (3),  -- Motorcycle
   car                  (4),  -- Passenger car
   carOther             (5),  -- Four tire single units
   bus                  (6),  -- Buses
   axleCnt2             (7),  -- Two axle, six tire single units
   axleCnt3             (8),  -- Three axle, single units
   axleCnt4             (9),  -- Four or more axle, single unit
   axleCnt4Trailer      (10), -- Four or less axle, single trailer
   axleCnt5Trailer      (11), -- Five or less axle, single trailer
   axleCnt6Trailer      (12), -- Six or more axle, single trailer
    axleCnt5MultiTrailer (13), -- Five or less axle, multi-trailer
    axleCnt6MultiTrailer (14), -- Six axle, multi-trailer
   axleCnt7MultiTrailer (15),   -- Seven or more axle, multi-trailer
   ... -- # LOCAL_CONTENT
   }
   -- values to 127 reserved for std use
   -- values 128 to 255 reserved for local use
```

XML Representation:

```
<xs:simpleType name=" VehicleType" >
      <xs:annotation>
         <xs:appinfo>
            none (0) -- Not Equipped, Not known or unavailable
            unknown (1) -- Does not fit any other category
            special (2) -- Special use
            moto (3) -- Motorcycle
            car (4) -- Passenger car
            carOther (5) -- Four tire single units
            bus (6) -- Buses
            axleCnt2 (7) -- Two axle, six tire single units
            axleCnt3 (8) -- Three axle, single units
            axleCnt4 (9) -- Four or more axle , single unit
            axleCnt4Trailer (10) -- Four or less axle, single trailer
            axleCnt5Trailer (11) -- Five or less axle, single trailer
            axleCnt6Trailer (12) -- Six or more axle, single trailer
```

```
            axleCnt5MultiTrailer (13) -- Five or less axle, multi-trailer
            axleCnt6MultiTrailer (14) -- Six axle, multi-trailer
            axleCnt7MultiTrailer (15) -- Seven or more axle,  multi-traile
         </xs:appinfo>
         <xs:documentation>
            values to 127 reserved for std use
            values 128 to 255 reserved for local use
         </xs:documentation>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="15"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="none"/>
               <xs:enumeration value="unknown"/>
               <xs:enumeration value="special"/>
               <xs:enumeration value="moto"/>
               <xs:enumeration value="car"/>
               <xs:enumeration value="carOther"/>
               <xs:enumeration value="bus"/>
               <xs:enumeration value="axleCnt2"/>
               <xs:enumeration value="axleCnt3"/>
               <xs:enumeration value="axleCnt4"/>
               <xs:enumeration value="axleCnt4Trailer"/>
               <xs:enumeration value="axleCnt5Trailer"/>
               <xs:enumeration value="axleCnt6Trailer"/>
               <xs:enumeration value="axleCnt5MultiTrailer"/>
               <xs:enumeration value="axleCnt6MultiTrailer"/>
               <xs:enumeration value="axleCnt7MultiTrailer"/>
            </xs:restriction>
         </xs:simpleType >
         <xs:simpleType>
            <xs:restriction base="local:VehicleType" />
         </xs:simpleType>
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 5 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleIdent	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>, and
MSG	MSG_EmergencyVehicleAlert(EVA)	<ASN>	<XML>, and
MSG	MSG_ProbeVehicleData (PVD)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.141 Data Element: DE_VehicleWidth

Use: The width of the vehicle expressed in centimeters, unsigned. Note that this is a 10 bit value and it is combined with a 14 bit value to form a 3 byte data frame. When sent alone it shall occupy 2 bytes with the upper six bits being set to zero. The width shall be the widest point of the vehicle with all factory installed equipment. The value zero shall be sent when data is unavailable.

ASN.1 Representation:

```
VehicleWidth ::= INTEGER (0..1023) -- LSB units are 1 cm
```

XML Representation:

```
<xs:simpleType name=" VehicleWidth" >
       <xs:annotation>
          <xs:documentation>
             LSB units are 1 cm
          </xs:documentation>
       </xs:annotation>
      <xs:restriction base="xs:unsignedShort">
          <xs:maxInclusive value="1023"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleSize	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Observe that this data element is often combined with DE_VehicleLength when used.

7.142 Data Element: DE_VerticalAccelerationThreshold

Use: A bit string enumerating when a preset threshold for vertical acceleration is exceeded at each wheel.

The "Wheel that exceeded Vertical G Threshold" Probe Data Element is intended to inform Probe Data Users which vehicle wheel has exceeded a pre-determined threshold of a percent change in vertical G acceleration per second at the time a Probe Data snapshot was taken. This element is primarily intended to be used in the detection of potholes and similar road abnormalities. This element only provides information for four wheeled vehicles. The element informs the user if the vehicle is NOT equipped with accelerometers on its wheels or that the system is off. 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.

ASN.1 Representation:

```
VerticalAccelerationThreshold ::= BIT STRING {
   allOff       (0), -- B'0000  The condition All Off or not equipped
   leftFront    (1), -- B'0001  Left Front Event
   leftRear     (2), -- B'0010  Left Rear Event
   rightFront   (4), -- B'0100  Right Front Event
   rightRear    (8)  -- B'1000  Right Rear Event
   } -- to fit in 4 bits
```

XML Representation:

```
<xs:simpleType name="VerticalAccelerationThreshold-item" >
       <xs:annotation>
          <xs:appinfo>
             allOff (0) -- B&amp;apos;0000  The condition All Off or not equipped
             leftFront (1) -- B&amp;apos;0001  Left Front Event
             leftRear (2) -- B&amp;apos;0010  Left Rear Event
             rightFront (4) -- B&amp;apos;0100  Right Front Event
             rightRear (8) -- B&amp;apos;1000  Right Rear Event
          </xs:appinfo>
          <xs:documentation>
             to fit in 4 bits
          </xs:documentation>
       </xs:annotation>
       <xs:union>
          <xs:simpleType>
             <xs:restriction base="xs:int">
                <xs:minInclusive value="0"/>
                <xs:maxInclusive value="8"/>
             </xs:restriction>
          </xs:simpleType>
```

```
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:enumeration value="allOff"/>
                  <xs:enumeration value="leftFront"/>
                  <xs:enumeration value="leftRear"/>
                  <xs:enumeration value="rightFront"/>
                  <xs:enumeration value="rightRear"/>
               </xs:restriction>
            </xs:simpleType >
         </xs:union>
</xs:simpleType>
<xs:simpleType name=" VerticalAccelerationThreshold">
    <xs:list  itemType="VerticalAccelerationThreshold-item"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.143 Data Element: DE_VerticalAcceleration

Use: A data element representing the signed vertical acceleration of the vehicle along the vertical axis in units of 0.02 G (where 9.80665 meters per second squared is one G, i.e 0.02 G = 0.1962 meters per second squared). This provides an uneven range of over +1.5 to -3.4G in each direction with some negative values for greater negative ranges as denoted. A one byte payload.

ASN.1 Representation:

```
VerticalAcceleration ::= INTEGER (-127..127)
   -- LSB units of 0.02 G steps over
   -- a range +1.54 to -3.4G
   -- and offset by 50  Value 50 = 0g, Value 0 = -1G
   -- value +127 = 1.54G,
   -- value -120 = -3.4G
   -- value -121 for ranges -3.4 to -4.4G
   -- value -122 for ranges -4.4 to -5.4G
   -- value -123 for ranges -5.4 to -6.4G
   -- value -124 for ranges -6.4 to -7.4G
   -- value -125 for ranges -7.4 to -8.4G
   -- value -126 for ranges larger than -8.4G
   -- value -127 for unavailable data
```

XML Representation:

```
<xs:simpleType name=" VerticalAcceleration" >
      <xs:annotation>
         <xs:documentation>
            LSB units of 0.02 G steps over
            a range +1.54 to -3.4G
            and offset by 50  Value 50 = 0g,  Value 0 = -1G
            value +127 = 1.54G,
            value -120 = -3.4G
            value -121 for ranges -3.4 to -4.4G
            value -122 for ranges -4.4 to -5.4G
            value -123 for ranges -5.4 to -6.4G
            value -124 for ranges -6.4 to -7.4G
            value -125 for ranges -7.4 to -8.4G
            value -126 for ranges larger than -8.4G
            value -127 for unavailable data
         </xs:documentation>
      </xs:annotation>
      <xs:restriction base="xs:byte">
         <xs:minInclusive value="-127"/>
      </xs:restriction>
```

```
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

Remarks: The association of a received value, e.g. -122, with a particular vertical acceleration in the indicated range is left to the discretion of the receiving system.

7.144 Data Element: DE_VINstring,

Use: The VINstring, data element is used to convey a unique identifying string about the vehicle. This may be the vehicle's VIN value assignment, or it may be another string selected by the owner-operator for fleet needs. A shorter value is in general preferred to save bandwidth.

ASN.1 Representation:

```
VINstring ::= OCTET STRING (SIZE(1..17))
   -- A legal VIN or a shorter value
   -- to provide an ident of the vehicle
   -- If a VIN is sent, then IA5 encoding
   -- shall be used
```

XML Representation:

```
<xs:complexType name=" VINstring" >
    <xs:simpleContent>
       <xs:annotation>
          <xs:documentation>
             A legal VIN or a shorter value
             to provide an ident of the vehicle
             If a VIN is sent,  then IA5 encoding
             shall be used
          </xs:documentation>
       </xs:annotation>
       <xs:extension base="VINstring-string" >
          <xs:attribute name="EncodingType" use="required">
            <xs:simpleType>
               <xs:restriction base="xs:NMTOKEN">
                  <xs:enumeration value="base64Binary"/>
               </xs:restriction>
            </xs:simpleType>
          </xs:attribute>
       </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:simpleType name="VINstring-string">
    <xs:restriction base="xs:base64Binary">
       <xs:minLength value="2"/>
       <xs:maxLength value="23"/>
    </xs:restriction>
</xs:simpleType >
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleIdent	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.145 Data Element: DE_WiperRate

Use: The current rate at which wiper sweeps are taking place on the subject vehicle. In units of sweeps per minute. Use a value of 1 for any sweep rate with a period greater than 60 seconds.

ASN.1 Representation:

```
WiperRate ::= INTEGER (0..127) -- units of sweeps per minute
```

XML Representation:

```
<xs:simpleType name=" WiperRate" >
      <xs:annotation>
         <xs:documentation>
            units of sweeps per minute
         </xs:documentation>
      </xs:annotation>
       <xs:restriction base="xs:unsignedByte">
          <xs:maxInclusive value="127"/>
      </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>, and
DF	DF_WiperStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.146 Data Element: DE_WiperStatusFront

Use: The current status of the wiper system on the front of the subject vehicle.

The "Wiper Status" Probe Data Element is intended to inform Probe Data Users whether or not it was raining/snowing at the vehicles location at the time the Probe Data snapshot was taken. The element also provides an indication as to how hard it was raining/snowing by including the "Swipes Per Minute" of the wiper blades across the windshield. The higher the "Swipes Per Minute", the harder it was raining/snowing. 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.

ASN.1 Representation:

```
WiperStatusFront ::= ENUMERATED {
     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
     ... -- # LOCAL_CONTENT
     }
```

XML Representation:

```
<xs:simpleType name=" WiperStatusFront" >
      <xs:annotation>
         <xs:appinfo>
            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
         </xs:appinfo>
      </xs:annotation>
      <xs:union>
```

```
            <xs:simpleType>
               <xs:restriction base="xs:unsignedInt">
                  <xs:minInclusive value="0"/>
                  <xs:maxInclusive value="127"/>
               </xs:restriction>
            </xs:simpleType>
            <xs:simpleType>
               <xs:restriction base="xs:string">
                  <xs:enumeration value="unavailable"/>
                  <xs:enumeration value="off"/>
                  <xs:enumeration value="intermittent"/>
                  <xs:enumeration value="low"/>
                  <xs:enumeration value="high"/>
                  <xs:enumeration value="washerInUse"/>
                  <xs:enumeration value="automaticPresent"/>
               </xs:restriction>
            </xs:simpleType >
            <xs:simpleType>
               <xs:restriction base="local:WiperStatusFront" />
            </xs:simpleType>
         </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>, and
DF	DF_WiperStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: See also the data element WiperRate which conveys the current sweep rate of wiper strokes.

7.147 Data Element: DE_WiperStatusRear

Use: The current status of the wiper system on the rear of the subject vehicle.

The "Wiper Status" Probe Data Element is intended to inform Probe Data Users whether or not it was raining/snowing at the vehicles location at the time the Probe Data snapshot was taken. The element also provides an indication as to how hard it was raining/snowing by including the "Swipes Per Minute" of the wiper blades across the windshield. The higher the "Swipes Per Minute", the harder it was raining/snowing. 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.

ASN.1 Representation:

```
WiperStatusRear ::= ENUMERATED {
      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 wipper equipped
      ... -- # LOCAL_CONTENT
      }
```

XML Representation:

```
<xs:simpleType name=" WiperStatusRear" >
       <xs:annotation>
          <xs:appinfo>
             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 wipper equipped
         </xs:appinfo>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="0"/>
               <xs:maxInclusive value="127"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="unavailable"/>
               <xs:enumeration value="off"/>
               <xs:enumeration value="intermittent"/>
               <xs:enumeration value="low"/>
               <xs:enumeration value="high"/>
               <xs:enumeration value="washerInUse"/>
               <xs:enumeration value="automaticPresent"/>
            </xs:restriction>
         </xs:simpleType >
         <xs:simpleType>
            <xs:restriction base="local:WiperStatusRear" />
         </xs:simpleType>
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>, and
DF	DF_WiperStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: See also the data element WiperRate which conveys the current sweep rate of wiper strokes.

7.148 Data Element: DE_YawRateConfidence

Use: This DE is used to provide the confidence interval of the 95% confidence level for the currently reported value of DE_YAWRate, taking into account the current calibration and precision of the sensor(s) used to measure and/or calculate yaw rate. This data element is only to provide the listener with information on the limitations of the sensing system; not to support any type of automatic error correction or to imply a guaranteed maximum error. This data element should not be used for fault detection or diagnosis, but if a vehicle is able to detect a fault, the confidence interval should be increased accordingly.

The frame of references and axis of rotation used shall be accordance with that defined in SAE J670, Issued 1976-07 and its successors. Note the definitions provided in Figure 1 (Tire Axis System) and Figure 2 (Directional Control Axis Systems).

ASN.1 Representation:

```
YawRateConfidence  ::= ENUMERATED {
   unavailable     (0), -- B'000  Not Equipped with yaw rate status
                        -- or yaw rate status is unavailable
   degSec-100-00   (1), -- B'001  100   deg/sec
   degSec-010-00   (2), -- B'010  10    deg/sec
   degSec-005-00   (3), -- B'011  5     deg/sec
```

```
degSec-001-00   (4), -- B'100  1     deg/sec
degSec-000-10   (5), -- B'101  0.1   deg/sec
degSec-000-05   (6), -- B'110  0.05  deg/sec
degSec-000-01   (7)  -- B'111  0.01  deg/sec
}
-- Encoded as a 3 bit value
```

XML Representation:

```
<xs:simpleType name=" YawRateConfidence" >
      <xs:annotation>
         <xs:appinfo>
            unavailable (0) -- B&apos;000  Not Equipped with yaw rate status
             -- or yaw rate status is unavailable
            degSec 100 00  (1) -- B&apos;001   100   deg/sec
            degSec 010 00  (2) -- B&apos;010   10    deg/sec
            degSec 005 00  (3) -- B&apos;011   5     deg/sec
            degSec 001 00  (4) -- B&apos;100   1     deg/sec
            degSec 000 10  (5) -- B&apos;101   0.1   deg/sec
            degSec 000 05  (6) -- B&apos;110   0.05  deg/sec
            degSec 000 01  (7) -- B&apos;111   0.01  deg/sec
         </xs:appinfo>
         <xs:documentation>
            Encoded as a 3 bit value
          </xs:documentation>
      </xs:annotation>
       <xs:union>
          <xs:simpleType>
              <xs:restriction base="xs:unsignedInt">
                 <xs:minInclusive value="0"/>
                 <xs:maxInclusive value="7"/>
              </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
              <xs:restriction base="xs:string">
                 <xs:enumeration value="unavailable"/>
                 <xs:enumeration value="degSec 100 00"/>
                 <xs:enumeration value="degSec 010 00"/>
                <xs:enumeration  value="degSec  005  00"/>
                 <xs:enumeration value="degSec 001 00"/>
                 <xs:enumeration value="degSec 000 10"/>
                 <xs:enumeration value="degSec 000 05"/>
                 <xs:enumeration value="degSec 000 01"/>
              </xs:restriction>
          </xs:simpleType >
       </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AccelSteerYawRateConfidence	<ASN>	<XML>, and
DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

7.149 Data Element: DE_YawRate

Use: The Yaw Rate of the vehicle, a signed value (to the right being positive) and expressed in 0.01 degrees per second. The "Yaw Rate" Probe Data Element is used in conjunction with the "Yaw Rate Confidence" Data Element to inform others on the amount of a vehicle's rotation about it's longitudinal axis within a certain time period, often at the time a Probe Data snapshot was taken. The Yaw Rate Element reports the vehicle's rotation in degrees per second with the Yaw Rate Confidence Element providing additional information on the coarseness of the Yaw Rate element also in degrees per second.

ASN.1 Representation:

```
YawRate ::= INTEGER (-32767..32767)
   -- LSB units of 0.01 degrees per second (signed)
```

XML Representation:

```
<xs:simpleType name=" YawRate" >
       <xs:annotation>
          <xs:documentation>
             LSB units of 0.01 degrees per second   (signed)
          </xs:documentation>
       </xs:annotation>
       <xs:restriction base="xs:short">
          <xs:minInclusive value="-32767"/>
       </xs:restriction>
</xs:simpleType>
```

Used By: This entry is used directly by one other data structure in this standard, a DF called DF_AllInclusive <ASN> <XML>. In addition, this item may be used by data structures in other ITS standards.

8. External Data Entries

This section defines the precise structure of the external data concepts reused by this standard. The DSRC 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 unless expressly marked otherwise. Definitions for this message set are presented in the following subclauses. The ASN.1 is presented in a section titled ASN.1 Representation. The equivalent XML expression is presented in a section titled XML Representation which follows the translation rule set cited in Clause Two (SAE Standard J2630). Should the two sections conflict in some way, the ASN.1 expression 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. The XML productions follow directly from the ASN.1 specifications and the same rules shall be applied. Users of this standard seeking to be in conformance with it shall follow the normative text outlined here.

8.1 Data Element: DE_Incident Response Equipment [ITIS]

Use: The ITIS enumeration list commonly refered to as "Incident Response Equipment," is assigned the upper byte value of [39] (which provides for value ranges from 9984 to 10239, inclusive). This list is formally called "IncidentResponseEquipment" in the ASN.1 and XML productions. The items in this enumeration list are not allowed to be used as an event category classification. This list contains a total of 72 different phrases. The remaining 55 values up to the lower byte value of [127] are reserved for additional "national" phrases in this byte range. Local phrases may be added to the list starting with the lower byte value of 128 and proceeding upward from there (in other words, the first value assigned for any local additions to this list would be given the value 10112).

ASN.1 Representation:

```
IncidentResponseEquipment ::= ENUMERATED {
    ground-fire-suppression           (9985),
    heavy-ground-equipment            (9986),
    aircraft                          (9988),
    marine-equipment                  (9989),
    support-equipment                 (9990),
    medical-rescue-unit               (9991),
    other                             (9993),   -- Depreciated by fire standards, do not
                                                -- use
    ground-fire-suppression-other     (9994),
    engine                            (9995),
    truck-or-aerial                   (9996),
    quint                             (9997),   -- A five-function type of fire apparatus.
                                                -- The units in the movie Backdraft were
                                                --  quints
    tanker-pumper-combination         (9998),
    brush-truck                       (10000),
    aircraft-rescue-firefighting      (10001),
    heavy-ground-equipment-other      (10004),
    dozer-or-plow                     (10005),
    tractor                           (10006),
    tanker-or-tender                  (10008),
    aircraft-other                    (10024),
    aircraft-fixed-wing-tanker        (10025),
    helitanker                        (10026),
    helicopter                        (10027),
    marine-equipment-other            (10034),
    fire-boat-with-pump               (10035),
    boat-no-pump                      (10036),
    support-apparatus-other           (10044),
    breathing-apparatus-support       (10045),
    light-and-air-unit                (10046),
    medical-rescue-unit-other         (10054),
    rescue-unit                       (10055),
    urban-search-rescue-unit          (10056),
    high-angle-rescue                 (10057),
    crash-fire-rescue                 (10058),
    bLS-unit                          (10059),
    aLS-unit                          (10060),
    mobile-command-post               (10075),  -- Depreciated, do not use
    chief-officer-car                 (10076),
    hAZMAT-unit                       (10077),
    type-i-hand-crew                  (10078),
    type-ii-hand-crew                 (10079),
    privately-owned-vehicle           (10083),  -- (Often found in volunteer fire teams)
    other-apparatus-resource          (10084),  --  (Remapped from fire code zero)
    ambulance                         (10085),
    bomb-squad-van                    (10086),
    combine-harvester                 (10087),
    construction-vehicle              (10088),
    farm-tractor                      (10089),
    grass-cutting-machines            (10090),
    hAZMAT-containment-tow            (10091),
    heavy-tow                         (10092),
    light-tow                         (10094),
    flatbed-tow                       (10114),
    hedge-cutting-machines            (10093),
    mobile-crane                      (10095),
    refuse-collection-vehicle         (10096),
    resurfacing-vehicle               (10097),
    road-sweeper                      (10098),
    roadside-litter-collection-crews  (10099),
    salvage-vehicle                   (10100),
    sand-truck                        (10101),
    snowplow                          (10102),
    steam-roller                      (10103),
    swat-team-van                     (10104),
    track-laying-vehicle              (10105),
```

```
    unknown-vehicle                 (10106),
    white-lining-vehicle            (10107),  -- Consider using Roadwork "road marking
                                              -- operations" unless the objective is to
                                              -- refer to the specific vehicle of this
                                              -- type.  Alternative Rendering: line
                                              --  painting vehicle
    dump-truck                      (10108),
    supervisor-vehicle              (10109),
    snow-blower                     (10110),
    rotary-snow-blower              (10111),
    road-grader                     (10112),  -- Alternative term: motor grader
    steam-truck                     (10113),  -- A special truck that thaws culverts and
                                              -- storm drains

    ... -- # LOCAL_CONTENT_ITIS
    }
```

XML Representation:

```
<xs:simpleType name=" IncidentResponseEquipment" >
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="9984"/>
               <xs:maxInclusive value="10239"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="ground fire suppression" id="_9985"/>
               <xs:enumeration value="heavy ground equipment" id="_9986"/>
               <xs:enumeration value="aircraft" id="_9988"/>
               <xs:enumeration value="marine equipment" id="_9989"/>
               <xs:enumeration value="support equipment" id="_9990"/>
               <xs:enumeration value="medical rescue unit" id="_9991"/>
               <xs:enumeration value="other" id="_9993"/>
               <xs:enumeration value="ground fire suppression other" id="_9994"/>
               <xs:enumeration value="engine" id="_9995"/>
               <xs:enumeration value="truck or aerial" id="_9996"/>
               <xs:enumeration value="quint" id="_9997"/>
               <xs:enumeration value="tanker pumper combination" id="_9998"/>
               <xs:enumeration value="brush truck" id="_10000"/>
               <xs:enumeration value="aircraft rescue firefighting" id="_10001"/>
               <xs:enumeration value="heavy ground equipment other" id="_10004"/>
               <xs:enumeration value="dozer or plow" id="_10005"/>
               <xs:enumeration value="tractor" id="_10006"/>
               <xs:enumeration value="tanker or tender" id="_10008"/>
               <xs:enumeration value="aircraft other" id="_10024"/>
               <xs:enumeration value="aircraft fixed wing tanker" id="_10025"/>
               <xs:enumeration value="helitanker" id="_10026"/>
               <xs:enumeration value="helicopter" id="_10027"/>
               <xs:enumeration value="marine equipment other" id="_10034"/>
               <xs:enumeration value="fire boat with pump" id="_10035"/>
               <xs:enumeration value="boat no pump" id="_10036"/>
               <xs:enumeration value="support apparatus other" id="_10044"/>
               <xs:enumeration value="breathing apparatus support" id="_10045"/>
               <xs:enumeration value="light and air unit" id="_10046"/>
               <xs:enumeration value="medical rescue unit other" id="_10054"/>
               <xs:enumeration value="rescue unit" id="_10055"/>
               <xs:enumeration value="urban search rescue unit" id="_10056"/>
               <xs:enumeration value="high angle rescue" id="_10057"/>
               <xs:enumeration value="crash fire rescue" id="_10058"/>
               <xs:enumeration value="bLS unit" id="_10059"/>
               <xs:enumeration value="aLS unit" id="_10060"/>
               <xs:enumeration value="mobile command post" id="_10075"/>
               <xs:enumeration value="chief officer car" id="_10076"/>
               <xs:enumeration value="hAZMAT unit" id="_10077"/>
               <xs:enumeration value="type i hand crew" id="_10078"/>
               <xs:enumeration value="type ii hand crew" id="_10079"/>
               <xs:enumeration value="privately owned vehicle" id="_10083"/>
               <xs:enumeration value="other apparatus resource" id="_10084"/>
```

```
                <xs:enumeration value="ambulance" id="_10085"/>
                <xs:enumeration value="bomb squad van" id="_10086"/>
                <xs:enumeration value="combine harvester" id="_10087"/>
                <xs:enumeration value="construction vehicle" id="_10088"/>
                <xs:enumeration value="farm tractor" id="_10089"/>
                <xs:enumeration value="grass cutting machines" id="_10090"/>
                <xs:enumeration value="hAZMAT containment tow" id="_10091"/>
                <xs:enumeration value="heavy tow" id="_10092"/>
                <xs:enumeration value="light tow" id="_10094"/>
                <xs:enumeration value="flatbed tow" id="_10114"/>
                <xs:enumeration value="hedge cutting machines" id="_10093"/>
                <xs:enumeration value="mobile crane" id="_10095"/>
                <xs:enumeration value="refuse collection vehicle" id="_10096"/>
                <xs:enumeration value="resurfacing vehicle" id="_10097"/>
                <xs:enumeration value="road sweeper" id="_10098"/>
                <xs:enumeration value="roadside litter collection crews" id="_10099"/>
                <xs:enumeration value="salvage vehicle" id="_10100"/>
                <xs:enumeration value="sand truck" id="_10101"/>
                <xs:enumeration value="snowplow" id="_10102"/>
                <xs:enumeration value="steam roller" id="_10103"/>
                <xs:enumeration value="swat team van" id="_10104"/>
                <xs:enumeration value="track laying vehicle" id="_10105"/>
                <xs:enumeration value="unknown vehicle" id="_10106"/>
                <xs:enumeration value="white lining vehicle" id="_10107"/>
                <xs:enumeration value="dump truck" id="_10108"/>
                <xs:enumeration value="supervisor vehicle" id="_10109"/>
                <xs:enumeration value="snow blower" id="_10110"/>
                <xs:enumeration value="rotary snow blower" id="_10111"/>
                <xs:enumeration value="road grader" id="_10112"/>
                <xs:enumeration value="steam truck" id="_10113"/>
            </xs:restriction>
        </xs:simpleType >
        <xs:simpleType>
            <xs:restriction base="xs:string">
              <xs:pattern value="\[.+\].*"/>
            </xs:restriction>
        </xs:simpleType>
        <xs:simpleType>
            <xs:restriction base="local:IncidentResponseEquipment" />
        </xs:simpleType>
    </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleIdent	<ASN>	<XML>, and
MSG	MSG_EmergencyVehicleAlert(EVA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

8.2 Data Element: DE_ITIS_Text [ITIS]

Use: Simple text used with ITIS codes.

ASN.1 Representation:

```
ITIStext ::= IA5String (SIZE(1..500))
```

XML Representation:

```
<xs:simpleType name=" ITIStext" >
    <xs:restriction base="xs:string">
      <xs:minLength value="1"/>
      <xs:maxLength value="500"/>
    </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ITIS-Codes_And_Text	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

8.3 Data Element: DE_Responder Group Affected [ITIS]

Use: The ITIS enumeration list commonly refered to as "Responder Group Affected," is assigned the upper byte value of [38] (which provides for value ranges from 9728 to 9983, inclusive). This list is formally called "ResponderGroupAffected" in the ASN.1 and XML productions. Items from this enumeration list can be used as an event category classification. This list contains a total of 14 different phrases. The remaining 113 values up to the lower byte value of [127] are reserved for additional "national" phrases in this byte range. Local phrases may be added to the list starting with the lower byte value of 128 and proceeding upward from there (in other words, the first value assigned for any local additions to this list would be given the value 9856).

ASN.1 Representation:

```
ResponderGroupAffected ::= ENUMERATED   {
    emergency-vehicle-units             (9729),  -- Default phrase, to be used when one of
                                                 -- the below does not fit better
    federal-law-enforcement-units       (9730),
    state-police-units                  (9731),
    county-police-units                 (9732),  -- Hint: also sheriff response units
    local-police-units                  (9733),
    ambulance-units                     (9734),
    rescue-units                        (9735),
    fire-units                          (9736),
    hAZMAT-units                        (9737),
    light-tow-unit                      (9738),
    heavy-tow-unit                      (9739),
    freeway-service-patrols             (9740),
    transportation-response-units       (9741),
    private-contractor-response-units   (9742),
    ... --  #  LOCAL_CONTENT_ITIS
    }
    -- These groups are used in coordinated response and staging area information
    -- (rather than typically consumer related)
```

XML Representation:

```
<xs:simpleType name=" ResponderGroupAffected" >
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="9728"/>
               <xs:maxInclusive value="9983"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="emergency vehicle units" id="_9729"/>
               <xs:enumeration value="federal law enforcement units" id="_9730"/>
               <xs:enumeration value="state police units" id="_9731"/>
               <xs:enumeration value="county police units" id="_9732"/>
               <xs:enumeration value="local police units" id="_9733"/>
               <xs:enumeration value="ambulance units" id="_9734"/>
               <xs:enumeration value="rescue units" id="_9735"/>
               <xs:enumeration value="fire units" id="_9736"/>
               <xs:enumeration value="hAZMAT units" id="_9737"/>
               <xs:enumeration value="light tow unit" id="_9738"/>
               <xs:enumeration value="heavy tow unit" id="_9739"/>
```

```
            <xs:enumeration value="freeway service patrols" id="_9740"/>
            <xs:enumeration value="transportation response units" id="_9741"/>
            <xs:enumeration value="private contractor response units" id="_9742"/>
         </xs:restriction>
      </xs:simpleType >
      <xs:simpleType>
         <xs:restriction base="xs:string">
            <xs:pattern value="\[.+\].*"/>
         </xs:restriction>
      </xs:simpleType>
      <xs:simpleType>
         <xs:restriction base="local:ResponderGroupAffected" />
      </xs:simpleType>
   </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleIdent	<ASN>	<XML>, and
MSG	MSG_EmergencyVehicleAlert(EVA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

8.4 Data Element: DE_Vehicle Groups Affected [ITIS]

Use: The ITIS enumeration list commonly refered to as "Vehicle Groups Affected," is assigned the upper byte value of [36] (which provides for value ranges from 9216 to 9471, inclusive). This list is formally called "VehicleGroupAffected" in the ASN.1 and XML productions. Items from this enumeration list can be used as an event category classification. This list contains a total of 35 different phrases. The remaining 92 values up to the lower byte value of [127] are reserved for additional "national" phrases in this byte range. Local phrases may be added to the list starting with the lower byte value of 128 and proceeding upward from there (in other words, the first value assigned for any local additions to this list would be given the value 9344).

ASN.1 Representation:

```
VehicleGroupAffected ::= ENUMERATED   {
   all-vehicles                          (9217),
   bicycles                              (9218),
   motorcycles                           (9219),  -- to include mopeds as well
   cars                                  (9220),  -- (remapped from ERM value of
                                                  -- zero)
   light-vehicles                        (9221),
   cars-and-light-vehicles               (9222),
   cars-with-trailers                    (9223),
   cars-with-recreational-trailers       (9224),
   vehicles-with-trailers                (9225),
   heavy-vehicles                        (9226),
   trucks                                (9227),
   buses                                 (9228),
   articulated-buses                     (9229),
   school-buses                          (9230),
   vehicles-with-semi-trailers           (9231),
   vehicles-with-double-trailers        (9232),  -- Alternative Rendering:  western
                                                  -- doubles
   high-profile-vehicles                 (9233),
   wide-vehicles                         (9234),
   long-vehicles                         (9235),
   hazardous-loads                       (9236),
   exceptional-loads                     (9237),
   abnormal-loads                        (9238),
   convoys                               (9239),
   maintenance-vehicles                  (9240),
```

```
    delivery-vehicles                           (9241),
    vehicles-with-even-numbered-license-plates  (9242),
    vehicles-with-odd-numbered-license-plates   (9243),
    vehicles-with-parking-permits               (9244),
    vehicles-with-catalytic-converters          (9245),
    vehicles-without-catalytic-converters       (9246),
    gas-powered-vehicles                        (9247),
    diesel-powered-vehicles                     (9248),
    lPG-vehicles                                (9249),
    military-convoys                            (9250),
    military-vehicles                           (9251),
    ... -- # LOCAL_CONTENT_ITIS
    }
    -- Classification of vehicles and types of transport
```

XML Representation:

```
<xs:simpleType name=" VehicleGroupAffected" >
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="9216"/>
               <xs:maxInclusive value="9471"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="all vehicles" id="_9217"/>
               <xs:enumeration value="bicycles" id="_9218"/>
               <xs:enumeration value="motorcycles" id="_9219"/>
               <xs:enumeration value="cars" id="_9220"/>
               <xs:enumeration value="light vehicles" id="_9221"/>
               <xs:enumeration value="cars and light vehicles" id="_9222"/>
               <xs:enumeration value="cars with trailers" id="_9223"/>
               <xs:enumeration value="cars with recreational trailers" id="_9224"/>
               <xs:enumeration value="vehicles with trailers" id="_9225"/>
               <xs:enumeration value="heavy vehicles" id="_9226"/>
               <xs:enumeration value="trucks" id="_9227"/>
               <xs:enumeration value="buses" id="_9228"/>
               <xs:enumeration value="articulated buses" id="_9229"/>
               <xs:enumeration value="school buses" id="_9230"/>
               <xs:enumeration value="vehicles with semi trailers" id="_9231"/>
               <xs:enumeration value="vehicles with double trailers" id="_9232"/>
               <xs:enumeration value="high profile vehicles" id="_9233"/>
               <xs:enumeration value="wide vehicles" id="_9234"/>
               <xs:enumeration value="long vehicles" id="_9235"/>
               <xs:enumeration value="hazardous loads" id="_9236"/>
               <xs:enumeration value="exceptional loads" id="_9237"/>
               <xs:enumeration value="abnormal loads" id="_9238"/>
               <xs:enumeration value="convoys" id="_9239"/>
               <xs:enumeration value="maintenance vehicles" id="_9240"/>
               <xs:enumeration value="delivery vehicles" id="_9241"/>
               <xs:enumeration value="vehicles with even numbered license plates"
id="_9242"/>
               <xs:enumeration value="vehicles with odd numbered license plates"
id="_9243"/>
               <xs:enumeration value="vehicles with parking permits" id="_9244"/>
               <xs:enumeration value="vehicles with catalytic converters" id="_9245"/>
            <xs:enumeration value="vehicles without catalytic converters" id="_9246"/>
               <xs:enumeration value="gas powered vehicles" id="_9247"/>
               <xs:enumeration value="diesel powered vehicles" id="_9248"/>
               <xs:enumeration value="lPG vehicles" id="_9249"/>
               <xs:enumeration value="military convoys" id="_9250"/>
               <xs:enumeration value="military vehicles" id="_9251"/>
            </xs:restriction>
         </xs:simpleType >
         <xs:simpleType>
            <xs:restriction base="xs:string">
              <xs:pattern value="\[.+\].*"/>
```

```
            </xs:restriction>
          </xs:simpleType>
          <xs:simpleType>
             <xs:restriction  base="local:VehicleGroupAffected"  />
          </xs:simpleType>
        </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 3 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleIdent	<ASN>	<XML>, and
MSG	MSG_EmergencyVehicleAlert(EVA)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

8.5 Data Frame: DF_ITIS-Codes_And_Text [ITIS]

Use: The use of ITIS codes interspersed with free text. The complete set of ITIS codes can be found in Volume Two of the J2540 Standard. This is a set of nealry 1,500 items which are used to encode common events and list items in ITS.

ASN.1 Representation:

```
ITIScodesAndText ::= SEQUENCE (SIZE(1..100)) OF SEQUENCE {
  item CHOICE     {
       itis  ITIScodes,
       text  ITIStext
       } -- # UNTAGGED
  }
```

XML Representation:

```
<xs:complexType name=" ITIScodesAndText" >
    <xs:sequence minOccurs="1" maxOccurs="100">
       <xs:choice >
          <xs:element name="itis" type="ITIScodes" />
           <xs:element name="text" type=" ITIStext" />
       </xs:choice>
    </xs:sequence>
</xs:complexType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
MSG	MSG_TravelerInformation Message (TIM)	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Refer to the SAE ITIS entry ITIScodes for the complete (and lengthy) listing of these codes and for an XML rendering.

8.6 Data Element: ESS_EssMobileFriction [NTCIP]

Use: Indicates measured coefficient of friction in percent. The value 101 shall indicate an error condition or missing value.

ASN.1 Representation:

```
EssMobileFriction ::= INTEGER (0..101)
```

XML Representation:

```
<xs:simpleType name=" EssMobileFriction" >
```

```
        <xs:restriction base="xs:unsignedByte">
           <xs:maxInclusive value="101"/>
        </xs:restriction>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

8.7 Data Element: ESS_EssPrecipRate_quantity [NTCIP]

Use: 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). A value of 65535 shall indicate an error condition or missing value.

ASN.1 Representation:

```
EssPrecipRate ::= INTEGER (0..65535)
```

XML Representation:

```
<xs:simpleType name=" EssPrecipRate" >
        <xs:restriction base="xs:unsignedShort"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

8.8 Data Element: ESS_EssPrecipSituation_code [NTCIP]

Use: Describes the weather situation in terms of precipitation.

ASN.1 Representation:

```
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)
    }
```

XML Representation:

```
<xs:simpleType name=" EssPrecipSituation" >
        <xs:annotation>
           <xs:appinfo>
              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)
         </xs:appinfo>
      </xs:annotation>
      <xs:union>
         <xs:simpleType>
            <xs:restriction base="xs:unsignedInt">
               <xs:minInclusive value="1"/>
               <xs:maxInclusive value="15"/>
            </xs:restriction>
         </xs:simpleType>
         <xs:simpleType>
            <xs:restriction base="xs:string">
               <xs:enumeration value="other"/>
               <xs:enumeration value="unknown"/>
               <xs:enumeration value="noPrecipitation"/>
               <xs:enumeration value="unidentifiedSlight"/>
               <xs:enumeration value="unidentifiedModerate"/>
               <xs:enumeration value="unidentifiedHeavy"/>
               <xs:enumeration value="snowSlight"/>
               <xs:enumeration value="snowModerate"/>
               <xs:enumeration value="snowHeavy"/>
               <xs:enumeration value="rainSlight"/>
               <xs:enumeration value="rainModerate"/>
               <xs:enumeration value="rainHeavy"/>
               <xs:enumeration value="frozenPrecipitationSlight"/>
               <xs:enumeration value="frozenPrecipitationModerate"/>
               <xs:enumeration value="frozenPrecipitationHeavy"/>
            </xs:restriction>
         </xs:simpleType >
      </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

8.9 Data Element: ESS_EssPrecipYesNo_code [NTCIP]

Use: Indicates whether or not moisture is detected by the sensor.

ASN.1 Representation:

```
EssPrecipYesNo ::= ENUMERATED {precip (1), noPrecip (2), error (3)}
```

XML Representation:

```
<xs:simpleType name=" EssPrecipYesNo" >
      <xs:annotation>
         <xs:appinfo>
            precip (1)
            noPrecip (2)
            error (3)
        </xs:appinfo>
```

```
        </xs:annotation>
        <xs:union>
           <xs:simpleType>
              <xs:restriction base="xs:unsignedInt">
                 <xs:minInclusive value="1"/>
                 <xs:maxInclusive value="3"/>
              </xs:restriction>
           </xs:simpleType>
           <xs:simpleType>
              <xs:restriction base="xs:string">
                 <xs:enumeration value="precip"/>
                 <xs:enumeration value="noPrecip"/>
                 <xs:enumeration value="error"/>
              </xs:restriction>
           </xs:simpleType >
        </xs:union>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Used in ATIS to gross coverage area reports, not just point sensor measurements.

8.10 Data Element: ESS_EssSolarRadiation_quantity [NTCIP]

Use: The direct solar radiation integrated over the 24 hours preceding the observation in Joules, per square meter. A value of 65535 shall indicate a missing value.

ASN.1 Representation:

```
EssSolarRadiation ::= INTEGER (0..65535)
```

XML Representation:

```
<xs:simpleType name=" EssSolarRadiation" >
       <xs:restriction base="xs:unsignedShort"/>
</xs:simpleType>
```

Used By: This entry is directly used by the following 2 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_VehicleStatus	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

8.11 Data Element: EXT_ITIS_Codes [ITIS]

Use: The complete set of ITIS codes can be found in Volume Two of the J2540 Standard. This is a set of over 1,000 items which are used to encode common events and list items in ITS.

ASN.1 Representation:

```
ITIScodes ::= INTEGER (0..65565)
-- 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.  Also the XML expressions commonly use a union of the
-- code values and the textual expressions.
-- Consult SAE J2540 for further details.
```

Used By: This entry is directly used by the following 7 other data structures in this standard (record type, descriptive name, ASN.1, and XML name (if present) of each):

DF	DF_AllInclusive	<ASN>	<XML>, and
DF	DF_ITIS_Phrase_ExitService	<ASN>	<XML>, and
DF	DF_ITIS_Phrase_GenericSignage	<ASN>	<XML>, and
DF	DF_ITIS_Phrase_SpeedLimit	<ASN>	<XML>, and
DF	DF_ITIS_Phrase_WorkZone	<ASN>	<XML>, and
MSG	MSG_RoadSideAlert (RSA)	<ASN>	<XML>, and
DF	DF_ITIS-Codes_And_Text	<ASN>	<XML>.

In addition, this item may be used by data structures in other ITS standards.

Remarks: Refer to the SAE ITIS documents for the complete (and lengthy) listing of these codes and for an XML rendering. An XML schema is also available in the "itis" namespace for this element. Note the "over the wire" format of items in these lists is a 16-bit value in some systems, hence, the use of INTEGER above, however, it is a numbered union of values and phrases in other systems such as XML.

9. Data Concepts Under Development

The following data frames and data elements are still in development in this edition of the standard. They are not recommended for use in new systems and are presented here for reference because there may be deployed systems which make use on of them or which depend on them (both in deployments of DSRC and in other ITS standards). These entries may in turn use definitions taken from other standards that were taken from the then current adopted standards of these organizations. The referenced standards shall be consulted for further information regarding their proper use. Unless otherwise noted in each entry, the below ASN.1 and XML definitions shall be taken as the governing definition when used in this standard, even when a more current revision of the standard is adopted by the issuing organization. In subsequent editions of this standard, these entries may no longer be present.

At this time there are no messages in this category.

10. Conformance

Since this SAE Standard specifies standard message set, data frames and data elements for use by applications intended to utilize the DSRC communications systems, an application will be judged to be in conformance with this Standard by demonstrating functional interoperability with other conformant applications. The level of interoperability possible will initially be limited to applications that can effectively use the initial representative message set, data frames and data elements specified in this Standard. Applications in conformance with this Standard shall be able to receive or to send at least one of the messages defined in this standard.

In addition, an implementation is considered compliant with this standard if all messages, data frames, and data elements that it sends conform to the format and encoding rules specified herein. Conformance to a format requires that:

- required data fields are present,
- no data field is included that is not either required, explicitly optional, or classified as local content,

- data fields appear in the indicated order, and
- numerical values are within specified ranges.

11. Other Application Notes (Informative)

11.1 On the use of TIME

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. This value (and its modulo derivatives) is commonly used in many DSRC applications and forms the basis of many "short" forms of time. Time within the current UTC minute is therefore expressed in a 2 bytes value (range 0 to 60,000 milliseconds) in many messages. The rest of the elements of time (minutes, hours, days, month years etc..) 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 sent as integer values (i.e. Jan is sent as Hex 0x01) and not as ASCII strings as is found in some representations (for example, ISO 8601 expressed as XML where Jan is represented as the ASCII pattern for "01" or Hex 0x3031). In addition, 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.

11.2 Persistence of the temporary MAC ID field

The MAC address used by OBUs is randomly generated at various times according to a timer, or 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.

11.3 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. The data element *URL-Short* must be combined with the contents of the data element *URL-Base* to create a valid URL string in such cases.

11.4 Forward Compatibility in the Standard

The ASN and XML 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 or XML defined here, refer to the Implementation Guide for additional details and examples.

11.5 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.

12. Notes

12.1 Marginal Indicia

A change bar (I) 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.

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Annex A Message Framework

Introduction

This annex is intended as a guide for message framework issues.

Message ID

J2735 messages have no need for a common header and none is defined. A message common header would be data that is common to all messages. It would be part of the transmitted message, unchanged by any lower levels and required and used by a receiving application or applications. The only datum that fits this definition is the DSRCmsgID. The DSRCmsgID is a mandatory element in every J2735 message, and it is required to be the first element.

Frequently Used Elements

For any generic message, the frequently used elements are defined as shown below.

```
-- Generic Message Structure
AnExampleMessage::= SEQUENCE {
   -- DSRCmsgID and Frequently Used Elements
   msgID         DSRCmsgID,
   msgCnt        MsgCount,
   id            TemporaryID,

   -- Message Content itself is defined here
   -- Message Content itself is defined here
   -- Message Content itself is defined here

   ... -- # LOCAL_CONTENT

   -- Final header item
   crc           Msg CRC OPTIONAL
   }
```

The `MsgCount` element is defined as either required or optional in several of the messages. When it is present, it should be placed in the order shown in the specific message set definition of Section 5. See the entry in the preceding section for its definition and usage notes.

The `TemporaryID` element is defined as either required or optional in several messages. When it is present, it should be placed in the order shown in the specific message set definition of Section 5. See the entry in the preceding section for its definition and usage notes.

The CRC element (of type `CRCvalue`) element is defined as either required or optional in several of the messages and the value should always occupy the last two bytes of the message payload.[2] This element is transmitted when the underlying protocols will not expressly provide a suitable CRC value for each recovered (received) message. The purpose of this data element is not to ensure message reception correctness (which the lower layers are presumed to handle) but rather as a message level hash value of the preceding payload content.

Application Programming Interface

An Application Programming Interface (API) is required to process common management information not included in a message (Application Protocol Data Unit). This message related information is not

[2] In fact the T-L-V of this data element occupies the last 4 bytes of the message payload, but only the last two bytes contain the actual crc value itself.

transmitted as part of the message set. An API for J2735 purposes is either information provided by an application which is required by the application's lower layers or is information required by an application and provided by the application's lower layers. The mechanism of communication is not considered in scope for J2735 and may or may not be provided by other standards. Any J2735 API should include the transmitted power level and the message priority.

PSC/PSID

The PSC/PSID is an example of information shared by application and its lower layers. It is considered out of scope for the J2735 standard.

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 J2735.

Priority Related Terms

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 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:

Priority		Access Category
7	Highest	AC3
6		
5		AC2
4		
3		AC1
0		
2		AC0
1	Lowest	

Message Priority (as considered in this annex): 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. Compliance to this standard does not require that an implementation support Message Priority, or that it use the specific values in this annex. Message Priority is not defined as a data element or conveyed within any of the messages 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 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.

DE_Priority: The Priority data frame is used in a DSRC message set to establish the relative importance of certain messages with respect to other similar messages 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.

Message Priority Enforcement

This annex is intended only to provide guidance for recommended priority assignments to messages and message sets. It is informative only.

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 annex and its associated table are simply a tool to promote harmony and communication within a DSRC community.

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.

Adjusting Priority

Although the J2735 defined 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.

Latency Ranges

In this annex, three latency (urgency) ranges are used:

- Less than 10 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.

General Message Priority Scheme

The general message priority scheme is:

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

Table 1 - General Message Priority Scheme

Message Priority Table

The message priority table below incorporates the current and probable message sets (designated as examples):

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])	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
	Background, private mobility data downloads and upgrades	> 20 ms	Area map or database download or upgrade	1

Table 2 - **Message Priorities**

Note that the relative priority of this message represents 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.

[3] **Wave Service Announcements:**

Annex B The Safety Message Handler (Informative)

Annex C 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 Basic Safety Message (BSM) [5.x] 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 annex 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 Annex C, 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 1[4]. 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 A La Carte (ALC) message to send the required information. The ALC has all of the flexibility of the BSM, but with no mandatory part; Part I of the ALC message is similar to Part II of the BSM. 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 1 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.

[4] In this annex, all references to specific applications, data elements, and message rates are purely illustrative.

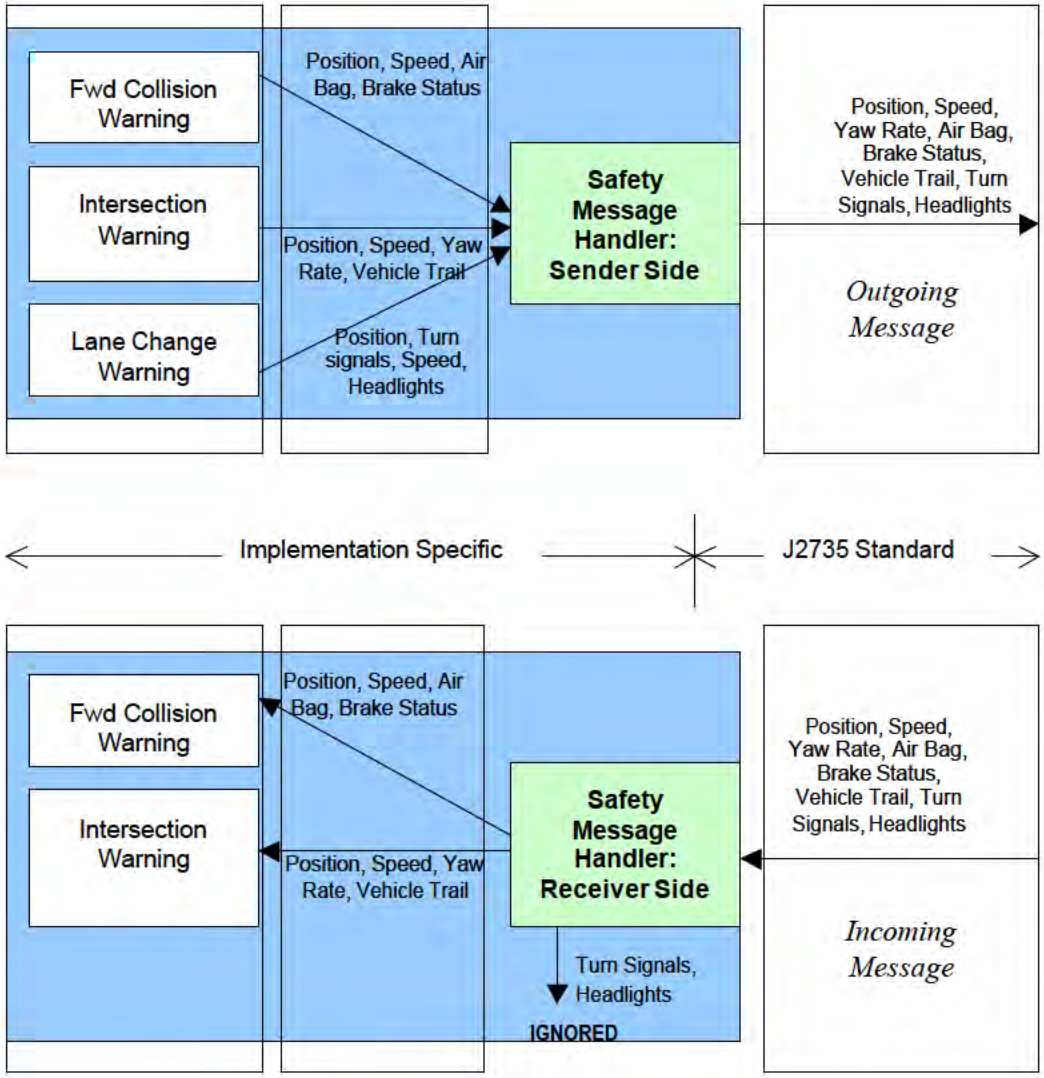


Figure 1: Example Vehicle DSRC Safety System with Safety Message Handler

Figure 1 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 1 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.

Annex C Operation with the Basic Safety Message in Vehicles

Application and Research Implementation Background

The Basic Safety Message 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:

- C.1 Intersection Collision Warning
- C.2 Emergency Electronic Brake Lights
- C.3 Pre-Crash Sensing
- C.4 Cooperative Forward Collision Warning
- C.5 Left Turn Assistant
- C.6 Stop Sign Movement Assistance
- C.7 Lane Change Warning
- C.8 CAMP VSC-A Implementation of V2V Safety Applications Using DSRC BSM

The use of the Basic Safety Message in the relevant vehicle safety application scenarios is described in this annex in Sections C-1 through C-7. These sections of the annex present vehicle safety application scenarios and are meant to illustrate the use of the Basic Safety Message 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 messages in this Standard will fully or partially enable the development of additional vehicle safety applications. Illustrations of such applications may be added to this annex in future versions of this Standard.

Section C-8 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 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 MSG_BasicSafetyMessage, which has a mandatory section (Part I) and an optional section (Part II):

Part I of the MSG_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 Basic Safety Message, and so might be broadcast more frequently than the optional Part II. The transmission frequency of the Basic Safety Message 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 MSG_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.

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.

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 MSG_BasicSafetyMessage 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.

Application use with DSRC

Basic Safety Messages 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 Basic Safety Message is examined for message content and relevance at the application layer of the protocol stack.

Basic Safety Messages 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[5] 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.

[5] Which is presumed to be able to provide position, velocity, and current time values for the vehicle.

Annex C-1 Intersection Collision Warning

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 MSG_BasicSafetyMessages and projects future vectors for these vehicles. If this analysis determines that a collision is likely, an appropriate warning is issued to the driver.

Flow of Events

Flow of events					
1. Vehicle "A" sends MSG_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**
		Driver	**Passenger**		**(Optional – for Relaying)**
	X	**X**			
Support information:	CAMP-VSC Task 3 Report, 2003				

Concept of Operations

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 MSG_BasicSafetyMessage, 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.

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.

Annex C-2 Emergency Electronic Brake Lights

Application Description

When a vehicle brakes hard, the Emergency Electronic Brake Light application conveys this information to surrounding vehicles via one or more Basic Safety Messages. 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.

Flow of Events

<table>
<tr><th colspan="6">Flow of events</th></tr>
<tr><td colspan="6">1. Vehicle "A" sends MSG_BasicSafetyMessage, possibly with additional data associated with the hard braking event, such as a hard-braking event flag</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 (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="6">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="5">DSRC radio
Positional and vehicle sensors
Human-Machine Interface</td></tr>
<tr><td rowspan="2">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></td><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>

Concept of Operation

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 (for example: 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 MSG_BasicSafetyMessage, 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 MSG_BasicSafetyMessage.

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.

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 MSG_BasicSafetyMessage to see if an alert to the driver is necessary.

Annex C-3 Pre-crash Sensing

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.

Flow of Events

<table>
<tr><th colspan="6">Flow of events</th></tr>
<tr><td colspan="6">1. Vehicle “A” sends MSG_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="2">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></td><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>

Concept of Operations

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 MSG_BasicSafetyMessages 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.

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.

Annex C-4 Cooperative Forward Collision Warning

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.

Flow of Events

Flow of events					
1. Vehicle "A" sends MSG_BasicSafetyMessage, periodically					
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.					
3. If so determined, Vehicle "B" processes the message information further to determine the threat level of a front-end crash with Vehicle A.					
4. Based on the threat level determined, Vehicle "B" warns its driver of the potential front-end crash.					
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				

Concept of Operations

This application is similar to the Emergency Electronic Brake Light scenario (Annex C-2). In the Cooperative Forward Collision Warning 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 MSG_BasicSafetyMessage, including the optional path history, at a certain frequency (path history might be included in a subset of all MSG_BasicSafetyMessages). 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.

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.

Annex C-5 Left Turn Assistant

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.

Flow of Events

<table>
<tr><th colspan="6">Flow of events</th></tr>
<tr><td colspan="6">1. Oncoming Vehicle "A" sends MSG_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 colspan="2">Hardware Devices:</td><td colspan="4">DSRC radio
Positional and vehicle sensors
Human-Machine Interface</td></tr>
<tr><td rowspan="2">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></td><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>

Concept of Operations

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

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.

Annex C-6 Stop Sign Movement Assistance

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.

Flow of Events

<table>
<tr><th colspan="6">Flow of events</th></tr>
<tr><td colspan="6">1. Vehicle "A", starting from stop, sends MSG_BasicSafetyMessage</td></tr>
<tr><td colspan="6">2. Vehicle "B" receives message</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td colspan="6">4. Vehicle "B" alerts its driver to a straight crossing path hazard.</td></tr>
<tr><td colspan="6">5. Vehicle "B" sends MSG_BasicSafetyMessage</td></tr>
<tr><td colspan="6">6. Vehicle "A" receives message.</td></tr>
<tr><td colspan="6">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)</td></tr>
<tr><td colspan="6">8. Vehicle "A" alerts its driver to a start-from-stop hazard.</td></tr>
<tr><td colspan="2">Hardware Devices:</td><td colspan="4">DSRC radio
Positional and vehicle sensors
Human-Machine Interface</td></tr>
<tr><td rowspan="2">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></td><td>X</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Support information:</td><td colspan="4">CAMP-VSC Task 3 Report, 2003</td></tr>
</table>

Concept of Operations

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 MSG_BasicSafetyMessages 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.

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.

Annex C-7 Lane Change Warning

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.

Flow of Events

<table>
<tr><th colspan="6">Flow of events</th></tr>
<tr><td colspan="6">1. Overtaking Vehicle "A" sends MSG_BasicSafetyMessage</td></tr>
<tr><td colspan="6">2. Lane-changing 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 (by location in adjacent lane, proximity or rate of overtaking)</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td colspan="2">Hardware Devices:</td><td colspan="4">DSRC radio
Positional and vehicle sensors
Human-Machine Interface</td></tr>
<tr><td rowspan="2">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></td><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>

Concept of Operations

As with the other vehicle safety application scenarios in this annex, 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 MSG_BasicSafetyMessages. 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.

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.

Annex C-8 Implementation of V2V Safety Applications Using DSRC BSM

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 annex 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.

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 1 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 1 – 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 1 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 1.

Safety Applications

The VSC-A Team and USDOT analyzed the crash imminent scenarios in Table 1 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 2 below illustrates the mapping between the crash imminent scenarios identified in Table 1 and the list of safety applications developed and built under the VSC-A program.

Table 2 – 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			✓	✓			

Safety System Structure

In order to support the functionality of the safety applications 0 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 2. This System Block Diagram provides an initial framework that is part of a comprehensive DSRC+Positioning-based safety system.

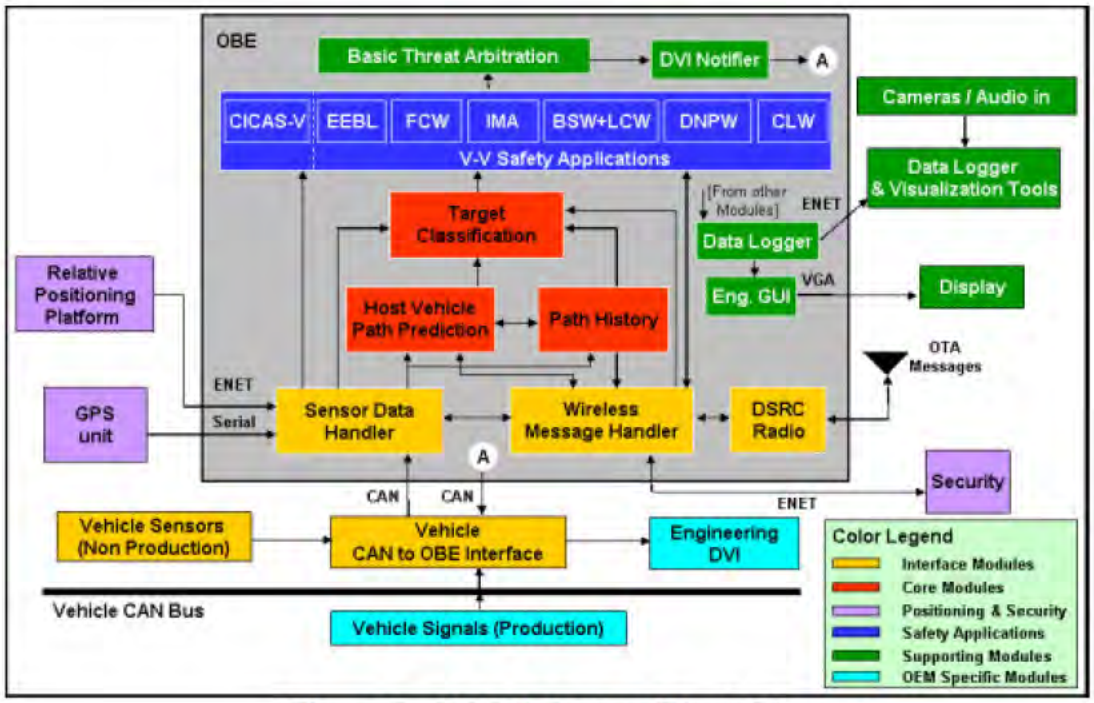


Figure 2 – VSC-A System Block Diagram

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 SAE J2735 Basic Safety Message (BSM) 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 3 – 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

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.

Part II Data Elements

Vehicle Events Object

This object corresponds to the SAE J2735 'DE_EventFlags" 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.

Vehicle Path History Object

This object corresponds to the SAE J2735 'DF_PathHistory' 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 2. 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 closet 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.
- elevOffset: 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 elevOffset described above.

Vehicle Path Prediction Object

This object corresponds to the SAE J2735 'DF_PathPrediction' 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 2. 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.

Vehicle Relative Positioning RTCM 1002 Data Object

This object corresponds to 'msg1002' of the SAE J2735 'DF_RTCMPackage' 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.

Core Modules of Interest for this Annex

A detailed discussion of the VSC-A system modules shown in Figure 2 will take us too far afield in this annex. 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.

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 3).
- Updates the path history concise representation periodically for use by the other VSC-A modules and for transmission over-the-air.

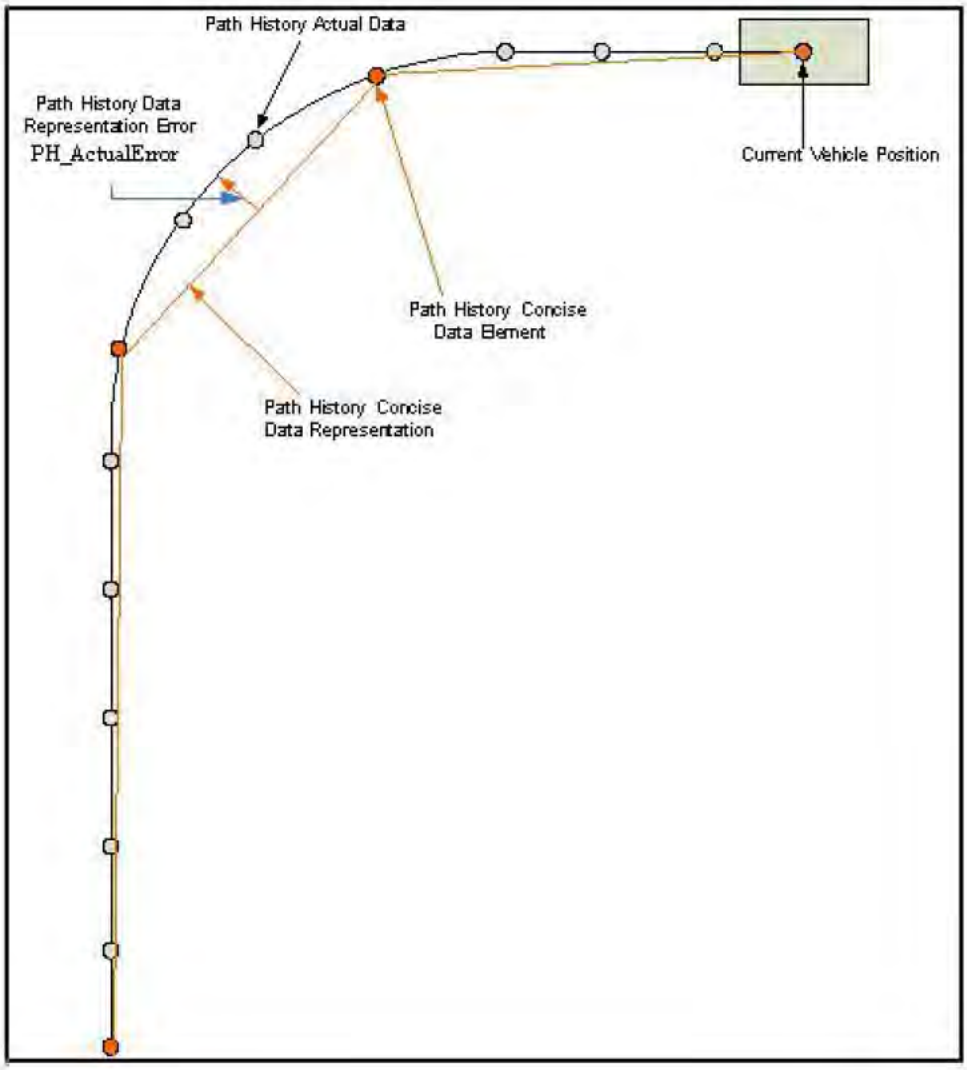


Figure 3 – Actual and Concise Path History Representations

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 4 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.

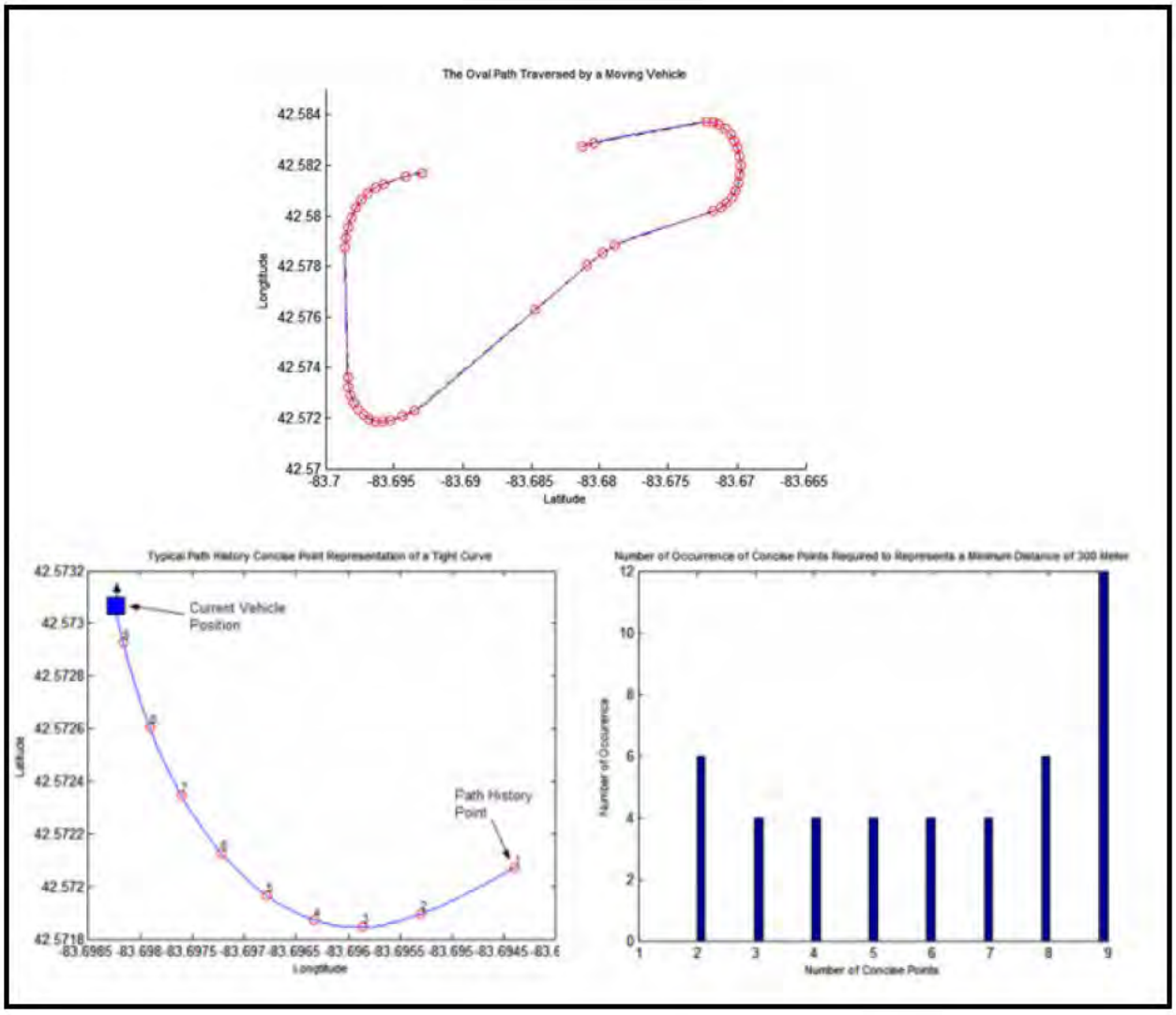


Figure 4 – Typical Concise Path History Representation

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

Radius = 1/curvature (ρ)

- 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.

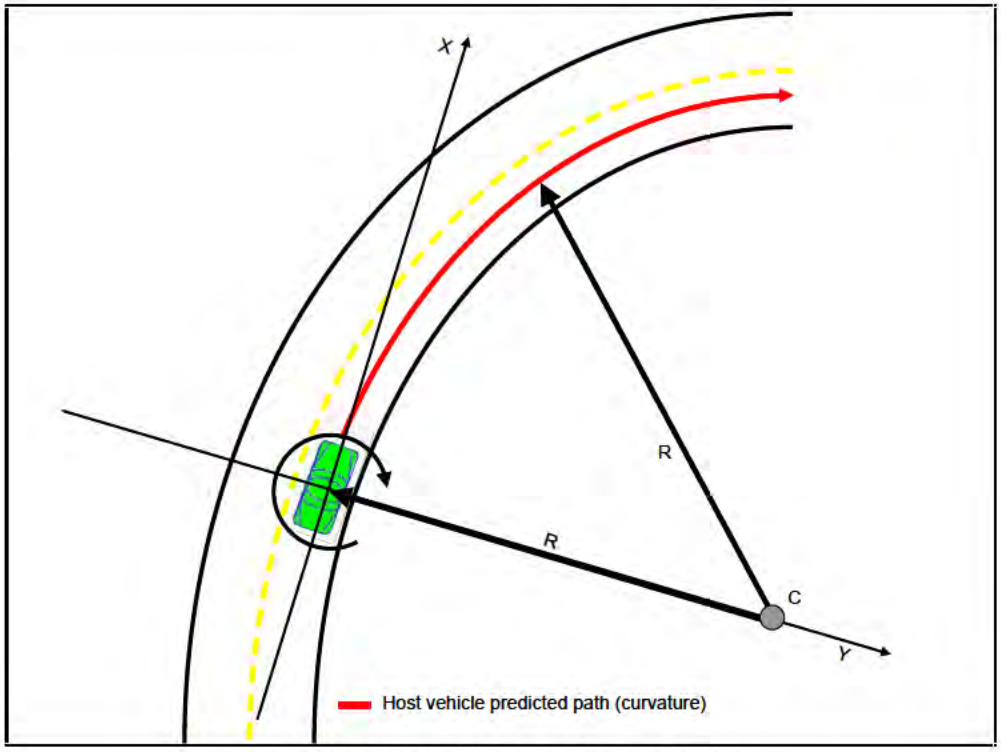


Figure 5 – Host Vehicle Path Prediction

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 5). 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.

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 6. 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 6.

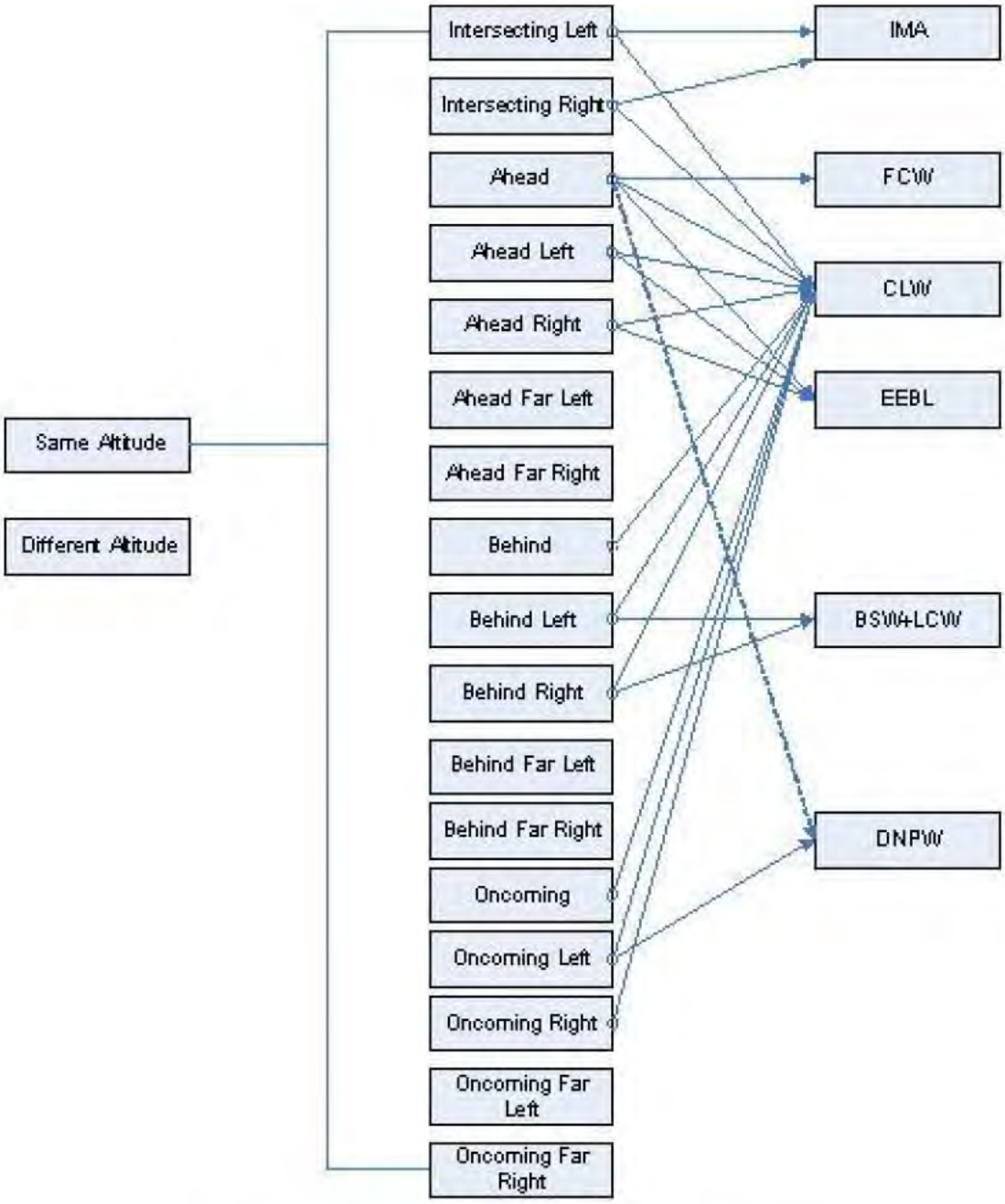
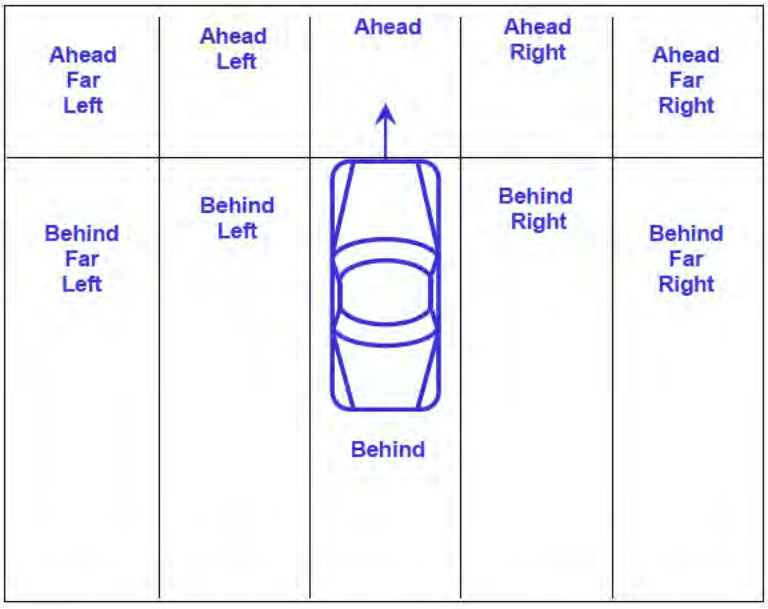
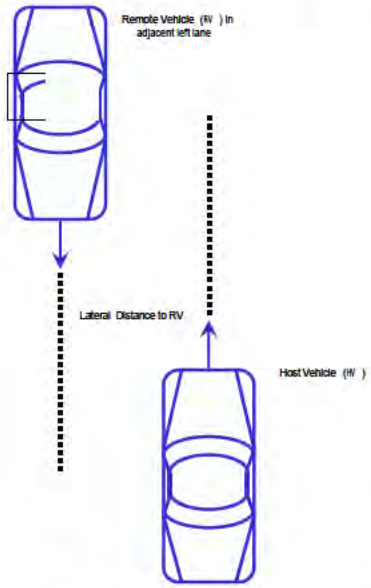


Figure 6 – Target Classifications used by VSC-A Applications



Same Direction RV Classifications



Oncoming Left RV Classification
(Oncoming Far Left, Right, and Far Right also supported)

Intersecting Right RV Classification
(Intersecting Left also supported)

Figure 7 – Remote Vehicle Target Classifications

Figure 7 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 3. 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.

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 8 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 annex.

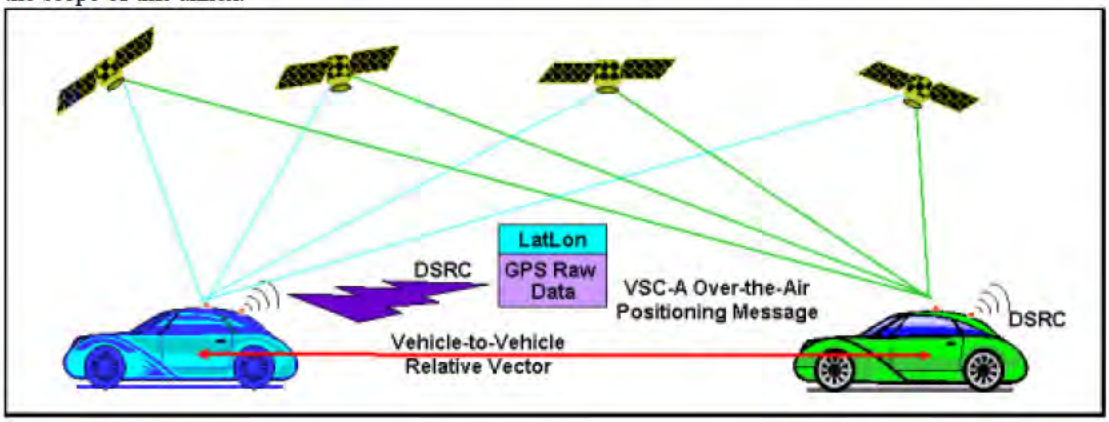


Figure 8 – Vehicle Position Data Exchange in VSC-A

References

[1] VSC 2 consortium, *"Vehicle Safety Communications – Applications VSC-A First Annual Report December 7, 2006 through December 31, 2007,"* found at: ***http://www.intellidriveusa.org/applications/cicas/09042008-vsc-a-report.pdf***

[2] 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'

Annex D: Traveler Information Message Use and Operation

This is an informative annex. It provides suggested implementations as well as descriptions of how the message set might be used. It is not a normative document.

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. 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 Annex 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.

Traveler Information Packet Structure

The following text describes the format of a packet containing multiple individual advisories or road signs. (Refer to Figure 1: Packet Format, on the following pages)

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.

```
packetID            OCTET STRING (SIZE(4)),
-- PacketID (4-Byte ID)
-- Recommended packetID structure
```

Byte 1	Bytes 2-4
Agency ID	MinuteOfTheYear

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, direction 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 is typically painted (and therefore static).

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.

Data Frame Content

All advisory content consists of multiple ITIS code/text fields and an optional URL to images or additional information.

The format of road sign content depends on the MUTCD code for the sign. Existing formats for road sign content include – speed limit, work zone warning, and exit services. Additional content formats will be defined in further editions of this Standard. These future formats will couple similar types of road signs into broad categories. Each broad category of road signs will share a common content format. The general format follows the established rules for using ITIS text and phrases, but with minor presumptions or restrictions for DSRC needs.

A provision also exists for a generic road sign category. The list of valid MUTCD codes (DE_MUTCDCode) includes a "generic" value. All generic road sign content also allows a text field and an optional URL[6] pointing to additional information. In general free text is avoided in the DRSC message set work, but here limited means are provided to allow some free text (often needed for local street and place names).

[6] Bring up the concept of a base URL/URI to be found in another periodically sent "background" message here. Will need yet another short annex to further develop this concept. Does the committee want to support NTCIP "MULTI" strings from CMS/VMS signs here as well?

Packet Format Diagram

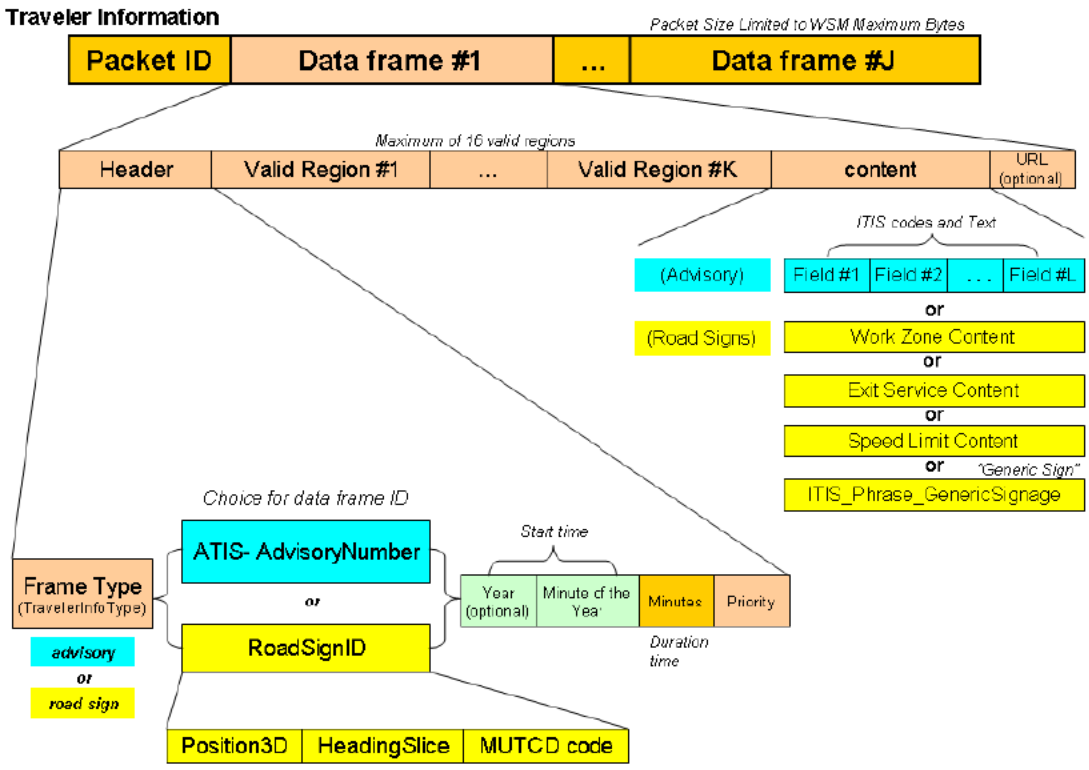


Figure 1: Packet Format

The ASN presentation of the message (`TravelerInformation`) can be found in section 5 of document (along with its XML form) .

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.

Packet Format							Meta Data for Example	Message Payload for Example
Packet Header			DSRC message ID	DSRCmsgID	traveler information message		TIM	16
			packet ID (optional) recommended Structure Not Required	UniqueMSG_ID	OCTET STRING	(4 Bytes)		0x04003570
				AgencyID	(0..255)	AgencyID	Agency Id	(0x04)
				MinuteOfTheYear	(0..527999)	Rubish time of packet	January 10th 2008 12:00 p.m.	13680 (0x003570)
			URL - Basis (optional)	IA5String	(1..45)			"http://traffic.gov...z"
			data frame count (optional)	INTEGER	(1..8)		2 advisories in packet	2
"Data Frame #1 of 2"	Part I (header)		frame type	TravelerInfoType	Enumeration		advisory	1
			message ID (Advisory choice)	FurtherInfoID (required)	OCTET STRING	(2 bytes)		0x1A51
			Start Time	DYear (optional)	INTEGER	(0..9999)	2008	2008
				MinuteOfTheYear	INTEGER	(0..527999)	1/10/08 2:45 p.m.	13,845
			Duration Time	MinutesDuration	INTEGER	(0..65000)	30 days	43,200
			SignPriority	INTEGER	(0..7)		very low	0
	Part II (regions)	applicable to all regions		commonAnchor	(optional)	Position3D		
				commonLaneWidth	(optional)	LaneWidth		
				commonDirectionality	(optional)	DirectionOfUse		
		VehReg#1	Extent	(optional)	Enumeration			
			(area choice) Circle	direction (HeadingSlice)	OCTET STRING	(2 bytes)	Westardly travel	B'0011100000000000
				(center) Position3D	Lattitude	INTEGER	42.2819N	338,255,600
					Longitude	INTEGER	84.29868W	-674,365,440
					Elevation	INTEGER	300 meters	13,000
				(choice) radiusSteps	INTEGER (0..32767)	LSB=2.5cm	100 meter radius	4,000
		VehReg#2	Extent	(optional)	Enumeration			
			(area choice) Circle	direction (HeadingSlice)	OCTET STRING	(2 bytes)	Westardly travel	B'0011100000000000
				(center) Position3D	Lattitude	INTEGER	42.27956N	338,237,280
					Longitude	INTEGER	84.30806W	-674,464,720
					Elevation	INTEGER	300 meters	13,000
				(choice) radiusSteps	INTEGER (0..32767)	LSB=2.5cm	100 meter radius	4,000
	Part III (content)	(advisory choice)		ITIS-Codes_And_Text	(ITIS_Codes choice)	INTEGER(0..65535)	drive carefully	7169
				ITIS-Codes_And_Text	(ITIS_Codes choice)	INTEGER(0..65535)	work in median	1030
		URL-Short (optional)		IA5String	(1..15)			"i603..."
"Data Frame #2 of 2"	Part I "Header"	frame type		TravelerInfoType	Enumeration		advisory	1
		message ID (Advisory choice)		FurtherInfoID (required)	OCTET STRING	(2 bytes)		0x1A52
		Start Time		DYear (optional)	INTEGER	(0..9999)	2008	2008
				MinuteOfTheYear	INTEGER	(0..527999)	1/10/08 12:00 p.m.	13,080
		Duration Time		MinutesDuration	INTEGER	(0..65000)	5 days	7,200
		SignPriority		INTEGER	(0..7)		very high	7
	Part II (regions)	applicable to all regions		commonAnchor	(optional)	Position3D		
				commonLaneWidth	(optional)	LaneWidth		
				commonDirectionality	(optional)	DirectionOfUse		
			Extent	(optional)	Enumeration			
			(area choice) Shape Point Set	(anchor) Position3D	DE_Latitude	INTEGER	42.269N	338,152,000
					DE_Longitude	INTEGER	84.532W	-676,256,000
					DE_Elevation	INTEGER	300 meters	13,000
				LaneWidth	INTEGER (0..32767)	LSB=1.0cm	50 meters	5,000
				DirectionOfUse	Enumeration	(forward, reverse, both)	forward	0
				node1	xOffset	INTEGER (LSB=1.0cm)	0 meters east	
					yOffset	INTEGER (LSB=1.0cm)	0 meters north	
					zOffset (optional)	INTEGER (LSB=1.0cm)		
					width (optional)	LaneWidth		
				node2	xOffset	INTEGER (LSB=1.0cm)	300 meters east	30,000
					yOffset	INTEGER (LSB=1.0cm)	42 meters north	4,200
					zOffset (optional)	INTEGER (LSB=1.0cm)		
					width (optional)	LaneWidth		
	Part III (content)	(advisory choice)		ITIS-Codes_And_Text	(ITIS_Codes choice)	INTEGER(0..65535)	reduced to one lane	777
				ITIS-Codes_And_Text	(ITIS_Codes choice)	INTEGER(0..65535)	paving operations	1029
				ITIS-Codes_And_Text	(ITIS_Codes choice)	INTEGER(0..65535)	use left lane	7420
		URL-Short (optional)		IA5String	(1..15)			"z/detroit604..."
CRC								0xWXYZ

Figure 2: Travel Advisory Example

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.

Packet Format							Meta Data for Sample	Message Payload for Sample
Packet Header		DSRC message ID		DSRCmsgID	traveler information message		TIM	16
		packet ID (optional) recommended Structure Not Required		UniqueMSG_ID	OCTET STRING	(4 Bytes)		0x010034BC
				AgencyID	*(0..255)*	*AgencyID*	Agency #1 January 10th, 2008 9:00 AM	0*1(0x01) 13600(0x0034BC)*
		URL - Base (optional)		IA5String	(1..45)			"http://traffic.gov...z"
		data frame count (optional)		INTEGER	(1..8)		2 signs in packet	2
"Data Frame #1 of 2"	Part I (header)	frame type		TravelerInfoType	Enumeration		road sign	2
		message ID (choice) - RoadSignID	Position3D	Latitude	INTEGER		42.285N	338,360,000
				Longitude	INTEGER		84.98W	-679,840,000
				Elevation	INTEGER		300 meters	13,000
			HeadingSlice	OCTET STRING	(2 bytes)		Seen Traveling West	B'0001000000000000
			MUTCDCode	(optional)	INTEGER	(0..127)	generic	tbd
			msgCRC	(optional)				
		Start Time	DYear (optional)	INTEGER	(0..9999)		2008	2008
			MinuteOfTheYear	INTEGER	(0..523960)		1/16/2008 9:00	20700
		Duration Time	MinutesDuration	INTEGER	(0..65000)		30 days	43,200
		SignPriority		INTEGER	(0 .. 7)		very low	0
	Part II (regions)	applicable to all regions	commonAnchor	(optional)	Position3D			
			commonLaneWidth	(optional)	LaneWidth			
			commonDirectionality	(optional)	DirectionOfUse			
		ValidRegion	Extent	(optional)	Enumeration			
			(area choice) Circle	direction	HeadingSlice	OCTET STRING	Westardly travel	B'0011100000000000
				(center) Position3D	Latitude	INTEGER	42.26195N	338,255,600
					Longitude	INTEGER	84.29568W	-674,365,440
					Elevation	INTEGER	300 meters	13,000
				(choice) radiusSteps	INTEGER (0..32767)	LSB=2.5cm	100 meter radius	4,000
	Part III (content)	(generic sign choice) ITIS_Phrase_GenericSignage			DE_ITIS_Text	IA5String		"sign 1 text here"
		URL-Short (optional)		IA5String	(1..15)			"/sign53..."
"Data Frame #2 of 2"	Part I (header)	Frame Type		TravelerInfoType	Enumeration		road sign	2
		message ID (choice) - RoadSignID	Position3D	Latitude	INTEGER		42.269N	338,152,000
				Longitude	INTEGER		84.532W	-676,256,000
				Elevation	INTEGER		300 meters	13,000
			HeadingSlice	OCTET STRING	(2 bytes)		Seen Traveling East	B'0000000000010000
			MUTCDCode	INTEGER	(0..127)		generic	tbd
			msgCRC	(optional)				
		Start Time	DYear (optional)	INTEGER	(0..9999)		February 2nd	33
			MinuteOfTheYear	INTEGER	(0..523960)		9:00 AM	540
		Duration Time	MinutesDuration	INTEGER	(0..65000)		10 days	14,400
		SignPriority		INTEGER	(0 .. 7)		very high	7
	Part II (regions)	applicable to all regions	commonAnchor	(optional)	Position3D			
			commonLaneWidth	(optional)	LaneWidth			
			commonDirectionality	(optional)	DirectionOfUse			
		ValidRegion	Extent	(optional)	Enumeration			
			(area choice) Circle	direction	HeadingSlice	OCTET STRING	Easterly travel	B'0000000000111000
				(center) Position3D	Latitude	INTEGER	42.269N	338,152,000
					Longitude	INTEGER	84.532W	-676,256,000
					Elevation	INTEGER	300 meters	13,000
				(choice) radiusSteps	INTEGER (0..32767)	LSB=2.5cm	100 meter radius	4,000
	Part III (content)	(generic sign choice) ITIS_Phrase_GenericSignage			DE_ITIS_Text	IA5String		"sign 2 text here"
		URL-Short (optional)		IA5String	(1..15)			"2/sign54..."
crc								0xWXYZ

Figure 3: Road Sign Example

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 Road Side Unit (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.

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.

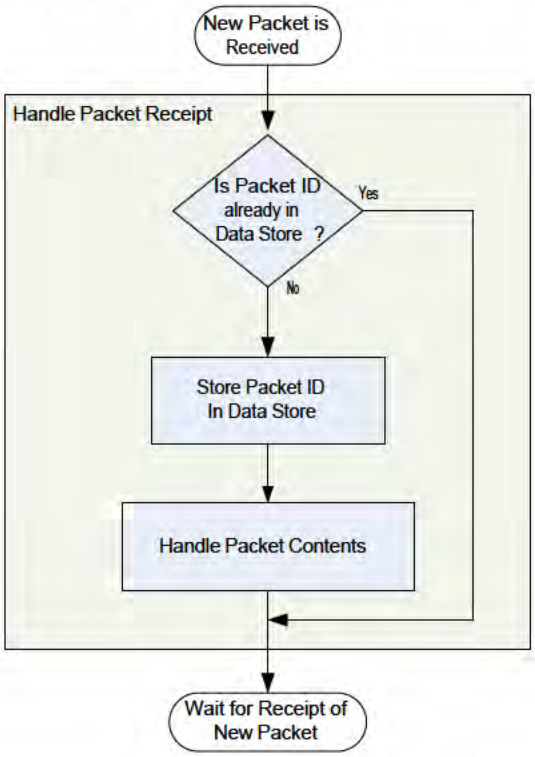


Figure 4: Handle Packet Receipt

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.

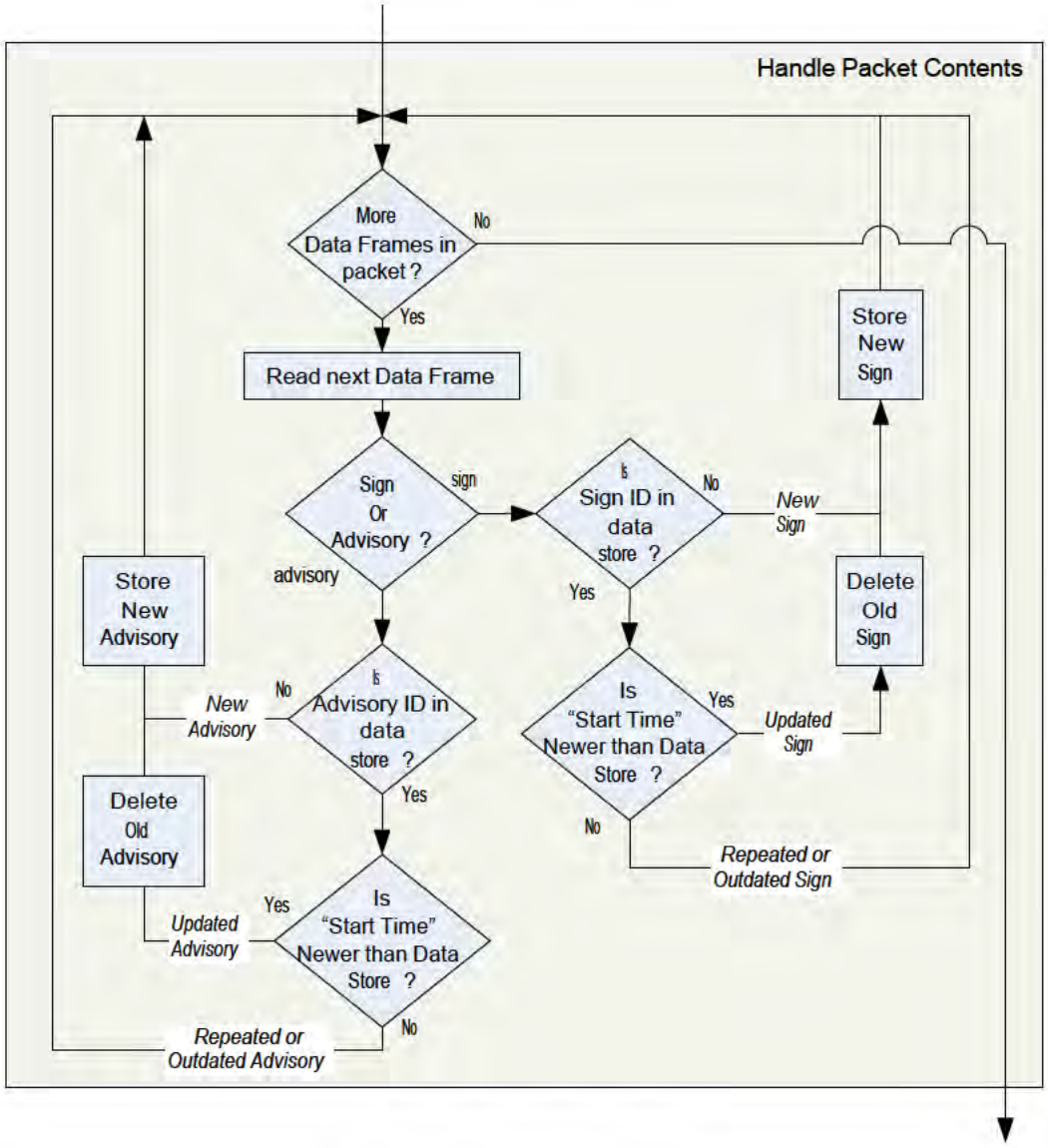


Figure 5: Handle Packet Contents

Replacement Policy for Locally-Stored Messages

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, FIFO, start time, etc.

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 1. This allows for updated traveler information. A weather advisory issued in the morning may need to be updated later as conditions change.

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.

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.)

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.

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.

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.

ASN.1 Representation:

```
ValidRegion ::= SEQUENCE {

   extent              Extent OPTIONAL,
                      -- the spatial distance over which this
                      -- message applies and should be presented
                      -- to the driver
   area     CHOICE  {
      shapePointSet    ShapePointSet,
                      -- A short road segment
      polygon          Polygon,
                      -- A polygon region
      circle           Circle
                      -- A point and radius
      }
   }
```

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.

ASN.1 Representation:

```
Circle ::= SEQUENCE {
   direction  HeadingSlice,     --field of view over which this applies
   center     Position3D,
   radius     CHOICE {
                radiusSteps  INTEGER (0..32767),
                              -- in unsigned values where
                              -- the LSB is in units of 2.5 cm
                miles        INTEGER (1..2000),
                km           INTEGER (1..5000)
              } --# UNTAGGED
   }
```

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 vehicle within the region. An advisory is valid anytime a vehicle is within the circular region and traveling within the direction defined by DE_HeadingSlice. In Figure 6, a circular region is used for a coastal flooding advisory. The region is centered on Zeeland, MI with a 30 mile radius. The DE_HeadingSlice 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.

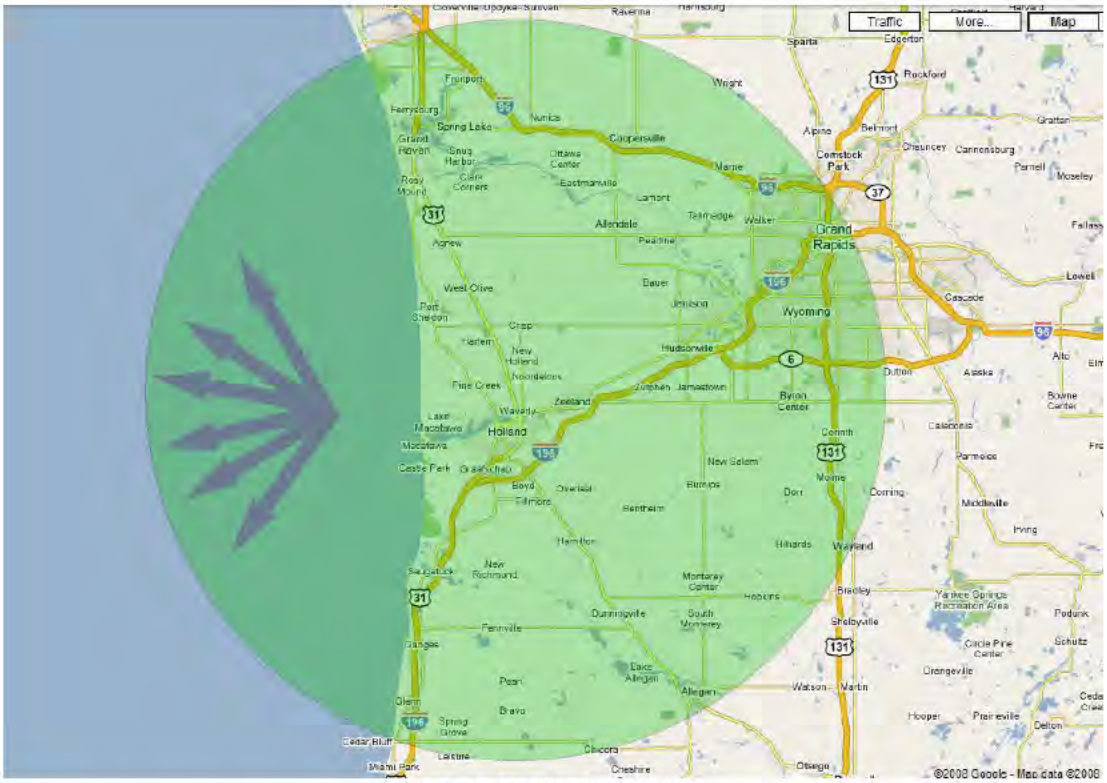


Figure 6: Circular Region

Extremely Large Regions

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 DE_HeadingSlice 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 7 graphically demonstrates the region.

DF_Circle (choice)	DE_HeadingSlice	INTEGER	(0..65535)		Omni-Directional	B'1111111111111111
	DF_Position3D	DE_Latitude	INTEGER		42.5N	340,000,000
		DE_Longitude	INTEGER		83.5W	-668,000,000
		DE_Elevation	INTEGER		300 meters	13,000
	km (choice)	INTEGER (0..5000)	kilometers		100 kilometer radius	100



Figure 7: Large Weather Advisory

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 below)

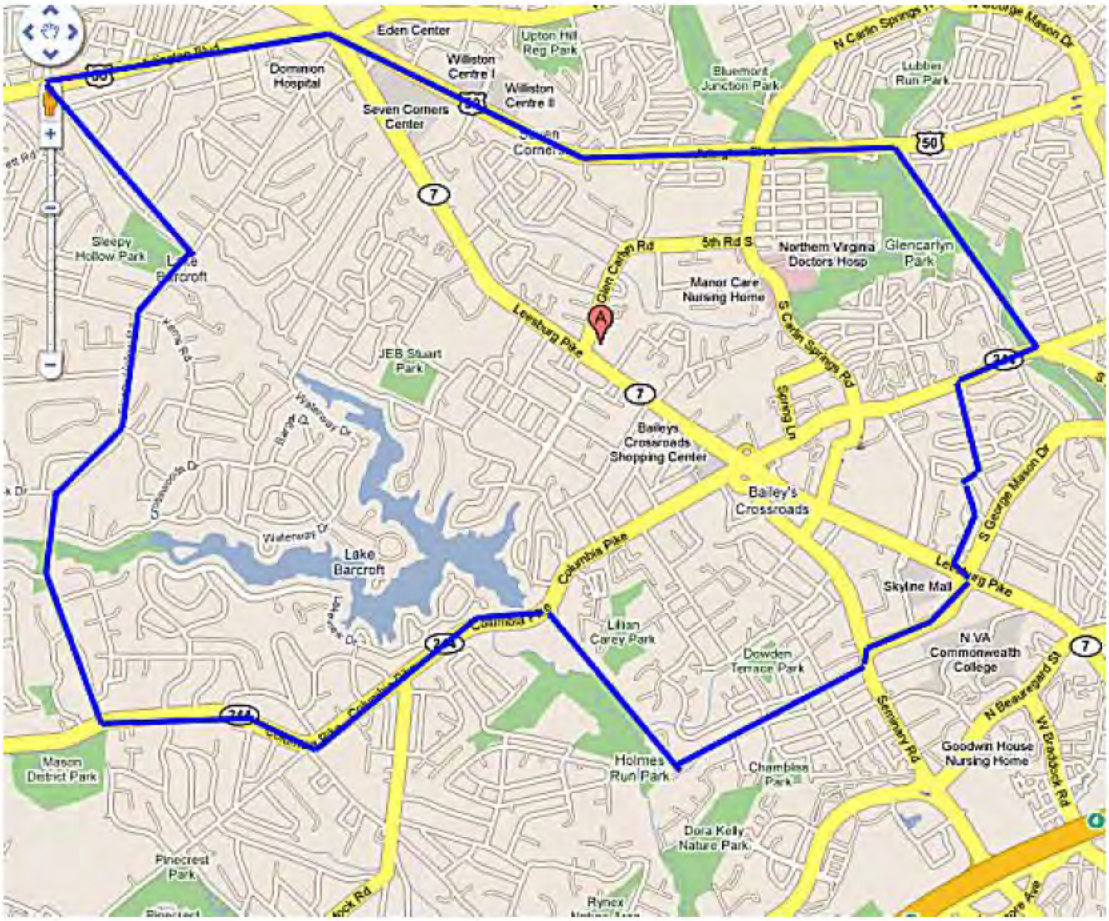


Figure 9: Jurisdictional Coverage of a particular Agency

ASN.1 Representation:

```
Polygon ::=    SEQUENCE {
       direction     HeadingSlice,
       anchor        position3D,          --anchor of polygon

       nodeList      NodeList,            --describes perimeter of polygon

}

where:


NodeList ::= SEQUENCE (SIZE(1..64)) OF  Offsets
       --each offset describes the next in-order
       --vertex around the polygon as referenced
       --to the anchor point.


Offsets ::= SEQUENCE {
    xOffset   INTEGER (-32767..32767),
    yOffset   INTEGER (-32767..32767),
    zOffset   INTEGER (-32767..32767) OPTIONAL,
              -- all in signed values where
              -- the LSB is in units of 1.0 cm

}
```

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).

ASN.1 Representation:

```
ShapePointSet ::= SEQUENCE {
   anchor            Position3D,
   laneWidth         LaneWidth   OPTIONAL, -- initial width
   nodeList          NodeList,             -- path details of the lane and width
   ...
   }
where:

NodeList ::= SEQUENCE (SIZE(1..64)) OF  Offsets

Offsets ::= SEQUENCE {
   xOffset   INTEGER (-32767..32767),
   yOffset   INTEGER (-32767..32767),
   zOffset   INTEGER (-32767..32767) OPTIONAL,
             -- all in signed values where
             -- the LSB is in units of 1.0 cm
   width     LaneWidth               OPTIONAL
   }
```

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 9, an intersection is defined by two ValidRegions. Both regions are simple shape point sets containing only two nodes each.

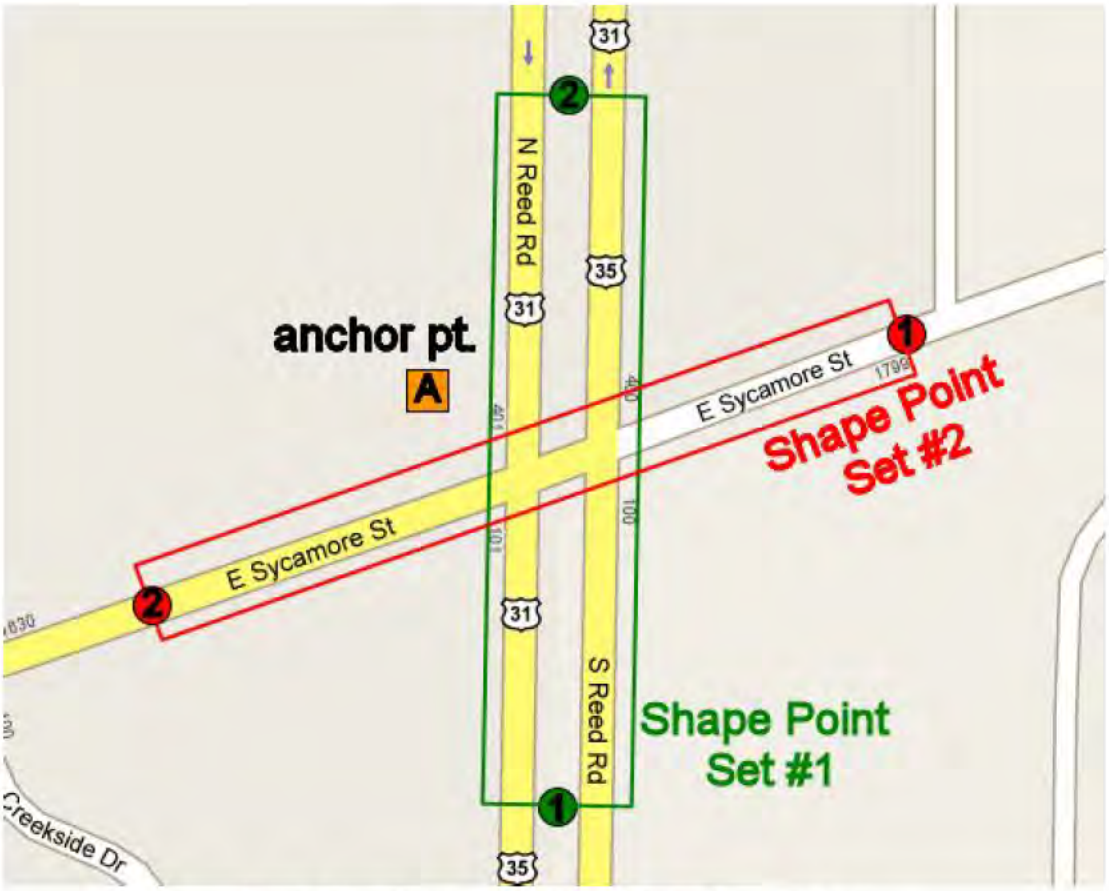


Figure 9: Simple Intersection defined by two shape point sets

Multiple-Regions

Traveler Advisory data frames can contain up to sixteen Valid Region elements. In figure 10, 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.

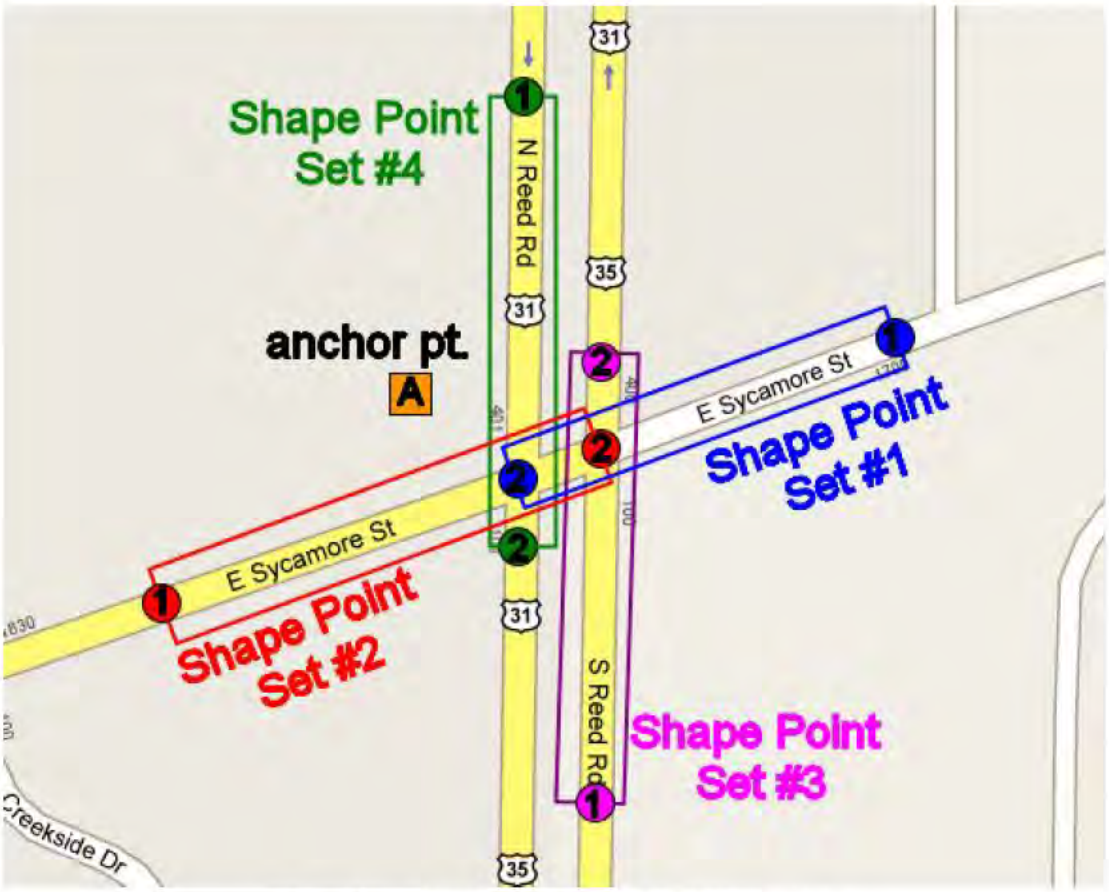


Figure 10: Intersection defined by 4 shape point sets

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 11, show that even a modest number of nodes can represent a curved road well.

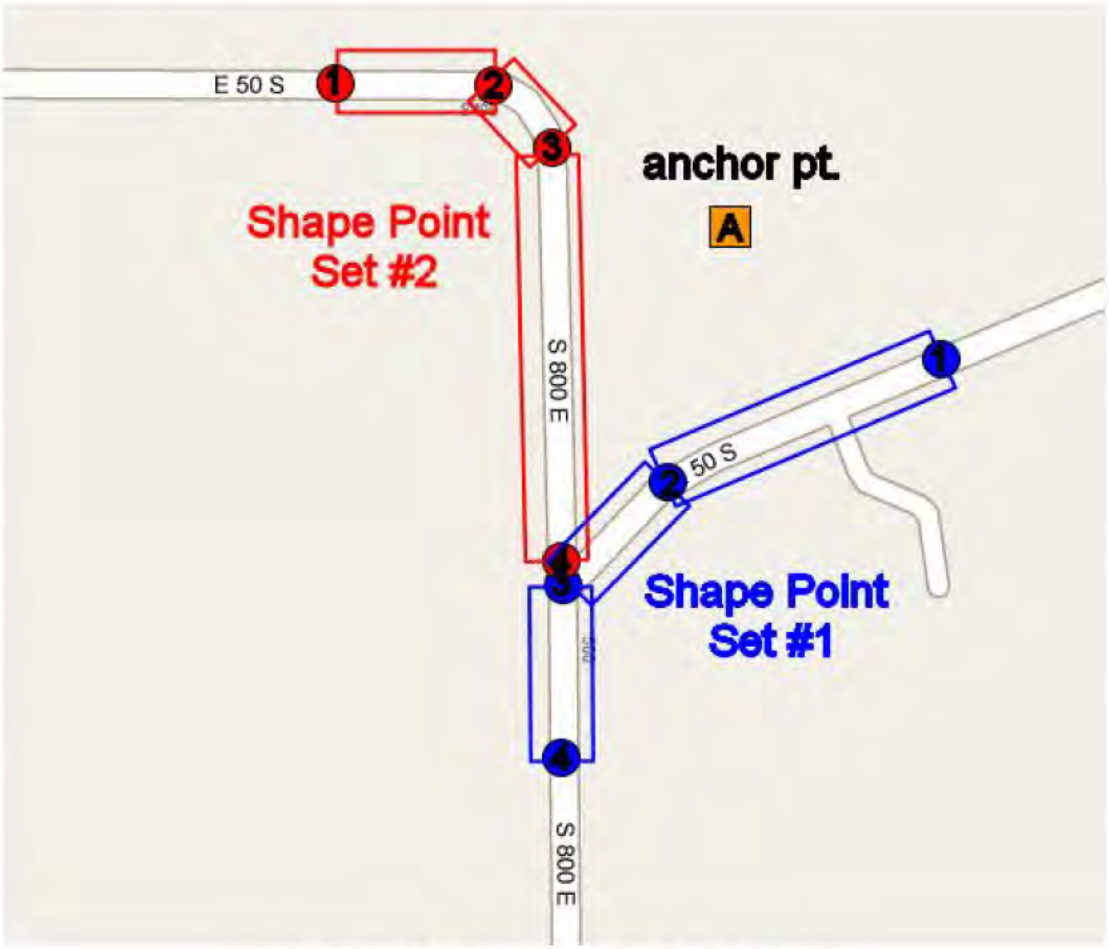


Figure 11: Multiple node Shape Point Sets

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.

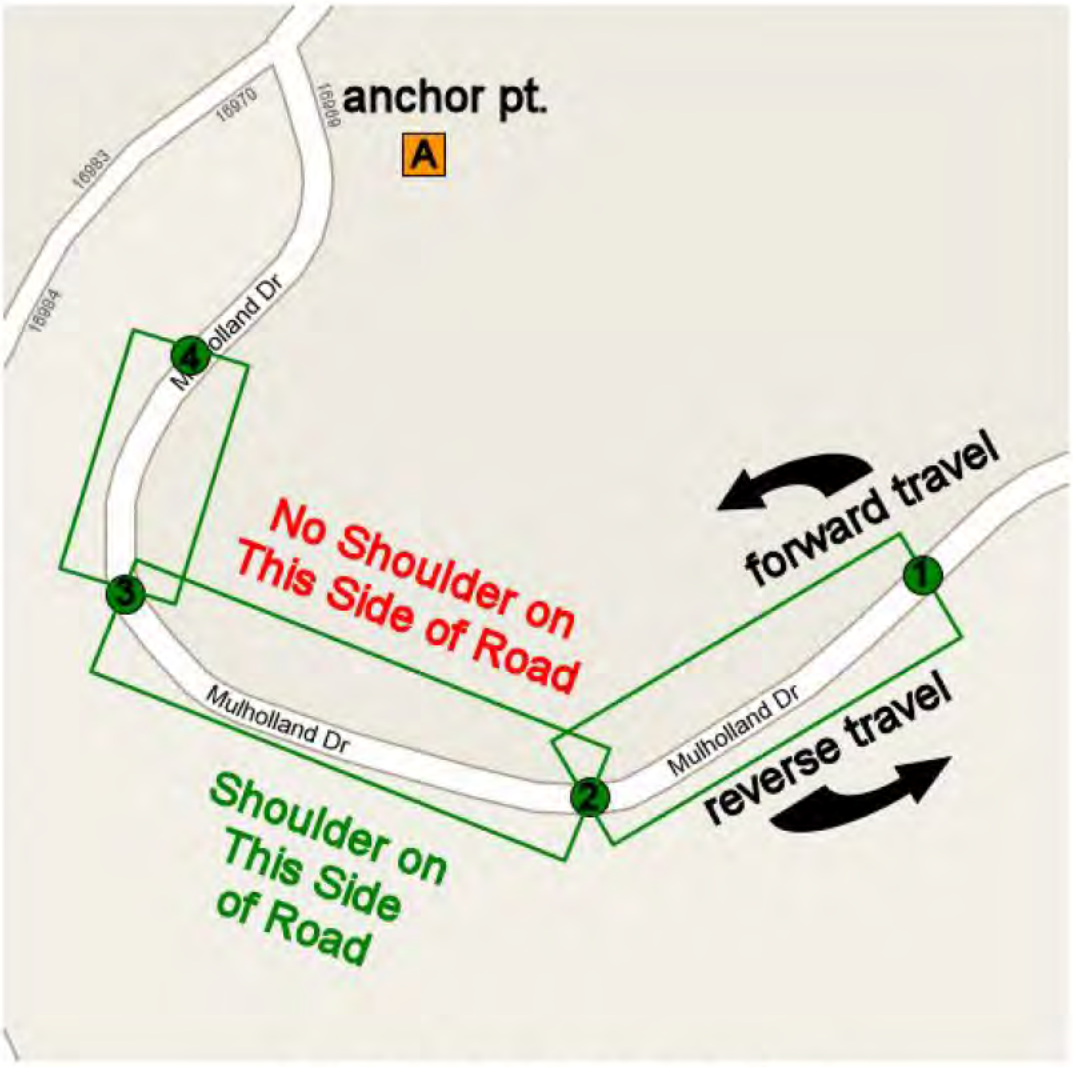


Figure 12: Shape Point set utilizing heading element

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 13, 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.

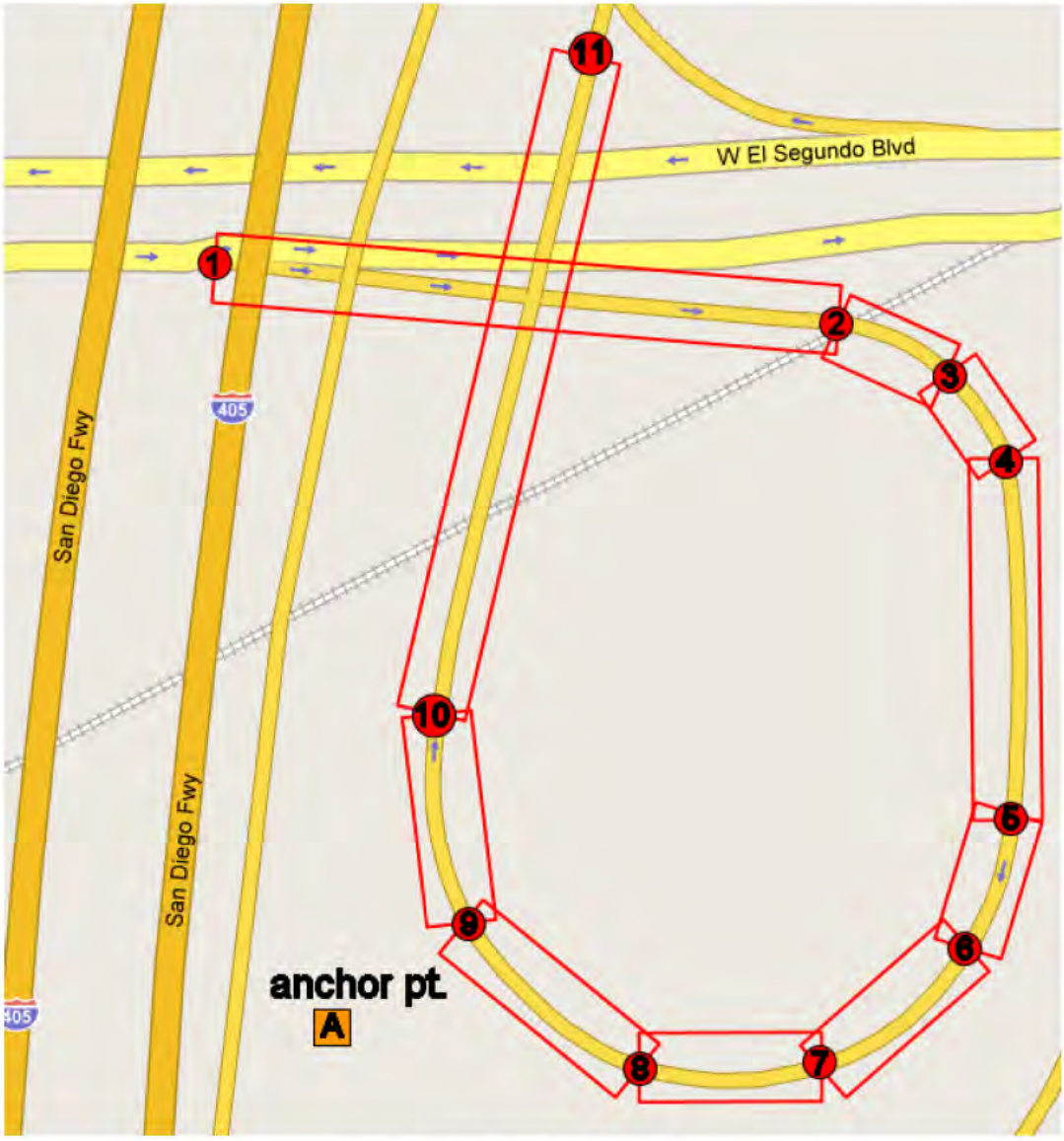


Figure 13: Overlapping Region

Annex E Traffic Probe Message Use and Operation

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 Annex 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.

Probe Message Structure

A **Probe Message** is transmitted from a vehicle to a *RSU*, which contains several snapshots, as well as the standard J2735 message common header. The simplified structure of a probe message and snapshots is illustrated below.

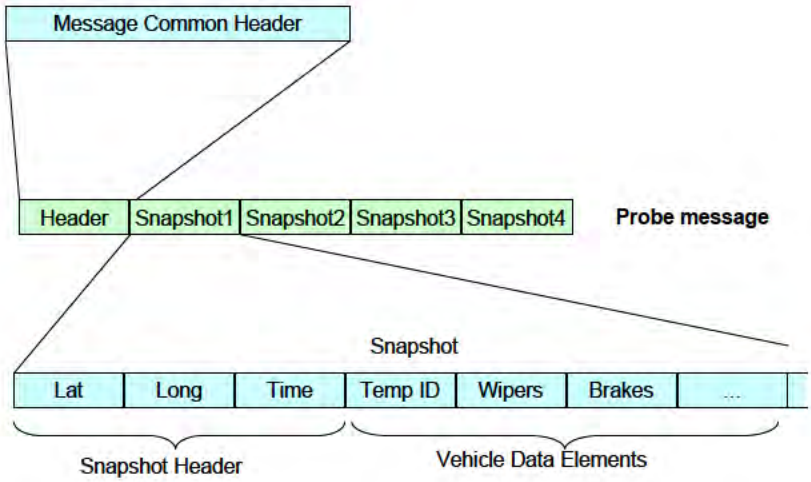


Figure 10 Probe Message and Snapshots

The current allowed vehicle data elements that are included in the probe snapshot are listed below. For description, ranges, formats and units see the definition provided in Sections 7 and 8 earlier in the Standard. The message structure allows additional data elements as technology changes in vehicles and as the standard is revised.

	Data Concept	Formal Name
1.	Acceleration	DE_Acceleration
2.	Acceleration Confidence	DE_AccelerationConfidence
3.	Ambient Air Pressure	DE_AmbientAirPressure (Barometric Pressure)
4.	Ambient Air Temperature	DE_AmbientAirTemperature

5.	Antilock Brake Status	DE_AntiLockBrakeStatus
6.	Brake Applied Pressure	DE_BrakeAppliedPressure
7.	Brake Applied Status	DE_BrakeAppliedStatus
8.	Brake Boost Applied	DE_BrakeBoostApplied
9.	Coefficient Of Friction	DE_CoefficientOfFriction
10.	Date	DF_DDate
11.	Driving Wheel Angle	DE_DrivingWheelAngle
12.	Elevation	DE_Elevation
13.	Exterior Lights	DE_ExteriorLights
14.	Heading	DE_Heading
15.	Heading Confidence	DE_HeadingConfidence
16.	Latitude	DE_Latitude
17.	Longitude	DE_Longitude
18.	Obstacle Direction	DE_ObstacleDirection
19.	Obstacle Distance	DE_ObstacleDistance
20.	Positioning confidence	DE_PositionConfidence
21.	Probe Segment Number	DE_ProbeSegmentNumber
22.	Rain Sensor	DE_RainSensor
23.	Speed	DE_Speed
24.	Speed Confidence	DE_SpeedConfidence
25.	Stability Control Status	DE_StabilityControlStatus
26.	Steering Wheel Angle Rate Of Change	DE_SteeringWheelAngleRateOfChange
27.	Steering Wheel Angle	DE_SteeringWheelAngle
28.	Steering Wheel Angle Confidence	DE_SteeringWheelAngleConfidence
29.	Sun Sensor	DE_SunSensor
30.	Time	DF_DTime
31.	Time confidence	DE_TimeConfidence
32.	Tire Location	DE_J1939-71-Tire Location
33.	Tire Pressure Threshold Detection	DE_J1939-71-Tire Pressure Threshold Detection
34.	Tire Pressure	DE_J1939-71-Tire Pressure
35.	Traction Control State	DE_TractionControlState
36.	Vehicle Type	DE_VehicleType
37.	Vertical Acceleration	DE_VerticalAcceleration
38.	Wiper Rate	DE_WiperRate
39.	Wiper Status Front	DE_WiperStatusFront
40.	Wiper Status Rear	DE_WiperStatusRear
41.	Yaw Rate	DE_YawRate
42.	Yaw Rate Confidence	DE_YawRateConfidence

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 senders 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.

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 and XML definitions provided previously. The possible elements to be sent are enclosed in a simple CHOICE statement, followed by the individual selected elements. 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.

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.

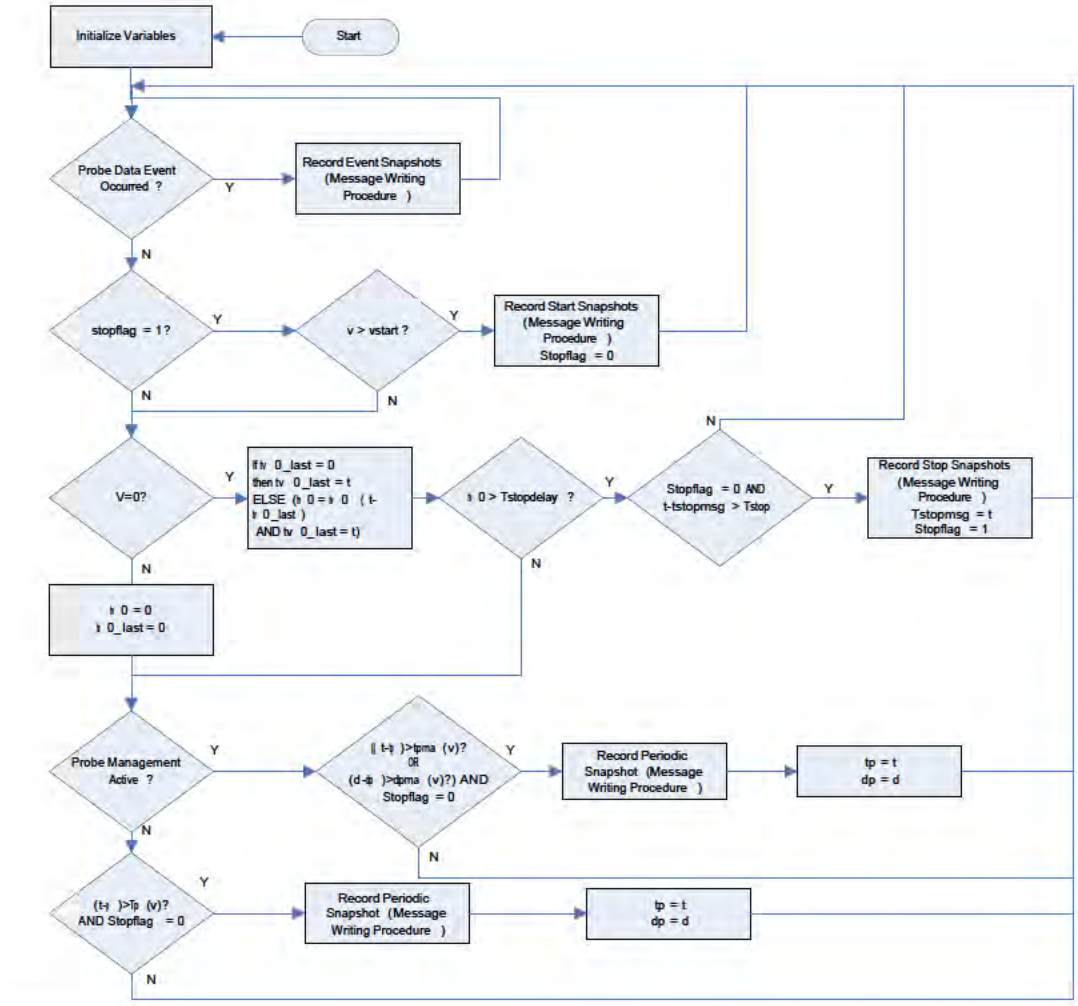
Thus the snapshot interval is:

- 4 seconds if speed is 20 mph and
- 20 seconds if speed is 60 mph

Between 20mph 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).

An example 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
tv 0 = amount of time , in seconds , vehicle speed has been 0 mph ?
tv 0_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 (15 s)
Tstopdelay = delay time at v =0 before observing vehicle stop (5s)
Vstart = minimum velocity to observe vehicle start

Figure 11 - 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.

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.

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.

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. One example implementation of the message transmit loop is shown below.

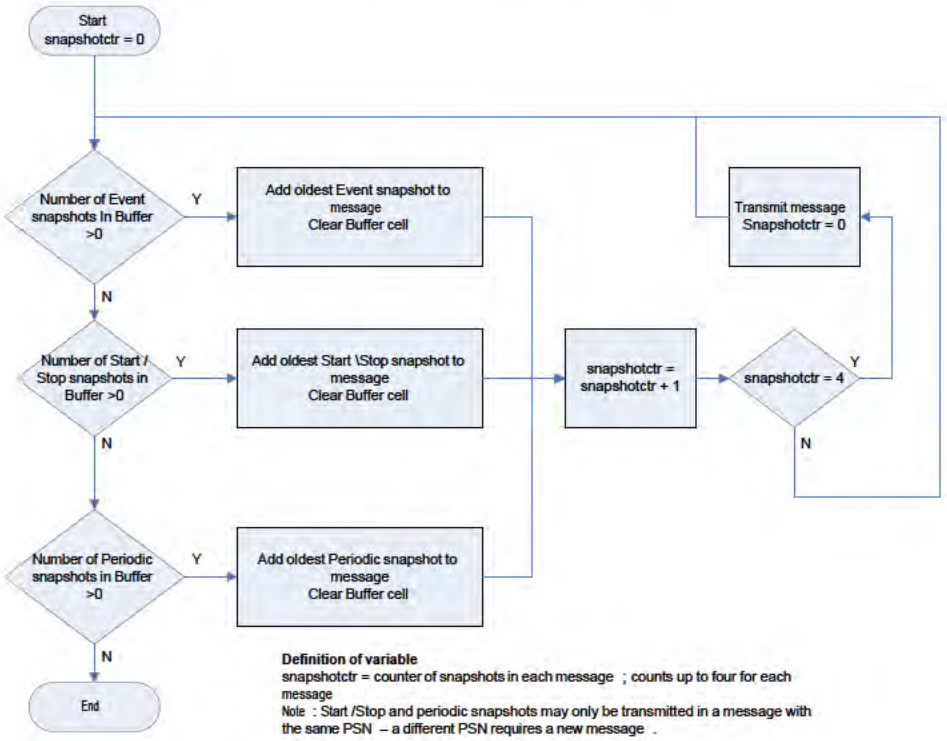


Figure 12 Transmit Loop

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, which ever comes first.)
- Event snapshots do not contain a PSN.

The figure on the next page illustrates the reasons for changing a PSN.

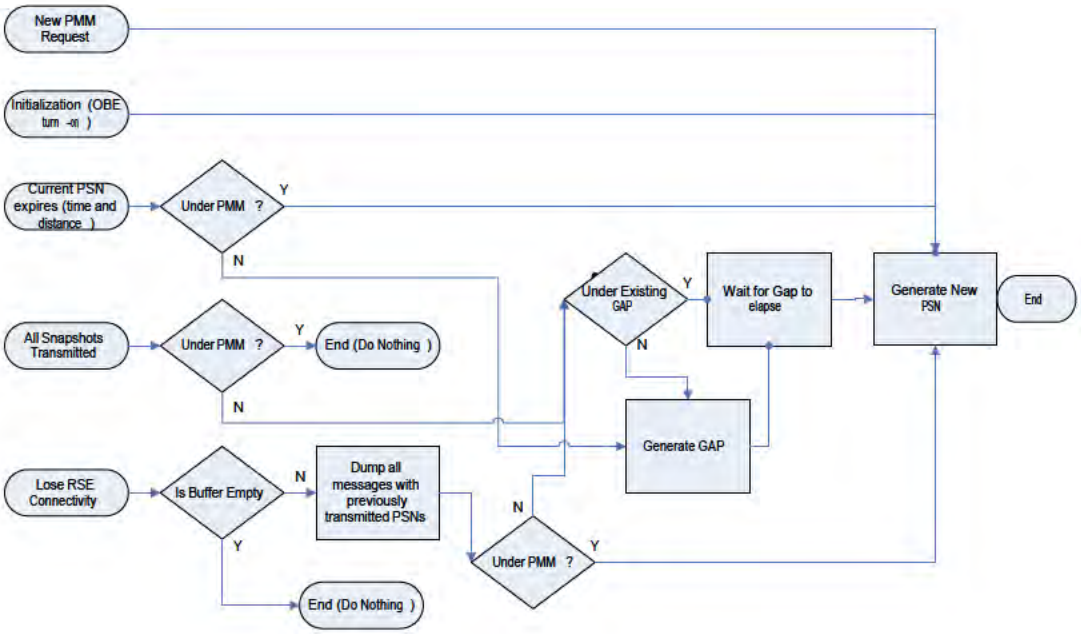


Figure 13 PSN Change Reasons

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 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 the figure below. 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.

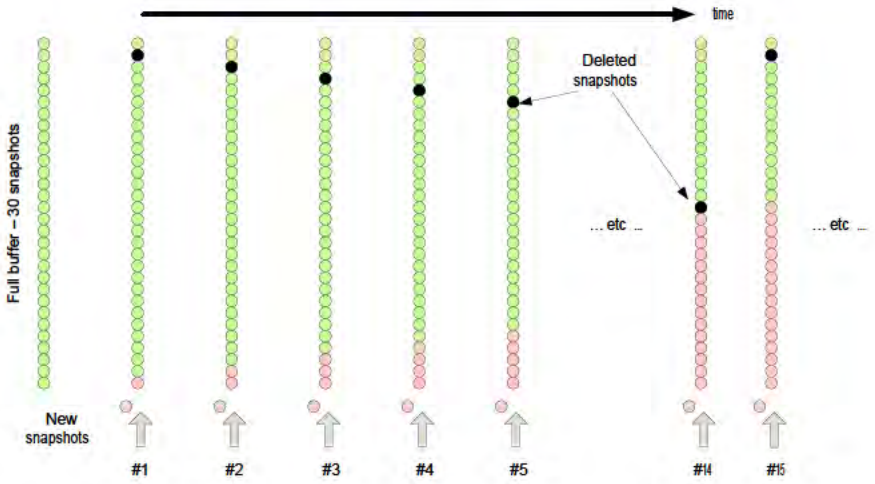


Figure 14 Snapshot Deletion Process

The figure below illustrates one implementation of the snapshot writing process.

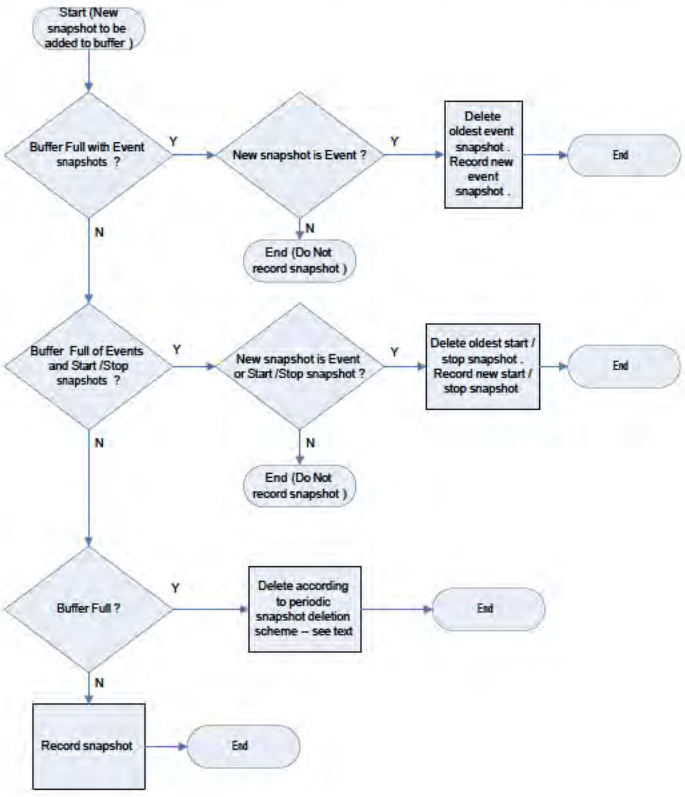


Figure 15 Snapshot Writing Procedure

Probe Data Messages 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.

Vehicle Anonymity

Probe snapshots when sent to the RSU and forwarded to an SDN publish/subscribe service will contain no record [7] 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 500m 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.

Probe Data Security

Probe Data Messages 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.

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

[7] Some public fleet vehicle types may provide additional identity information.

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

Speed	Time Between Snapshots
S_1	T_1
$>S_1$ & $< S_2$	linear extrapolation
$>S_2$	T_2

Table X Table - Snapshot Generation Intervals

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 T_1 and T_2, thus taking snapshots at constant intervals, independent of speed, such as one per second (T_1 = 1 and T_2 = 1).

If distance is to be used then a similar set of parameters can be sent, but instead the times (T_1 and T_2) would be replaced with distances (D_1 and D_2) in meters. In the same manner as the time calculation above, the distance used between speeds S_1 and S_2 will be linearly extrapolated. As before, two speeds (S_1 and S_2) can also be set, yielding the following:

Speed	Distance Between Snapshots
S_1	D_1
$>S_1$ & $< S_2$	linear extrapolation
$>S_2$	D_2

Table X Table - Snapshot Generation Distances

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.

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 1km along a road way (and therefore spanning 2km of any vehicle's path) would have an individual OBU in view for about 400 seconds if the vehicle were traveling at ~10mph. For example, this may be used at a complex interstate intersection to determine the onset of congestion at merge areas.

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 1km 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.

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.

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 $1/4^{th}$ 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.

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 Managed Vehicle Heading 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 0x0081 were used only those vehicles traveling directly east-bound would be affected, while a value of 0x8100 would indicate only west-bound vehicles, and 0x8181 would include both directions.

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 16 below illustrates one example implementation of the probe management process.

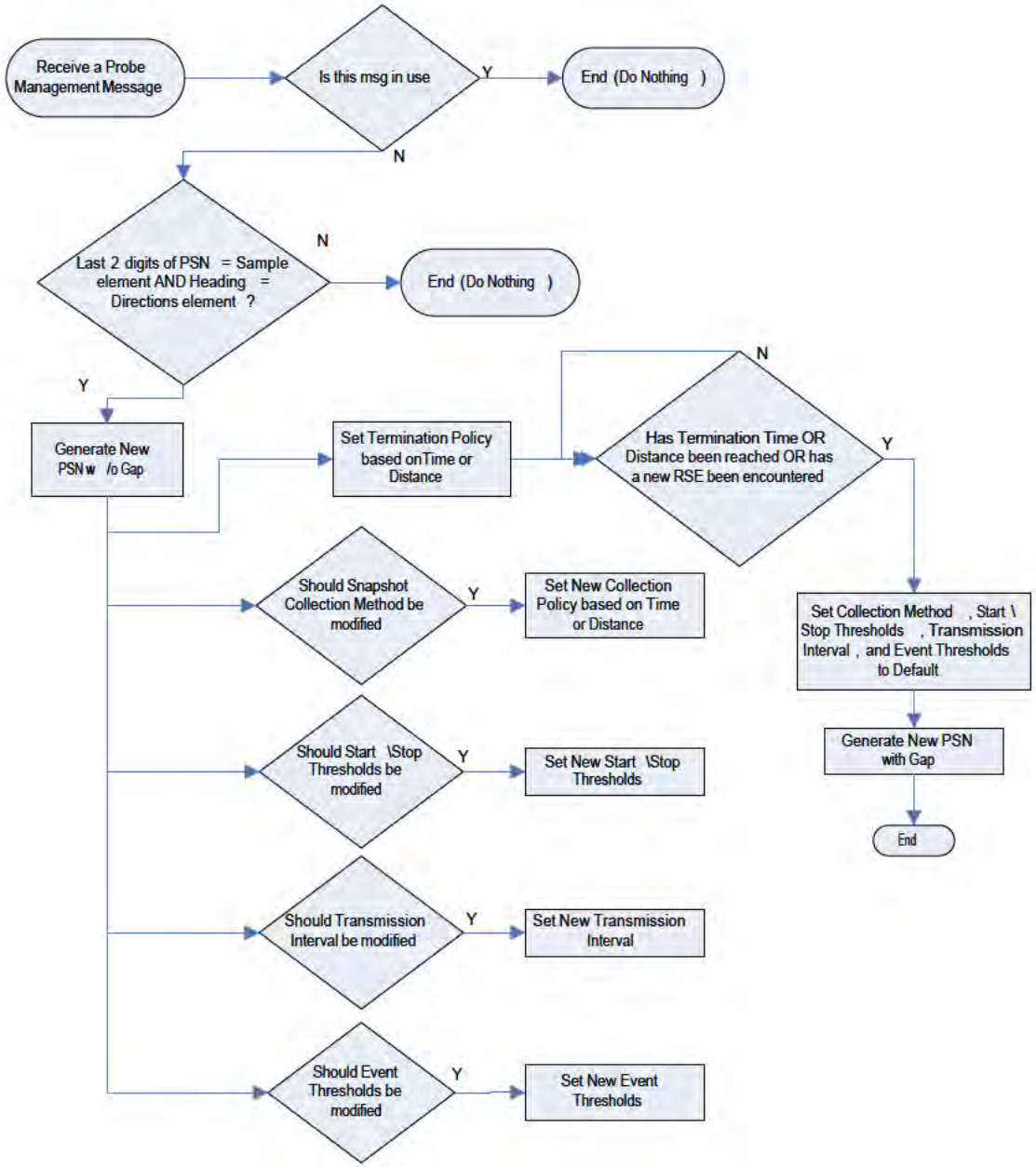


Figure 16 Probe Management Process

Annex F Emergency Vehicle Message Use and Operation

1. Application Description

This is a vehicle to infrastructure message, it is typically sent from an emergency vehicle or transit vehicle. The Emergency Vehicle Message set consists of three distinct messages, as outlined below. Each will be discussed in turn in this annex.

Signal Request Message (SRM)	Used to request a preemption or priority signal state 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.
Emergency Vehicle Approaching Message	Used to announce to other vehicles that such an emergency vehicle is operating in the local area.

The first two of these messages are used in relation to the control of a signalized intersection during emergency response operations. The first is transmitted by an emergency vehicle and is used by the controller of a signalized intersection. The second 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. The third message is emitted by public safety vehicles while responding to emergencies, so as to alert other nearby vehicles to that fact.

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 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 advanced signal controller (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.

The third message, or *Emergency Vehicle Approaching Message,* (EVA) is a simple broadcast message to alert nearby vehicles of the presence of an emergency vehicle operating in the area. It uses the familiar ITIS codes for this message, packaged in the format defined in the Roadside Alert message, but adds additional useful details about the emergency vehicle itself (its use of sirens, lights and other alerts, its basic type or class of vehicle). The purpose of this message is to provide warning to other drivers when a PSOBU equipped vehicle such as police, fire or ambulance is in the vicinity and a potential interference with the emergency vehicle's path is eminent.

Two safety issues are being addressed by the 3rd message. First, the notification to the driver that an emergency vehicle with its siren/lights flashing is in the area. This can occur even if the emergency lights are hidden behind an obstruction and the sirens cannot be heard above the surrounding audio (noise, radio, etc). The second is identification of where the vehicle is and what to do to avoid interference with its path.

It should also be noted that many times police will respond to a service call with lights flashing but without sirens being active (an event which is also covered[8]).

When an emergency vehicle and other surrounding vehicles are equipped with PSOBU's and OBU's, 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 OBU's. 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.

2. Preconditions for operation:

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 and EVA 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 required for the EVA message and 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 thier location, speed, direction of travel.

3. Flow of Events

The first two messages are handled in the initial use case to control the intersection. The 3rd messages is then handled in another use case. In actual practice, the flow of events of these two use cases would be interspersed in time.

Flow of events, Typical Intersection use

[8] Alerting others to the presence of the siren or flashing lights is optional and the standard allows for "silent running" response as well. Police officials differ in opinion on the utility of this aspect of the message, so its use is optional.

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 Basic Safety Messages (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 PSAT message are being sent out by the RSU for the target intersection on a periodic basis.
2. Vehicle "A" determines that activation of an Signal Request message is needed. This could occur through various determinants, but is likely to be combined with the next use case at the same time.
3. This activates a PSOBU broadcast of Signal Request message (SRM), which contains the preemption or priory requested as well as the optional "BSM blob" with current location information, speed, and direction of travel in it. See GG note about need for destination here, unresolved issue. Current codes support "at destination" but not where it is.
4. The intersection RSU, receives the of Signal Request message (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 Signal Status message (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 of Signal Request message (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 Signal Request message (SRM) with the cancel bit set, or after a duration of 3 seconds may simply cease sending.

Flow of events, Typical EVA 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 Basic Safety Message (BSM).
2. Vehicle "A" determines that activation of an Emergency Vehicle Approaching Warning is needed. This could occur through various determinants such as activation of its siren and emergency lights, or other inputs to be determined by application developers.

3. This activates a PSOBU broadcast of emergency notification warning, current location information, speed, and direction of travel as well a vehicle type
4. Vehicle "B", which may be a standard OBU equipped vehicle or another PSOBU equipped vehicle in the vicinity, receives the emergency notification message and other data.
5. Vehicle "B" determines whether Vehicle "A's" message is relevant (calculates its relative position to the emergency vehicle and determines if a potential interference may exist). If not, no action is taken; the vehicles may be moving away from each other, on a different street, etc.
6. If an imminent interference is detected, an alarm of some type is sent to the driver's HMI. It is assumed that vehicles will have differing levels of HMI sophistication.
7. Data updates continue; When the Vehicle "B" path is no longer a potential interference for the PSOBU equipped vehicle, the warning will terminate.

Vehicle "A"Hardware Devices:	PSOBU Positional Sensors Human-Machine Interface			
Vehicle "A" Actors: (What entities play an active role in use)	**Vehicle System**	**Occupant**	**Service Provider**	**Road Department**
	X	**X**		

Vehicle "B" Hardware Devices:	OBU Positional Sensors Human-Machine Interface				
Vehicle "B" 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				

4. System Architecture and Concept of Operation

A PSOBU vehicle is put into emergency service. Upon being put into emergency service, emergency messages begin being sent to surrounding vehicles and signal request messages are emitted as the vehicle travels. The Emergency Vehicle Approaching Warning message includes: Location, Direction, Speed, Type of vehicle, Type of response, Siren in use, Light bar in use, and Multiple vehicles responding (optional). See GG note about need for destination here, unresolved issue The signal request message contains the requested priority or preemption value to be requested of each ASC, and some vehicle identification number (nominally a fleet number or VIN number). Any signal state messages recovered (from ASCs that are processing to this or another request) 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 Emergency Vehicle Approaching data 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 type of emergency vehicle
- 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 signal request and signal status 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 Emergency Vehicle Approaching message, 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 type of emergency vehicle
- 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 signal requests and receiving signal status messages at the same time (often in ad hoc convoys proceeding through the same intersection). The signal state message 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.

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"[9] (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.

[9] 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 Annex A 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.

Annex G Roadside Alerting Message Use and Operation

1. Application Description

The purpose of the Roadside Alerting message is to provide warnings to a driver from either a RSU or a PSOBU equipped vehicle such as police, fire, transportation, or ambulance vehicle which is sending data about a nearby event of interest to travelers. This message was originally developed by the SAE ATIS committee. It has been used by the DSRC committee in the initial published version of the Standard (as an external imported data concept), and with this edition has been brought into DSRC Standard itself with minor modifications to take advantage of the BER-DER encoding style now being used. The message allows a sender to "strip down" the more verbose ATIS event message and send the critical content ITIS phrase content over the DSRC WSM stack. Variations of the message, used when less urgent content is to be sent, can be encoded over XML and sent as an IP datagram. Examples of the proper use and encoding of this message are covered in the DSRC Users Guide documents.

2. Preconditions for operation:

The following general conditions are presumed to prevail in this application:

1 The private vehicles are equipped with active OBU.
2 There is an RSU or an incident response vehicle equipped with active PSOBU in range.
3 Both systems are active and functional.
4 Private vehicles have available it's location, speed, direction of travel (to filter content with)

3. Flow of Events

Flow of events	
1 The sender (an RSU or an PSOBU) receives or creates a suitable Roadside Alert message for transmission .	
2 The sender (an RSU or an PSOBU) begins transmitting the message using the proper encoding, channel and repetitive rate.	
3 The Vehicle, which is typically a standard OBU equipped vehicle in the vicinity, receives the message for the first time	
4 The Vehicle determines whether the message is relevant (calculates its relative position to the event and determines if a potential interference may exist). If not, no action is taken; the vehicle may be moving away from the event, it may not apply, or it may have already been processed.	
5 If an imminent interference is detected, an alarm of some type is sent to the driver's HMI. It is assumed that vehicles will have differing levels of HMI sophistication.	
6 Data updates continue as warranted and depending on the event type.	
Sender Devices:	And RSU or an PSOBU

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Vehicle Actors: (What entities play an active role in use)	**Vehicle System**	**Occupant**	**Service Provider**	**Road Department**
	X	**X**		
Support information:				

4. System Architecture and Concept of Operation

An RSU (or a PSOBU vehicle) is put into emergency service by the reception or the creation of a Roadside alert message. The messages begin being sent to surrounding vehicles (using the WSM for urgent messages and IP for less urgent advisory type messages). The message content includes: Location, Direction (applicability), and a set of descriptive ITIS codes.

Private vehicles in the area may use this data to analyze the event when they receive the data. If this is relevant, applicable information may be communicated to the operator. The warning could include information about:

- The type of event, a general event description.
- The location or proximity of the event
- Instructions on action that the driver may want to take

The warning presented to the driver may be different depending upon the type and its proximity to the receiving vehicle. If additional information is available from the sender, the information may be sent via other applications and messages.

5. Application use with DSRC

The messages in this application are typically transmitted using the BER-DER encoding and the Wave 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"[10] (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.

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).

[10] The ultimate determination of this classification, and therefore the encoding and bandwidth allocated to either type of message is a local jurisdictional consideration.

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 Annex A 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.

Annex H Map and SPAT Message Use and Operation

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 of the VII program. 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 annex 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

1.1 Intended Audience

This document 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.

1.2 Philosophy of SPAT and MAPs

In normal use the OBU units are expected to receive the MAP message before entering the intersection. This map 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 barriers, 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 approach and lane that is active. The SPAT and MAP share a common lane numbering assignment between them to allow mapping.

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 in all approaches in 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 on 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).

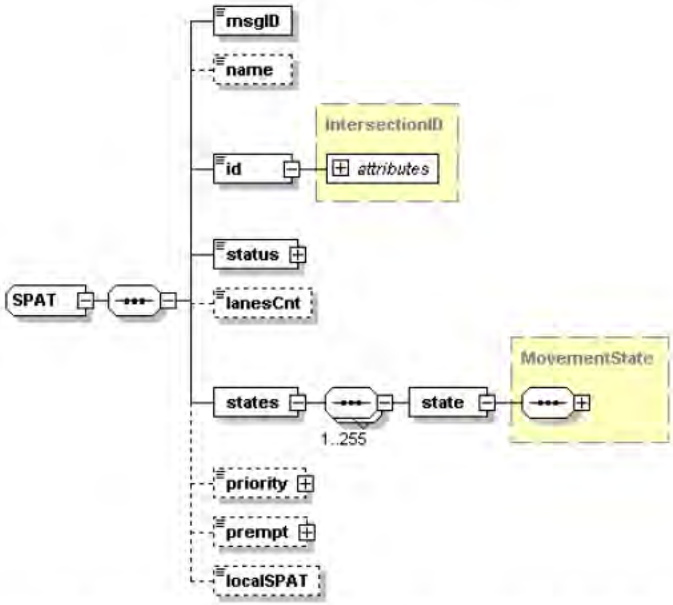
Here is a message fragment illustrating this:

```
SPAT Message
   Msg id =  0x0c  (indicates a  SPAT message)
    SPAT id = TBD        (indicates a unique value for this intersection)
   States
          State #1
                 Lane Set             (list of lanes this applies to)
                    1, 2
                 Movement State(signal state or pedestrian state)
                         SignalState  = Green light
                  TimeToChange       =  12.3 seconds
                 YellowSignalState   =
          State #2
                 Lane Set             (list of lanes this applies to)
                        3,4.5.6, etc...
                 Movement State(signal state or pedestrian state)
                         SignalState  = Red light
                  TimeToChange       =  Indeterminate for this state
                 YellowSignalState   =
   Preempt   = none present
```

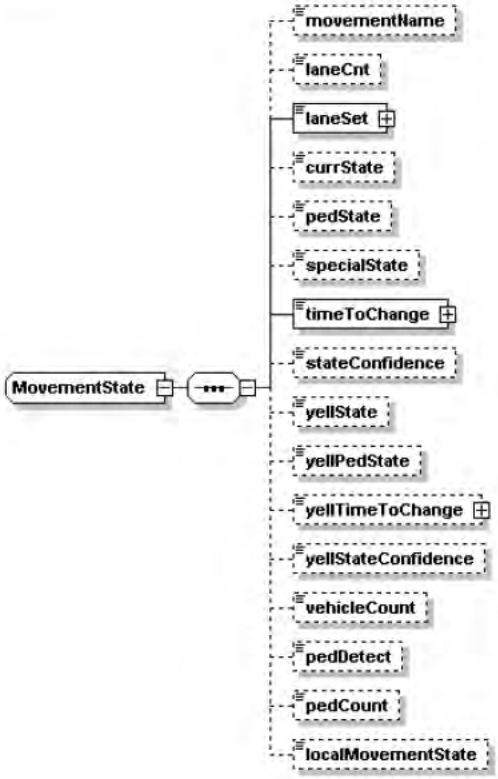
The SPAT message consists of a sequence of *MovementStates* for each *lane* in the intersection.[11] The SPAT status information is associated with the lanes found in the MAP message by the use of shared lane numbering values. The overall framework consists of the regionally unique *intersectionID* (required), the collation of current lane states, any signal-wide preemption data, and some optional content (such as the human readable name of the intersection) as follows. Some additional information regarding the internal preemption or priority request status of the signal controller itself can be obtained in the Signal Status Messages (SSM) message.

Up to 255 unique states can be sent, although more commonly only active states are sent at any time (the phase of the active lane-approach, and all other lanes which are in a red-phase). Considering the *MovementState* data frame further we see that it includes a great deal of timing information:

[11] 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.



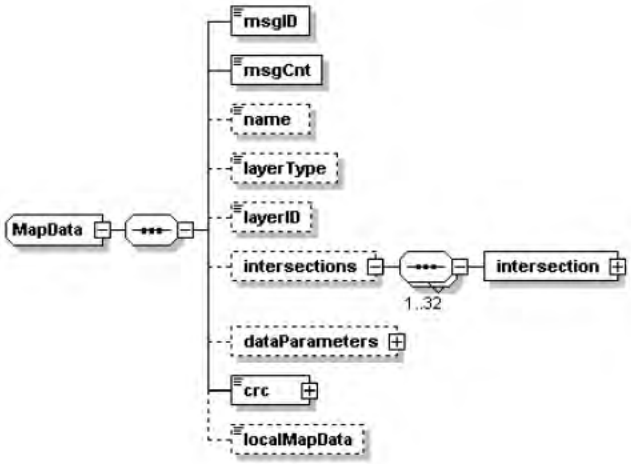
Note that only the *laneSet* (the list of lanes to which this applies) and the *timeToChange* are required, the other elements are optional (indicated by the dotted lines). When presenting information about a vehicle lane, the *currState* element is used. When presenting other types of timing data other elements are used. For example, a pedestrian crosswalk timing uses the pedState element, while a train crossing an intersection uses the *specialState* element.



The lane set lists all the lanes (by their assigned number defined in the GID-MAP) 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 *timeToChange* indicates the minimum value of time for which this state will persist in a count down timer. An optional confidence value may follow this and allows asserting complex concepts like min or max times or times which are likely to change in adaptive intersections. A second (optional) state called the "yellow state" allows sending phase time data about the NEXT phase of the state 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 the number of vehicles that have been detected or counted in the lane.

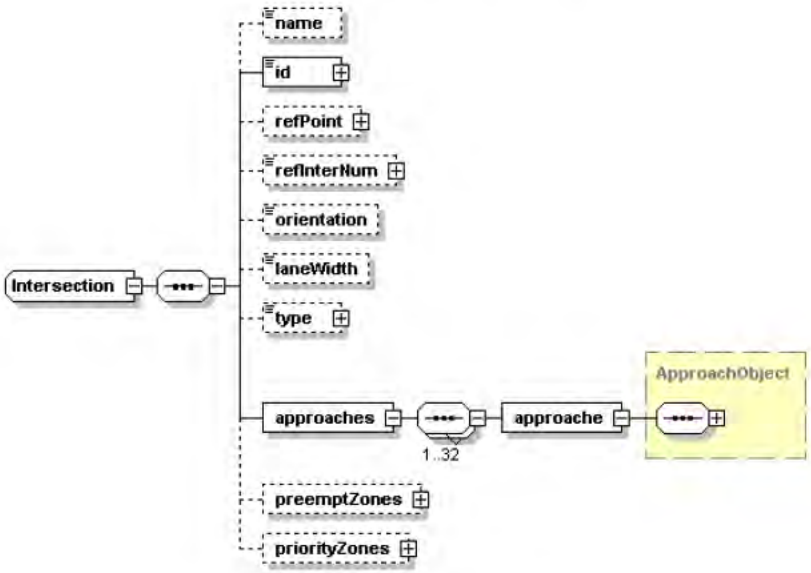
3. The overall framework of the MAP

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. Some of these remain to be defined in future editions of the Standard. However, the "intersections" or GID portion of the map is defined and is used along with the SPAT message to relate information about intersections.



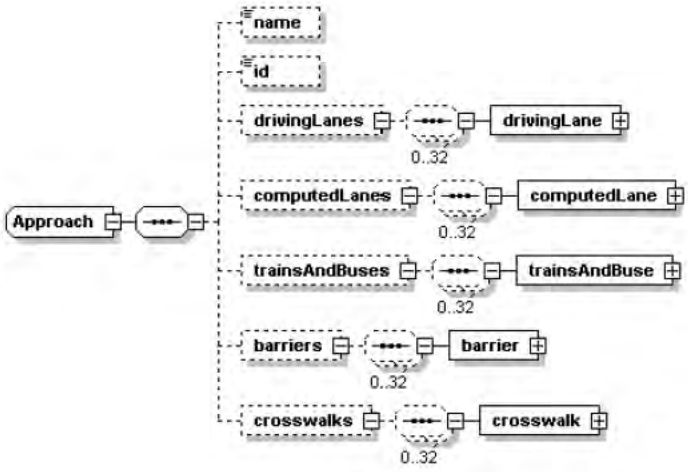
The intersection data frame, shown below, is used to relate all the needed physical geometry of an intersection, assign the intersection a unique ID, and to assign numbers to specific lanes (the set of lanes being a sub-set of an approach). Up to 32 intersections can be contained in a single map message.

Intersections are defined as collections of approaches, which are in turn defined as a collection of related lanes. Each intersection has a regionally unique ID associated with this. It may optionally have a name string as well. A reference point is used to define a precise position from which local offset values are used to describe the geometry of the lanes. Other, optionally present reference points can be further defined in the structures when needed to simplify extremely complex intersections. Intersections, like traffic lanes, often follow repeating patterns, so a data compression scheme that allows "computed intersections" to replicate simple intersections is provided (data elements *refInterNum* and *orientation* support this)

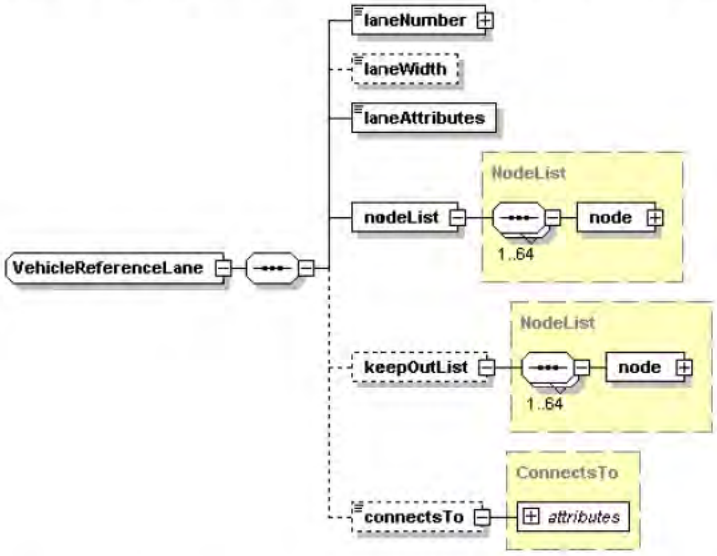


The *ApproachObject* structure allow arbitrary groupings of lanes to be created, as determined by the designer. Lanes in this context refers to both driven vehicle use type lanes as well as several other lane types defined by the Standard. Lanes defined at this time include "pedestrian" lanes (cross walks) and "special" lanes for shared lanes, rail track and other multi-modal uses, and "barriers" for various dividers. Approach lanes are further divided into approach (ingress, incoming) and egress (outgoing) lanes, allowing a clear division of the lanes coming into an intersection. Egress lanes are in fact optional and may discarded under certain conditions when not needed

Within each approach are descriptions of one or more lanes of various types. Each of these can be related in terms of its *path* and *attributes* (and in the SPAT its current status). A structure called nodeList is used to relate the path of the lanes centerline with whatever degree of precision and number of data points are required (including changes in width and elevation as needed).

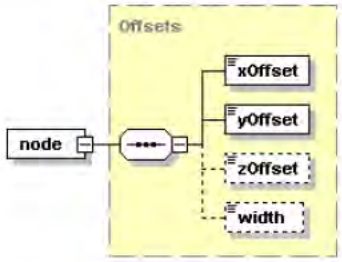


Here is the data structure of the driving lanes, used to relate the typical lane of traffic flow.



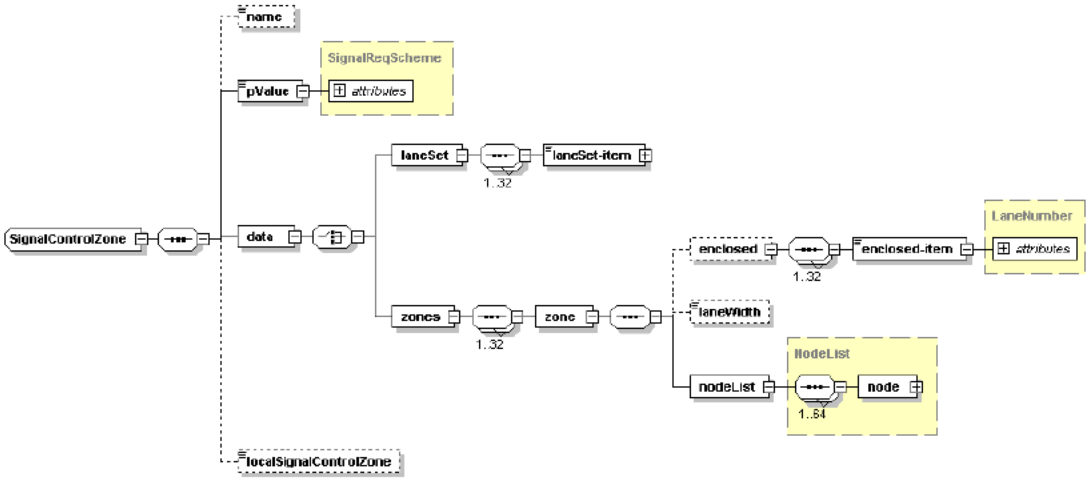
The *laneAttributes* is a bitstring which relates the allowed vehicle maneuvers such as noTurnOnRight etc. In some complex cases (such as multiple soft left turns) the *connectsTo* data element can be present (in ingress lanes) to further clarify how this lane interacts with the egress lanes.

The *nodelist* relates the path of the lane itself over the ground. The *keepOutList* is an optional further overlay for places along the node list that the vehicle (or user) cannot" safely come to rest in (typical an area marked do not stop or do not block on the ground). The *nodelist* itself it is made up of a sequence of from one to 64 node points as shown below which relate the path in increments (precision) of 1.0 cm units. The *width* or *zOffset* points, when present, establish a new standing value for that item until a subsequent update, in a manner similar to the anchor points.



This collection of lane data is repeated for every lane to be described in the intersection. This consist of at least all drivable lanes approaching the intersection and may include those lanes leaving the intersection (egress lanes) and other supporting information (such as pedestrian lane details) as determined by the message author.

In addition to the above, two optional structures (*preemptionZones* and *priorityZones*) are provided to support priority and preemption requests at the intersection. These two items are used to determine which specific request to make. They allow mapping of the intersection geometry into specific request zones and values (0~7). They are identical in structure, using sets of the *SignalControlZone*, shown below.



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 encloses lanes (*LaneSet*) or a *nodeList* forming a polygon of coverage. Public safety vehicles use this data to determine which request to make, then use that value in the Signal Request Message (SRM) 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 Signal Status Message (SSM) message.

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.

Annex I Cooperative Cruise Control (CCC) Use and Operation

1. Introduction

The Cooperative Cruise Control Message Set provides a mechanism for vehicles to effectively communicate relevant information to each other, and operate as a coherent group. Vehicles will communicate internally within the team in order to maintain group cohesion, operational safety, and maximize individual and team mobility. The vehicle team will be able to communicate as a collective with other vehicle teams, individual vehicles, and roadside infrastructure devices.

The goal in developing this message set is to standardize the process for communication within a cooperative vehicle system, which is independent of the level of functional autonomy of the vehicle. The message set is not meant to replace existing sensors and equipment on vehicles; rather, to enhance existing sensor systems with information not directly acquired through intrinsic capabilities, enabling the formation of a cooperative vehicle system.

In essence, the message set enables an adaptive cruise control capability, which utilizes low latency communications in conjunction with vehicle sensors and controls. Data formatting follows the SAE J2735 message set. By utilizing this message set, the vehicle following distance can be dynamically managed in cooperation with a driver. While it is not envisioned that full control of the vehicle is managed, the throttle and brake may be may be utilized similar to current cruise control implementations, as well as audible and visual warnings to the driver. A mechanism for providing active and automatic brake control may be required for controlling the shorter following distances envisioned during cooperative cruise control operations. Alterations to the preset driving condition will alert the driver while automatically ensuring a safe following distance.

This message set is not meant to define such a system and set limits such as safe following distance, as these are beyond the scope of the cooperative cruise control message set. System-related design concepts should be considered in the development of the message set, where operational requirements and implementation are left to vehicle OEMs, and the driver.

2. Operational Concept

The following section provides a definition for the operational concept of teaming operations, and more specifically cruise control operations enhanced with low latent communications.

- Team:
  - Finite number of vehicles.
  - Possessing DSRC communications.
  - Traveling in same direction.
  - Consecutively traveling in the same lane.
  - Vehicles shall be of compatible Vehicle Type as defined by the FHWA Office of Highway Policy Information. The J2735 Vehicle Type data representation will be used.
  - Any single vehicle shall not be a member of more than one team concurrently.

- Cooperative Cruise Control
  - Adaptive cruise control mechanism or operation.
  - Enhanced via low latent vehicle-to-vehicle and vehicle-to-infrastructure communications.

- Vehicle shall have lane resolution positioning.
- Voluntary yet implicit participation via traditional cruise control triggers.
- Vehicle behaviors moderated via the guidelines of the team, including:
  - Target speed
  - Following distance thresholds
  - Destination (optional)

3. Cooperative Cruise Control Message Set

The Cooperative Cruise Control message set includes several messages which support the form, join, end, leave, and status system operations. These are identified by message type identifiers. A table listing message type identifiers follows.

Flag Type	Bit Flag
Form	0x0
Join	0x1
Leave	0x2
End	0x3
Team Status	0x4

Table 4: Message Type Identifiers

4. Form and Join Message Operations

- Vehicle should broadcast a request to form, or it's availability to join, a team.
  - Provides the ability to begin a team. Allows the vehicle to broadcast to the surrounding environment that it is available and willing to initiate a team.
  - If multiple vehicles broadcast a request to form a team, the implementation will handle "Team Leader" and "Team ID" designations relative to GPS location. (Team ID: 64 bit random number)

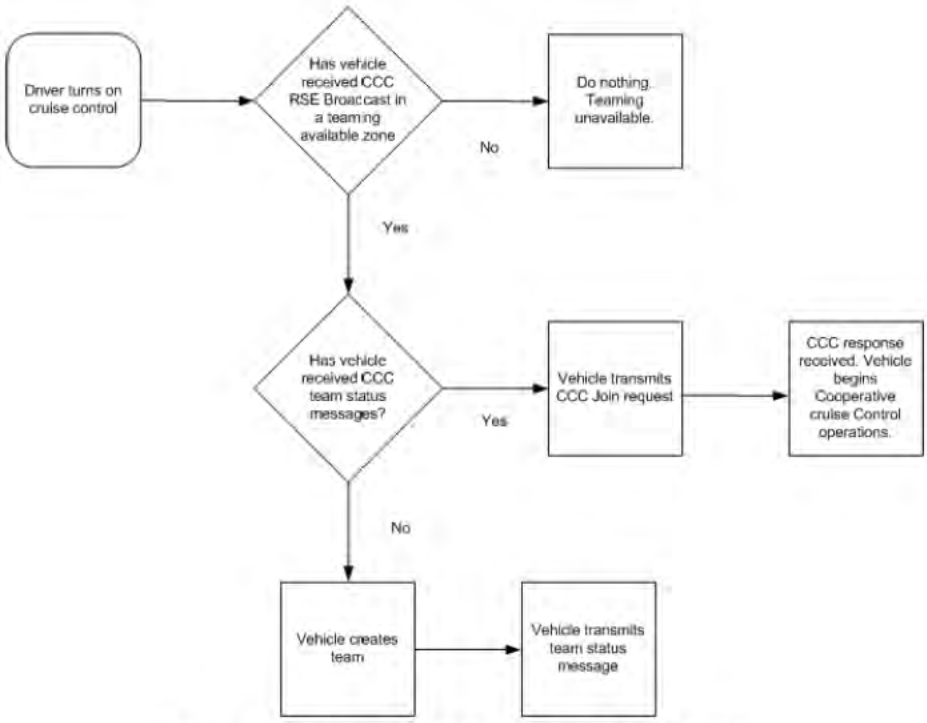


Figure 19: CCC High Level Forming and Joining Process

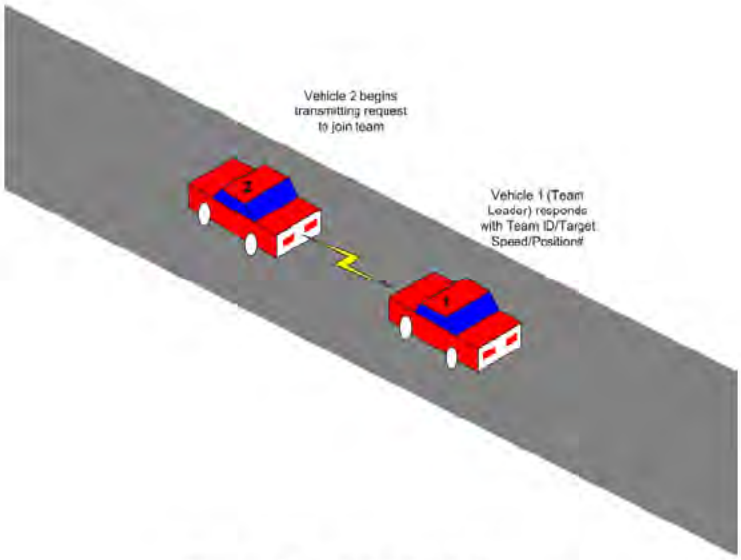


Figure 20: Basic CCC Join Request

Join Message Request/Response

Generated by an individual vehicle, or team leader, to join a team.

- DE_MessageType
  - Message Type
- Data Frame: DF_DDateTime
  - Timestamp
- DE _Team Requestor Identifier
  - Requester ID
- DE _Team Identifier
  - Team ID
- DE _Team Position Number
  - Position # assigned to joining vehicle (Optional, under discussion)
- DF_FullPositionVector
  - Position
  - Heading
- DE _Speed
  - Target Speed
- DF_Position3D
  - Destination (Optional)
- DE _LaneNumber
  - Lane # (Optional) – Still under discussion
- DE _VehicleType
  - Vehicle Class – Utilize J2735 Vehicle types
- DE_JoinResponseFlag
  - Allowed/Disallowed flag
- Response Text

Flag Type	Bit Flag	Description
Reserved	0x0	Reserved
Join Allowed	0x1	Join Allowed
Disallowed - Max Vehicles	0x2	Join disallowed due to team at max vehicles
Disallowed - Vehicle type	0x3	Join disallowed due to vehicle type incompatibility
Disallowed - Lane Position	0x4	Join disallowed due to vehicle in different lane from team
Disallowed - Vehicle Position	0x5	Join disallowed due to vehicle is forward of team leader
Disallowed - Private Team	0x6	Join disallowed due to team not accepting public vehicles
Disallowed - Team Disbanding	0x7	Join disallowed due to team in disbanding process
Disallowed – Fault Identification	0x8	Join disallowed due to team leader system fault

Table 5: Allow/Disallow Flag Settings

Form Message Request

Request sent by a vehicle to form a team. No response is sent in the case of a lone vehicle forming a team.

- DE_MessageType
  - Message Type
- _Team Requestor Identifier
  - Requester ID
- DF_DDateTime
  - Timestamp
- DF_FullPositionVector
  - Position
  - Heading
- DE _Speed
  - Target Speed of the team. Limited by the speed limit value received from the RSU broadcast message.
- DE _Team Identifier
  - Team ID
- DF_Position3D
  - Destination (Optional)

5. RSU Broadcast Operations

Roadside should announce zone information regarding team-formation authorization. The following characteristics are envisioned:

- The roadside infrastructure broadcasts zone information, indicating the permissibility of team formation.
- The message must be received prior to vehicles entering the zone, which will provide approaching teams suitable time to disband if required.
- Periodically sent from an RSU indicating the availability of teaming operations.
- When a team of vehicles approaches an unauthorized teaming zone, all vehicles within the team will end teaming operations. This could be accomplished by terminating Status messages to team members, or by sending a specific termination message. Vehicles will terminate teaming operations in accordance with defined Exit procedures as defined in Section 3.3.
- Levels of Authority
  - The levels of authority define the role a participant maintains or possesses within the cooperative vehicle system. In order to maintain team integrity, levels of authority must be established within the team concept. Overall authority is reserved for the roadside infrastructure. Teaming operations leadership resides with the Team Leader. All team members must maintain direct communications with the Team Leader. If direct communications are unattainable, the vehicle must leave the team.
    - Roadside – 0
    - Team Leader (optional) – 1
    - Team Member – 2

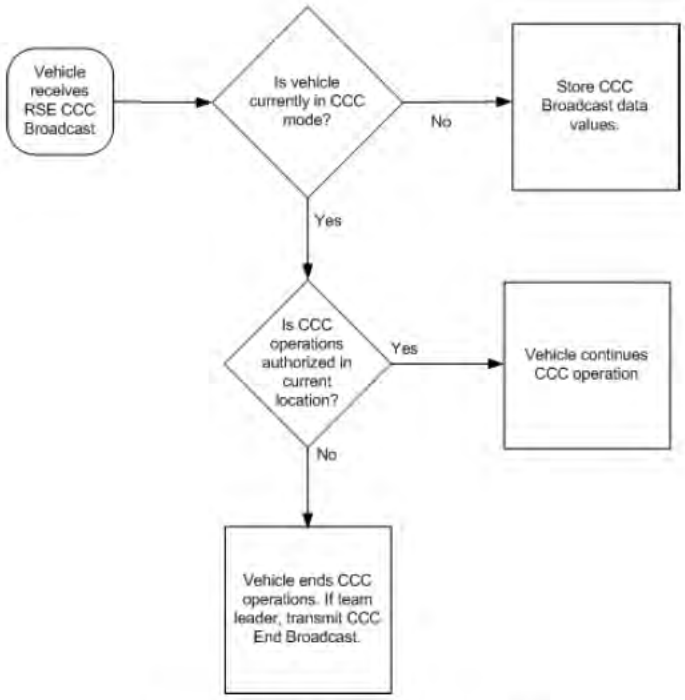


Figure 21: RSU CCC Broadcast Flow

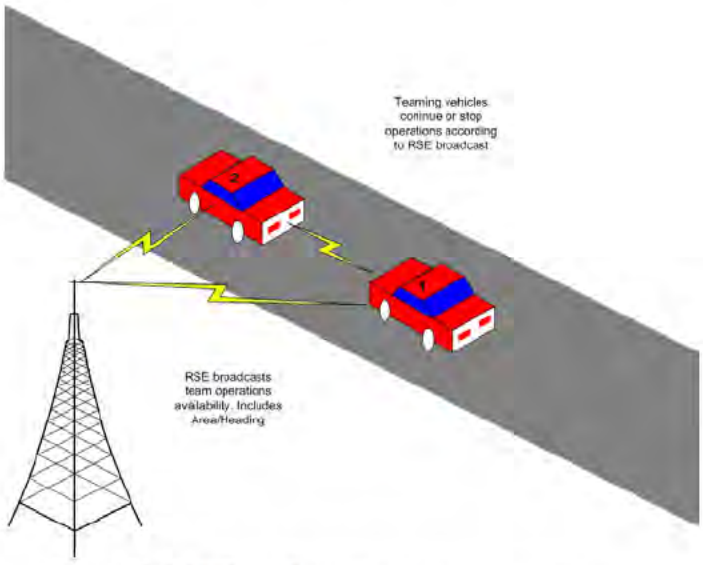


Figure 22: RSU Team Operations Announcement

Roadside Broadcast Message

Roadside broadcast message includes the following data elements:

- DE_MessageType
  - Message Type
- ShapePointSet
  - Area (zone or authorized lane)
- DF_FullPositionVector
  - Heading
- DE _Speed
  - Speed Limit: this value shall provide the system limits for target speed values utilized by the vehicle teams.
- DE _Max Team Vehicles
  - Max Vehicles Per Team
- DE _VehicleType
  - Vehicle Class – Utilize J2735 Vehicle types

6. Leave Team Message Operations

Vehicles are allowed to leave from any position within the team.

- Any vehicle will be allowed to leave the team at any time.
- The Leave event should be an event-based trigger or active control of the vehicle. Active control should be something similar to cruise control features already in place, such as a driver pressing on the brake. A trigger may also be a team-specific limit, such as a destination reached, or the team dynamics have changed.
- The vehicle should define an allowable separation distance threshold. The separation threshold will define a threshold that the vehicle will maintain during teaming operations. If the separation threshold is exceeded, the vehicle may choose to leave the team or adjust its threshold to maintain teaming operations.
- Prior to Leaving a team, the vehicle shall increase its separation distance to the next vehicle to enable safe human-controlled operations.

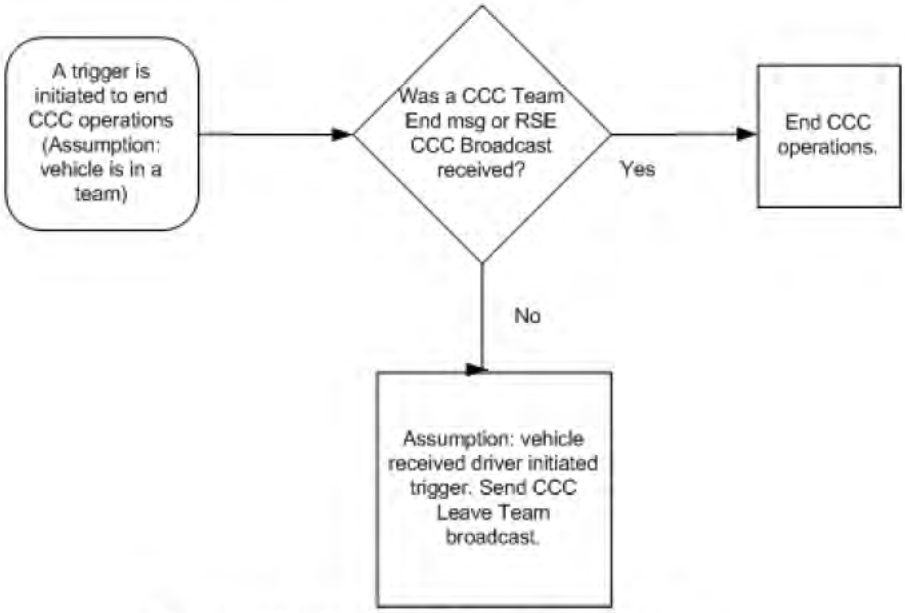


Figure 23: High-level CCC "Leave" Process Flow

Leave Message Broadcast

Leave Message broadcast includes the following data elements:

- DE_MessageType
  - Message Type
- DF_DDateTime
  - Timestamp
- DE _Team Position Number
  - Position (Team Position)
- Leave identifier
  - Switch Lanes
  - Turn Right/Left
  - Speed Change

7. Team Status Message Operations

Team members should broadcast current position information.

- Vehicles will broadcast A "Status" message that provides location information to surrounding members of the team. The frequency of this message will depend on factors such as vehicle speed and following distance.
- The teaming status message may be linked to map applications for other use-cases such as private teams that specify a destination.
- Status data elements
  - DE_MessageType
    - Message Type

- DF_DDateTime
  - Timestamp
- DF_FullPositionVector
  - Position
  - Heading
- DE _Team Identifier
  - Team ID
- DE _Team Position Number
  - Position ID
- DE _Speed
  - Target Speed
- DE _Speed
  - Speed
- DE _Num Team Vehicles
  - Number of Vehicles

8. Conclusion

From the requirements listed above, the following initial data sets are envisioned. This list is not meant to be exhaustive, but gives us the initial operations for a functioning team. Further complex datasets are envisioned.

- V2V messaging
  - Team Status Message
  - Begin
  - End
  - Join
  - Leave

- RSU Service Announcement
  - Zone Identification
  - Signal Phase and Timing (SPAT) Information
  - Road/Weather/Traffic Conditions

9. Developer Notes

Vehicle Class Compatibility

Cooperative Cruise Control systems utilizing this message set aim to increase mobility, safety, and fuel – efficiency through enabling low-latency communications between vehicles. Such communications provide information which allow shorter distances or separation between two vehicles traveling in the same direction, in the same lane, and at the same speed. A team shall be made up of similar or compatible vehicle types in order to achieve the same operational characteristics and safety between team vehicles. Different vehicle platforms have significantly different operational characteristics and therefore make the benefits to safety and mobility unachievable. For instance, a passenger vehicle and a freight truck have different acceleration, braking, turning, and reaction characteristics. It would be extremely unlikely if not feasible at all to implement a system where the two could co-exist in the system environment envisioned for Cooperative Cruise Control.

Leader to Team Communications

The purpose of the Cooperative Cruise Control message set is to provide a mechanism to improve the mobility throughput, fuel efficiency and vehicular safety of the roadway through the use of a team or collective of vehicles. Industry expert experience involved with committee brought to bear during the development of this message set deem communications between the team leader and team members must be direct. Direct communications is defined as receiving the message packets directly from the sender of the packets themselves and not being relayed those packets through an intermediary or other mechanism.

The side effect of in-direct communications proves to undermine the intent of the message set. Even through the use of low-latent communications, a lag or latency exists between the time a team leader sends a message and when a team member receives the message directly. Should an intermediary have to receive the message and relay to following team members the benefit of the information contained in the message is reduced or lost. In some cases, the effect may be increased. Thus, instead of improving vehicular reaction time in response to external variables, vehicle reaction times may decrease. The result may increase the traffic caterpillar or slinky effect. This is also known as adversely affecting the string stability of the vehicle team.

Reducing the caterpillar effect is the overarching goal of the message set. This is achieved or accomplished by maintaining team size limits, vehicle class compatibility within teams, and direct communications with the team leader. These factors may change given the type of low latent communications utilized. Alterations are left to the implementation of the system.

Broadcast Strategy

The cooperative Cruise Control message set as defined in this document follows a broadcast or non-acknowledgment response strategy. A broadcast strategy is one in which the communications infrastructure necessitates a handshaking mechanism which includes dedicated or verified connection. There is no intent to provide a sense of ad-hoc mobile network functionality through the use of this message set. That said, vehicle networks based on ad-hoc networking or some other strategy may still use this message set without needing to modify the message set structure.

Teaming Speed Limit

The teaming concept provides a strategy for vehicles traveling with similar goals, such as speed, heading, and roadway lane. The strategy is intended to improve mobility, roadway throughput, reduce roadway

caterpillar effect, and improve fuel efficiency to name a few. However, these goals must not be achieved by exceeding the roadway limitations as governed by Federal, State and Local authorities and agencies. Thus, the broadcasting of the speed limit value for the teaming zone provides the speed limitation required for safe and successful teaming operations in the particular zone of interest. In absence of a speed limit, a vehicle shall make the assumption that teaming operations are unavailable for the current zone. This possibility may occur in areas where RSU coverage is not as saturated. Once a vehicle enters an RSU coverage zone, authorization for teaming operations may be received.

FHWA Vehicle Classes

FHWA Vehicle Class has been previously defined for the SAE J2735. A detailed discussion of the FHWA vehicle Class definitions may be found at the FHWA Office of Highway Policy Information. An excerpt of this information follows.

FHWA Vehicle Classes with Definitions

Motorcycles -- All two or three-wheeled motorized vehicles. Typical vehicles in this category have saddle type seats and are steered by handlebars rather than steering wheels. This category includes motorcycles, motor scooters, mopeds, motor-powered bicycles, and three-wheel motorcycles.

Passenger Cars -- All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and including those passenger cars pulling recreational or other light trailers.

Other Two-Axle, Four-Tire Single Unit Vehicles -- All two-axle, four-tire, vehicles, other than passenger cars. Included in this classification are pickups, panels, vans, and other vehicles such as campers, motor homes, ambulances, hearses, carryalls, and minibuses. Other two-axle, four-tire single-unit vehicles pulling recreational or other light trailers are included in this classification. *Because automatic vehicle classifiers have difficulty distinguishing class 3 from class 2, these two classes may be combined into class 2.*

Buses -- All vehicles manufactured as traditional passenger-carrying buses with two axles and six tires or three or more axles. This category includes only traditional buses (including school buses) functioning as passenger-carrying vehicles. Modified buses should be considered to be a truck and should be appropriately classified.

NOTE: In reporting information on trucks the following criteria should be used:

1. Truck tractor units traveling without a trailer will be considered single-unit trucks.
2. A truck tractor unit pulling other such units in a "saddle mount" configuration will be considered one single-unit truck and will be defined only by the axles on the pulling unit.
3. Vehicles are defined by the number of axles in contact with the road. Therefore, "floating" axles are counted only when in the down position.
4. The term "trailer" includes both semi- and full trailers.

Two-Axle, Six-Tire, Single-Unit Trucks -- All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., with two axles and dual rear wheels.

Three-Axle Single-Unit Trucks -- All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., with three axles.

Four or More Axle Single-Unit Trucks -- All trucks on a single frame with four or more axles.

Four or Fewer Axle Single-Trailer Trucks -- All vehicles with four or fewer axles consisting of two units, one of which is a tractor or straight truck power unit.

Five-Axle Single-Trailer Trucks -- All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power unit.

Six or More Axle Single-Trailer Trucks -- All vehicles with six or more axles consisting of two units, one of which is a tractor or straight truck power unit.

Five or fewer Axle Multi-Trailer Trucks -- All vehicles with five or fewer axles consisting of three or more units, one of which is a tractor or straight truck power unit.

Six-Axle Multi-Trailer Trucks -- All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power unit.

Seven or More Axle Multi-Trailer Trucks -- All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power unit.

10. Message Set Human Interaction

The message set concept follows a fundamental operational paradigm which assumes automatic operation of the system. This means that once the system is turned on via human interaction the system operates based on system parameters and implementation criteria. However, pertinent messages are received from the vehicle team or the roadside infrastructure which detail operational status or operational changes which may be of interest to the driver. This information may be presented to the driver via the display in a similar manner as other defined traveler information messages. The current intent is not to provide system interaction for the driver but only provide system and team interaction monitoring.

Annex J: Verbose Basic Safety Message

This section is informative.

Message: MSG_BasicSafetyMessage_Verbose

Use: The verbose variant of the basic safety message is defined here. This message is only used in cases when the part I contents of the message is expanded with BER tagging between each data element (no data blobs are used) and is NEVER transmitted over the air in the WSM format in a production environment. It is intended for system testing and development use only. Refer to the *MSG_BasicSafetyMessage* for additional details.

ASN.1 Representation:

```
BasicSafetyMessageVerbose ::= SEQUENCE {
   -- Part I, sent at all times
   msgID          DSRCmsgID,              -- App ID value, 1 byte

   msgCnt         MsgCount,               -- 1 byte
   id             TemporaryID,            -- 4 bytes
   secMark        DSecond,                -- 2 bytes
   -- pos         PositionLocal3D,
   lat            Latitude,               -- 4 bytes
   long           Longitude,              -- 4 bytes
   elev           Elevation,              -- 2 bytes
   accuracy       PositionalAccuracy,     -- 4 bytes

   -- motion      Motion,
   speed          TransmissionAndSpeed,   -- 2 bytes
   heading        Heading,                -- 2 bytes
   angle          SteeringWheelAngle,     -- 1 bytes
   accelSet       AccelerationSet4Way,    -- 7 bytes

   -- control     Control,
   brakes         BrakeSystemStatus,      -- 2 bytes

   -- basic       VehicleBasic,
   size           VehicleSize,            -- 3 bytes

   -- Part II, sent as required
   -- Part II,
   safetyExt      VehicleSafetyExtension OPTIONAL,
   status         VehicleStatus          OPTIONAL,
   ... -- # LOCAL_CONTENT
   }
```

XML Representation:

```
<xs:element  name="basicSafetyMessageVerbose"  type=" BasicSafetyMessageVerbose"/>
<xs:complexType name=" BasicSafetyMessageVerbose" >
      <xs:sequence>
         <!-- Part I,  sent at all times -->
         <xs:element  name="msgID"  type=" DSRCmsgID" />
         <!-- App ID value,  1 byte -->
          <xs:element name="msgCnt" type=" MsgCount" />
         <!-- 1 byte -->
          <xs:element name="id" type=" TemporaryID" />
         <!-- 4 bytes -->
          <xs:element name="secMark" type=" DSecond" />
         <!-- 2 bytes
         pos       PositionLocal3D, -->
          <xs:element name="lat" type=" Latitude" />
         <!-- 4 bytes -->
          <xs:element name="long" type=" Longitude" />
         <!-- 4 bytes -->
```

```
            <xs:element name="elev" type=" Elevation" />
           <!-- 2 bytes -->
            <xs:element name="accuracy" type=" PositionalAccuracy" />
           <!-- 4 bytes
           motion   Motion, -->
            <xs:element name="speed" type=" TransmissionAndSpeed" />
           <!-- 2 bytes -->
            <xs:element name="heading" type=" Heading" />
           <!-- 2 bytes -->
            <xs:element name="angle" type=" SteeringWheelAngle" />
           <!-- 1 bytes -->
            <xs:element name="accelSet" type=" AccelerationSet4Way" />
           <!-- 7 bytes
           control  Control, -->
            <xs:element name="brakes" type=" BrakeSystemStatus" />
           <!-- 2 bytes
           basic    VehicleBasic, -->
            <xs:element name="size" type=" VehicleSize" />
           <!-- 3 bytes
           Part II,  sent as required
           Part II, -->
            <xs:element name="safetyExt" type=" VehicleSafetyExtension"  minOccurs="0"/>
            <xs:element name="status" type=" VehicleStatus"   minOccurs="0"/>
             <xs:element name="localBasicSafetyMessageVerbose"
type="local:BasicSafetyMessageVerbose" minOccurs="0"/>
       </xs:sequence>
</xs:complexType>
```

In addition, this item may be used by data structures in other ITS standards.

Remarks: This message is intended for testing and development uses only.

```
<!-- END of the output -->
```