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**JPO**

Operational Data Environment

**Output Schema Reference**

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|  |  |  |  |
| --- | --- | --- | --- |
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| 0.1 | Hamid Musavi | 4/20/2018 | Initial draft |
| 0.2 | Hamid Musavi | 4/20/2018 | Converted end-notes to footnotes |
| 0.3 | Hamid Musavi | 4/23/2018 | Converted footnotes back to end-notes and added document references and more. |

# Introduction

The Intelligent Transportation Systems Joint Program Office’s (ITS JPO) Operational Data Environment (ODE) is a real-time virtual data router that ingests and processes operational data from various connected devices—including vehicles, infrastructure, and traffic management centers—and distributes it to other devices and subscribing transportation management applications. Using the ITS ODE within intelligent transportation deployments increases data fluidity and interoperability while meeting operational needs and protecting user privacy. The software’s microservices architecture makes it easy to add new capabilities to meet local needs.

This document describes the schema of the data published by the ODE to be consumed by client applications. For additional information about developing applications to interface with the ODE, refer to the ODE Users Guide. (Booz Allen Hamilton, 2018)

# Published Topics

ODE publishes Connected Vehicle data via Kafka messaging platform. The data is streamed in two basic formats:

* Plain Old Java Objects (POJO) – serialized in binary format
* JavaScript Object Notation (JSON) – serialized in plain text format

The following table provides the name, record type and record format of the topics published by ODE.

|  |  |  |  |
| --- | --- | --- | --- |
| Topic Name | Content Description | Data Type | Format |
| topic.OdeBsmPojo | All Basic Safety Messages process by ODE (unfiltered and un-sanitized) | us.dot.its.jpo.ode.model.OdeBsmData | POJO |
| topic.OdeBsmJson | All Basic Safety Messages process by ODE (unfiltered and un-sanitized) | us.dot.its.jpo.ode.model.OdeBsmData | JSON |
| topic.FilteredOdeBsmJson | Filtered based on a configured Geo-fence and sanitized (PII removed) Basic Safety Message | us.dot.its.jpo.ode.model.OdeBsmData | JSON |
| topic.OdeBsmRxPojo | Unfiltered and un-sanitized Basic Safety Message received by the Ego Vehicle (EV) OBU from a Remote Vehicles (RV) | us.dot.its.jpo.ode.model.OdeBsmData | POJO |
| topic.OdeBsmTxPojo | Unfiltered and un-sanitized Basic Safety Message transmitted by the Ego Vehicle (EV) OBU | us.dot.its.jpo.ode.model.OdeBsmData | POJO |
| topic.OdeBsmDuringEventPojo | Unfiltered and un-sanitized Basic Safety Message received by the Ego Vehicle (EV) OBU from a Remote Vehicles (RV) during an event. | us.dot.its.jpo.ode.model.OdeBsmData | POJO |
| topic.OdeTimJson | All Traveler Information Message processed by ODE (unfiltered and un-sanitized) | J2735 TravelerInformation | JSON |
| topic.FilteredOdeTimJson | Filtered based on a configured Geo-fence and sanitized (PII removed) Traveler Information Message | J2735 TravelerInformation | JSON |
| topic.OdeDNMsgJson | Unfiltered and un-sanitized Traveler Information Message containing a Distress Notification received by EV | J2735 TravelerInformation | JSON |
| topic.OdeTimRxJson | Unfiltered and un-sanitized Traveler Information Message received by the Ego Vehicle (EV) OBU from a Remote Vehicles (RV) | J2735 TravelerInformation | JSON |
| topic.OdeTimBroadcastPojo | Traveler Information Message broadcast by Transportation Management Center (TMC) | us.dot.its.jpo.ode.model.OdeTimData | POJO |
| topic.OdeTimBroadcastJson | Traveler Information Message broadcast by Transportation Management Center (TMC) | us.dot.its.jpo.ode.model.OdeTimData | JSON |
| topic.OdeDriverAlertJson | Driver Alert messages received by the EV OBU | us.dot.its.jpo.ode.model.OdeDriverAlertData | JSON |

Table 1 - ODE Published Topics

# Common Data Schemas

ODE output data is provided from the following sources:

* OBU Log files uploaded to ODE. These log files may contain one or more of the following data types:
  + J2735 (SAE International, 2016) Basic Safety Message (BSM)
  + J2735 (SAE International, 2016) Traveler Information Message (TIM)
  + Driver alert message
  + TIM deposit request from Transportation Management Center (TMC)

## ODE Data

The top-level structure of ODE Data Message is defined in the Table 2below:

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| metadata | One of [OdeMsgMetadata](#_ODE_Message_Metadata) types | See section 2.2 |
| payload | One of [OdeMsgPayload](#_ODE_Data_Message) types. | See section 2.6 and its subsections |

Table 2 – OdeData

## ODE Message Metadata

The structure of OdeMsgMetadata is defined in Table 3.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| schemaVersion | Integer | The version number for this schema, an integer starting with 1. |
| payloadType | String | The Java type of the payload data structure |
| serialId | Object [SerialId](#_SerialId) | A unique serial number representing this record. |
| odeReceivedAt[[1]](#endnote-1) | String | The date and time that the payload paired with this metadata was received by the ODE. ISO standard format include time zone: **yyyy-MM-ddThh:mm:ss.sssZ** |
| recordGeneratedAt | String | The date and time that the data was generated at the source defined by recordGeneratedBy. ISO standard format include time zone: **yyyy-MM-ddThh:mm:ss.sssZ** |
| recordGeneratedBy | String | An enumeration value from **enum** GeneratedBy {***TMC***, ***OBU***, ***RSU***} |
| sanitized | Boolean String | true or false. True if the record has been processed by a privacy protection module. |
| logFileName | String | Simple name of the log file ingested. This element is defined in OdeLogMetadata |
| recordType | String | This field identifies the file type from which the record was ingested and the record type. Current valid file types are: {***bsmLogDuringEvent***, ***rxMsg***, ***dnMsg***, ***bsmTx***, ***driverAlert***, ***unsupported***}. Supported record types are: {***DN\_MSG, ENVIRONMENT\_MSG, DRIVER\_ALERT, UPGRADES, SYSTEM\_LOG, RX\_MSG, SCMS, BSM\_TX, BSM\_RX***}.  This field will show a combination of the file type and record type in a doted notations as in ***rxMsg.BSM\_RX*** |
| securityResultCode | String | One of **enum** constant SecurityResultCode {***success***, ***unknown***, ***inconsistentInputParameters***, ***spduParsingInvalidInput***, ***spduParsingUnsupportedCriticalInformationField***, ***spduParsingCertificateNotFound***, ***spduParsingGenerationTimeNotAvailable***, ***spduParsingGenerationLocationNotAvailable***, ***spduCertificateChainNotEnoughInformationToConstructChain***, ***spduCertificateChainChainEndedAtUntrustedRoot***, ***spduCertificateChainChainWasTooLongForImplementation***, ***spduCertificateChainCertificateRevoked***, ***spduCertificateChainOverdueCRL***, ***spduCertificateChainInconsistentExpiryTimes***, ***spduCertificateChainInconsistentStartTimes***, ***spduCertificateChainInconsistentChainPermissions***, ***spduCryptoVerificationFailure***, ***spduConsistencyFutureCertificateAtGenerationTime***, ***spduConsistencyExpiredCertificateAtGenerationTime***, ***spduConsistencyExpiryDateTooEarly***, ***spduConsistencyExpiryDateTooLate***, ***spduConsistencyGenerationLocationOutsideValidityRegion***, ***spduConsistencyNoGenerationLocation***, ***spduConsistencyUnauthorizedPSID***, ***spduInternalConsistencyExpiryTimeBeforeGenerationTime***, ***spduInternalConsistencyextDataHashDoesntMatch***, ***spduInternalConsistencynoExtDataHashProvided***, ***spduInternalConsistencynoExtDataHashPresent***, ***spduLocalConsistencyPSIDsDontMatch***, ***spduLocalConsistencyChainWasTooLongForSDEE***, ***spduRelevanceGenerationTimeTooFarInPast***, ***spduRelevanceGenerationTimeTooFarInFuture***, ***spduRelevanceExpiryTimeInPast***, ***spduRelevanceGenerationLocationTooDistant***, ***spduRelevanceReplayedSpdu***, ***spduCertificateExpired***}. This element is defined in OdeLogMetadata |
| Encodings | Array of [Encoding](#_Encodings) | A list of Asn1Encodings. See section 2.4 |
| bsmSource | String | One of **enum** BsmSource {***EV***, ***RV***, ***unknown***} constants. |
| receivedMessageDetails | [ReceivedMessageDetails](#_ReceivedMessageDetails) | See section 2.5 |

Table 3 - OdeMsgMetadata

## SerialId

This data structure can serve as a unique key for each record.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| streamId | String | Universally Unique ID (UUID) of Stream that process the original log file | N/A | N/A | N/A |
| bundleSize | Integer | Size of the bundle within the processed file | N/A | 1 | MAX\_INT |
| bundleId | Integer | Bundle identifier within the stream | N/A | 0 | MAX\_LONG-1 |
| recordId | Integer | Record identifier within the bundle | N/A | 0 | MAX\_INT - 1 |
| serialNumber | Integer | Combined identifier within the stream, a combination of bundleSize, bundleId, and recordId. | N/A | 0 | MAX\_LONG-1 |

Table 4 - SerialId

## Encodings

A list of ASN.1 encoding instructions provided to the ASN.1 CODEC module. This entire object is removed from the stream prior to publishing the data.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| elementName | String | Name of element to be ASN.1 encoded |
| elementType | String | ASN.1 type/data structure to be encoded |
| encodingRule | String | One of the following  **enum** EncodingRule {***UPER***, ***COER***} |

Table 5 - Encodings

## ReceivedMessageDetails

This data structure contains the location of the vehicle when this data record was logged and the source of the data.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| locationData | Object | A data structure containing the following:  String latitude;  String longitude;  String elevation;  String speed;  String heading;  Latitude and longitude will be represented in degrees, elevation in meters, speed in meters per second and heading in degrees. |
| rxSource | String | One of **enum** RxSource {***RSU***, ***SAT***, ***RV***, ***SNMP***, ***NA***} constants |

Table 6 - ReceivedMessageDetails

## OdeMessagePayload

OdeMsgPayload is the parent class for all payload data structures, each of which contain the following data elements.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| dataType | String | The type of data contained in the data element. |
| Data | OdeObject | The data within this payload |

Table 7 - OdeMsgPayload

The following subsections describe the child schemas of [OdeMsgPayload](#_ODE_Data_Message_1). The following OdeMsgPayload types are currently supported:

* OdeTimPayload – containing a J2735TravelerInformationMessage
* OdeDriverAlertPayload – containing an *alert* text message
* OdeBsmPayload – containing a J2735Bsm

The following subsections describe the structure, element types, and valid range of values for each of the above payload types.

# OdeTimPayload

J2735 TravelerInformation messages are decoded from ASN.1 binary format to XER format and then directly translated into JSON format. No transformation of data is performed on the JSON format that is published to Kafka topics. For full details of the fields within TravelerInformation message please refer to J2735 Standard Specification (<http://standards.sae.org/j2735_201603/> ).

# OdeDriverAlertPayload

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| Alert | Alert | Driver alert message in plain text. |

# OdeBsmPayload

The basic safety message (BSM) is used in a variety of applications to exchange safety data regarding vehicle state.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| coreData | [J2735BsmCoreData](#_J2735BsmCoreData) | This data frame contains the critical core data elements deemed to be needed with every BSM issued. See section 5.1 |
| partII | Array of [J2735BsmPart2Content](#_J2735BsmPart2Content) | Part II data items are optional for a given BSM and are included as needed according to policies that are beyond the scope of this standard. See section 5.2 |

Table 8 - OdeBsmPayload

## J2735BsmCoreData

J2735BSMcoreData data frame contains the critical core data elements deemed to be needed with every BSM issued. This data frame’s contents are often referred to as the "BSM Part One", although it is reused in other places as well.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| msgCnt | Integer | MsgCount data element is used to provide a sequence number within a stream of messages with the same DSRCmsgID and from the same sender. | N/A | 0 | 127 |
| secMark | Integer | The DSRC second expressed in this data element consists of integer values from zero to 60999, representing the milliseconds within a minute. A leap second is represented by the value range 60000 to 60999. The value of 65535 shall represent an unavailable value in the range of the minute. The values from 61000 to 65534 are reserved. | Second | 0 | 65535 |
| speed[[2]](#endnote-2) | decimal | This data element represents the vehicle speed | m/s | 0 | 163.8 |
| heading† | decimal | This data element provides the current heading of the sending device. | Degrees | 0.000 | 360.000 |
| angle† | decimal | The angle of the driver’s steering wheel | Degrees | 0.000 | 360.000 |

Table 9 - J2735BsmCoreData (1)

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| Id | HEX String | This is the 4-octet random device identifier, called the TemporaryID. When used for a mobile OBU device, this value will change periodically to ensure the overall anonymity of the vehicle, unlike a typical wireless or wired 802 device ID. |
| position | [OdePosition3D](#_J2735Position3D) | Position of the vehicle. See section 5.3 |
| accelSet | [J2735AccelerationSet4Way](#_J2735AccelerationSet4Way) | Acceleration values in 3 orthogonal directions of the vehicle and with yaw rotation rates. See section 5.4 |
| accuracy | [J2735PositionalAccuracy](#_J2735PositionalAccuracy) | See section 5.5 |
| transmission | string | Used to provide the current state of the vehicle transmission. One of:   * ***neutral***, // Neutral, speed relative to the vehicle alignment * ***park***, // Park, speed relative to the vehicle alignment * ***forwardGears***, // Forward gears, speed relative to the vehicle alignment * ***reverseGears***, // Reverse gears, speed relative to the vehicle alignment * ***reserved1***, ***reserved2***, ***reserved3***, * ***unavailable***; // not-equipped or unavailable value |
| brakes | [J2735BrakeSystemStatus](#_J2735BrakeSystemStatus) | See section 5.6 |
| size | [J2735VehicleSize](#_J2735VehicleSize) | See section 5.7 |

Table 10 - J2735BsmCoreData (2)

## J2735BsmPart2Content

Part II data items are optional for a given BSM and are included as needed according to policies that are beyond the scope of this standard.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| id | String | One of: {***VehicleSafetyExtensions***, ***SpecialVehicleExtensions***, ***SupplementalVehicleExtensions*** } |
| value | Object | One of the following object types:   * [J2735VehicleSafetyExtensions](#_J2735VehicleSafetyExtensions) * [J2735SpecialVehicleExtensions](#_J2735SpecialVehicleExtensions) * [J2735SupplementalVehicleExtensions](#_J2735SupplementalVehicleExtensions) |

Table 11 - J2735BsmPart2Content

## OdePosition3D

This data structure provides a precise location in the WGS-84 coordinate system, from which short offsets may be used to create additional data using a flat earth projection centered on this location.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| elevation† | decimal | The geographic position above or below the reference ellipsoid (typically WGS-84) | meters | -409.5 | 6143.9 |
| latitude† | decimal | The geographic latitude of an object | Degrees | -90.0000000 | +90.0000001 |
| longitude† | decimal | The geographic longitude of an object | Degrees | - 179.9999999 | + 180.0000001 |

Table 12 - OdePosition3D

## J2735AccelerationSet4Way

This data frame is a set of acceleration values in 3 orthogonal directions of the vehicle and with yaw rotation rates, expressed as a structure.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| accelLat† | decimal | Latitudinal acceleration, i.e. acceleration perpendicular to the direction of travel. | m/s2 | -20.00 | +20.00 |
| accelLong† | decimal | Longitudinal acceleration, i.e. acceleration in the direction of travel. | m/s2 | -20.00 | +20.00 |
| accelVert† | decimal | Vertical acceleration, i.e. acceleration along the z-axis | G | -3.4 | +1.54 |
| accelYaw† | decimal | Rotational acceleration around the z axis | Degrees/sec | -327.67 | +327.67 |

Table 13 - J2735AccelerationSet4Way

## J2735PositionalAccuracy

The J2735PositionalAccuracy data frame consists of various parameters of quality used to model the accuracy of the positional determination with respect to each given axis.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| semiMajor† | decimal | semi-major axis accuracy at one standard dev | Meter | 0.00 | 12.70 |
| semiMinor† | decimal | semi-major axis accuracy at one standard dev | Meter | 0.00 | 12.70 |
| orientation† | decimal | orientation of semi-major axis -- relative to true north (0~359.9945078786 degrees) | Degree | 0.0000000000 | 359.9945078786 |

Table 14 - J2735PositionalAccuracy

## J2735BrakeSystemStatus

The Brake System Status data frame conveys a variety of information about the current brake and system control activity of the vehicle. The structure consist of a sequence of items which provide status flags for any active brakes per wheel, the traction control system, the anti-lock brake system, the stability control system, the brake boost system, and the auxiliary brake system.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| wheelBrakes | [J2735BitString](#_J2735BitString) | Indicates independently for each of four wheels whether braking is currently active. A Boolean dictionary of the following indicators:  **enum** {***unavailable***, ***leftFront***, ***leftRear***, ***rightFront***, ***rightRear***}   * unavailable -- When set, the brake applied status is unavailable * leftFront -- Left Front Active * leftRear -- Left Rear Active * rightFront -- Right Front Active * rightRear -- Right Rear Active |
| traction | string | Reflects the status of the vehicle traction control system. One of:   * unavailable -- B'00 Not Equipped with traction control or traction control status is unavailable * off -- B'01 traction control is Off * on -- B'10 traction control is On (but not Engaged) * engaged -- B'11 traction control is Engaged |
| abs | string | Reflects the status of the vehicle ABS. One of:   * unavailable -- B'00 Vehicle Not Equipped with ABS Brakes or ABS Brakes status is unavailable * off -- B'01 Vehicle's ABS are Off * on -- B'10 Vehicle's ABS are On ( but not Engaged ) * engaged -- B'11 Vehicle's ABS control is Engaged on any wheel |
| scs | string | Reflects the current state of the stability control system. One of:   * unavailable, -- B'00 Not Equipped with SC or SC status is unavailable * off, -- B'01 Off * on, -- B'10 On or active (but not engaged) * engaged -- B'11 stability control is Engaged |
| brakeBoost | string | This is a data element which, when set to the "on" state, indicates emergency braking. One of:   * unavailable, -- Vehicle not equipped with brake boost or brake boost data is unavailable * off, -- Vehicle's brake boost is off * on -- Vehicle's brake boost is on (applied) |
| auxBrakes | string | Reflects the status of the auxiliary brakes (sometimes referred to as the parking brake) of the vehicle. One of:   * unavailable -- B'00 Vehicle Not Equipped with Aux Brakes or Aux Brakes status is unavailable * Off -- B'01 Vehicle's Aux Brakes are Off * on -- B'10 Vehicle's Aux Brakes are On (Engaged) * reserved -- B'11 |

Table 15 - J2735BrakeSystemStatus

## J2735VehicleSize

The J2735VehicleSize is a data structure representing the vehicle length and vehicle width in a single data concept.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| length | integer | Vehicle length | Centimeter | 0 | 16383 |
| width | integer | Vehicle Width | Centimeter | 0 | 1023 |

Table 16 - J2735VehicleSize

## J2735BitString

A J2735BitString is represented by a Boolean dictionary, a collection of name-value pairs where the name identifies a Boolean indicator and the value represents the state of the indicator as *true* or *false*.

## J2735VehicleSafetyExtensions

J2735VehicleSafetyExtensions data frame is used to send various additional details about the vehicle.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| events | [J2735BitString](#_J2735BitString) | Conveys the sender's state regarding a set of events. A Boolean dictionary of the following indicators:   * eventHazardLights * eventStopLineViolation -- Intersection Violation * eventABSactivated * eventTractionControlLoss * eventStabilityControlactivated * eventHazardousMaterials * eventReserved1 * eventHardBraking * eventLightsChanged * eventWipersChanged * eventFlatTire * eventDisabledVehicle -- The DisabledVehicle DF may also be sent * eventAirBagDeployment | | | |
| pathHistory | [J2735PathHistory](#_J2735PathHistory) | A geometric path reflecting time-tagged vehicle movement over some period of time and/or distance. | | | |
| pathPrediction | [J2735PathPrediction](#_J2735PathPrediction) | Allows vehicles and other type of users to share their predicted path trajectory by estimating a future path of travel. | | | |
| lights | [J2735BitString](#_J2735BitString) | Provides the status of various exterior lights. A Boolean dictionary of the following indicators:   * lowBeamHeadlightsOn * highBeamHeadlightsOn * leftTurnSignalOn * rightTurnSignalOn * hazardSignalOn * automaticLightControlOn * daytimeRunningLightsOn * fogLightOn * parkingLightsOn | | | |

Table 17 - J2735VehicleSafetyExtensions

## J2735SpecialVehicleExtensions

J2735SpecialVehicleExtensions is used to send various additional optional information elements in the Part II BSM used by special vehicles.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| vehicleAlerts | [J2735EmergencyDetails](#_J2735EmergencyDetails) | Combines several bit level items into a structure for efficient transmission about the vehicle during a response call. See section 5.14. |
| description | [J2735EventDescription](#_J2735EventDescription) | Provides a short summary of an event or incident. It is used by a sending device (often a public safety vehicle) to inform nearby equipped devices about an event or about the driving action the sending device is taking or is about to take. Typical use cases include such concepts as a slow-moving vehicle as well as fire/police movement with flashing light details. |
| trailers | [J2735TrailerData](#_J2735TrailerData) | Provides a means to describe trailers pulled by a motor vehicle and/or other equipped devices. |

Table 18 - J2735SpecialVehicleExtensions

## J2735SupplementalVehicleExtensions

This data structure is used to send various optional additional information elements in the Part II BSM. The range of use cases supported by these elements is very broad and includes both additional V2V functionality and various V2I monitoring applications. A variety of "vehicle as probe" applications fit within this overall functionality as well. Further use cases and requirements are developed in relevant standards. It should be noted that the use of the regional extension mechanism here is intended to provide a means to develop experimental message content within this data frame.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| classification | Integer | Used to provide a common classification system to categorize DSRC- equipped devices for various cross-cutting uses. See J2735 spec for details. | N/A | 0 | 255 |

Table 19 - J2735SupplementalVehicleExtensions (1)

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| classDetails | [J2735VehicleClassification](#_J2735VehicleClassification) | Used in ITS and DSRC work. See 5.17 |
| vehicleData | [J2735VehicleData](#_J2735VehicleData) | Used to convey additional data about the vehicle not found in the BSM Part I data frame. |
| weatherReport | [J2735WeatherReport](#_J2735WeatherReport) | Used to convey weather measurements made by the sending device |
| weatherProbe | [J2735WeatherProbe](#_J2735WeatherProbe) | Provides basic data on the air temperature and barometric pressure experienced by a vehicle, as well as the current status of the wiper systems on the vehicle, including front and rear wiper systems (where equipped) to indicate coarse rainfall levels. |
| obstacle | [J2735ObstacleDetection](#_J2735ObstacleDetection) | Used to relate basic location information about a detect obstacle or a road hazard in a vehicles path. |
| status | [J2735DisabledVehicle](#_J2735DisabledVehicle) | Provides a means for a vehicle (or other equipped device) to describe its operational status and gross location to others using a subset of the ITIS codes. |
| speedProfile | [J2735SpeedProfile](#_J2735SpeedProfile) | Supports connected vehicles which will be collecting and parsing BSMs as they travel: these consist of speed data reported from the opposite direction. Each equipped vehicle collects the reported BSM speeds from the vehicles traveling in the opposite direction and store the average speed of these vehicles every 100 meters. |
| theRTCM | [J2735RTCMPackage](#_J2735RTCMPackage) | Used to convey RTCM messages which deal with differential corrections between users from one mobile device to another. |
| regional | Array of [J2735RegionalContent](#_J2735RegionalContent) | Regional extensions is NOT currently implemented. |

Table 20 - J2735SupplementalVehicleExtensions (2)

## J2735PathHistory

The J2735PathHistory data frame defines a geometric path reflecting time-tagged vehicle movement over some period of time and/or distance. A sequence of Path History Points is used along with an initial position (and the GNSS status at that time) to create a set of straight line segments representing the path.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| initialPosition | [J2735FullPositionVector](#_J2735FullPositionVector) | A complete report of the vehicle's position, speed, and heading at an instant in time. |
| currGNSSstatus | [J2735BitString](#_J2735BitString) | A Boolean (true/false) dictionary (name/value pairs) of the following indicators:   * unavailable -- Not Equipped or unavailable * isHealthy * isMonitored * baseStationType -- Set to zero if a moving base station, or if a rover device (an OBU), set to one if it is a fixed base station * aPDOPofUnder5 -- A dilution of precision greater than 5 * inViewOfUnder5 -- Less than 5 satellites in view * localCorrectionsPresent -- DGPS type corrections used * networkCorrectionsPresent -- RTK type corrections used |
| crumbData | Array of [J2735PathHistoryPoint](#_J2735PathHistoryPoint) | The Path History Point data frame is used to convey a single point in the path of an object (typically a motor vehicle) described as a sequence of such position points. The sequence and number of these points is selected to convey the desired level of accuracy and precision required by the application. |

Table 21 - J2735PathHistory

## J2735PathPrediction

The J2735PathPrediction data frame allows vehicles and other type of users to share their predicted path trajectory by estimating a future path of travel.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| confidence† | decimal | The Confidence is a data element representing the general confidence of another associated value, in this case, the confidence level of radiusOfCurve | percent | 0.0 | 100.0 |
| radiusOfCurve† | decimal | A data element representing an estimate of the current trajectory of the sender. See J2735 spec for details. | meters | -32767.0 | +32767.0 |

## J2735EmergencyDetails

This data structure combines several bit level items into a structure for efficient transmission about the vehicle during a response call.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| sspRights | integer | Index set by CERT. The SSP index (0-31) is used to control the data elements that follow the occurrence of the index. | | | |
| events | [J2735PrivilegedEvents](#_J2735PrivilegedEvents) | Provides a means to describe various public safety events. | | | |
| lightsUse | String | One of the following enumeration constants:   * ***unavailable***, * ***notInUse***, * ***inUse***, * ***yellowCautionLights***, * ***schooldBusLights***, * ***arrowSignsActive***, * ***slowMovingVehicle***, * ***freqStops*** | | | |
| multi | String | One of the following enumeration constants:   * ***unavailable***, * ***singleVehicle***, * ***multiVehicle***, * ***reserved*** | | | |
| responseType | String | One of the following enumeration constants:   * ***notInUseOrNotEquipped***, * ***emergency***, * ***nonEmergency***, * ***pursuit***, * ***stationary***, * ***slowMoving***, * ***stopAndGoMovement*** | | | |
| sirenUse | String | One of the following enumeration constants:   * ***unavailable***, * ***notInUse***, * ***inUse***, * ***reserved*** | | | |

## J2735EventDescription

This data structure provides a short summary of an event or incident. It is used by a sending device (often a public safety vehicle) to inform nearby equipped devices about an event or about the driving action the sending device is taking or is about to take. Typical use cases include such concepts as a slow moving vehicle as well as fire/police movement with flashing light details.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| description | Array of integers | 1 to 8 ITIS.ITIScodes |
| extent | string | The spatial distance over which this message applies and should be presented to the driver. An enumeration constant:   * ***USEINSTANTLYONLY***, * ***USEFOR3METERS***, * ***USEFOR10METERS***, * ***USEFOR50METERS***, * ***USEFOR100METERS***, * ***USEFOR500METERS***, * ***USEFOR1000METERS***, * ***USEFOR5000METERS***, * ***USEFOR10000METERS***, * ***USEFOR50000METERS***, * ***USEFOR100000METERS***, * ***USEFOR500000METERS***, * ***USEFOR1000000METERS***, * ***USEFOR5000000METERS***, * ***USEFOR10000000METERS***, * ***FOREVER*** |
| heading | [J2735BitString](#_J2735BitString) | A Boolean dictionary of the following indicators:   * from000-0to022-5degrees * from022-5to045-0degrees * from045-0to067-5degrees * from067-5to090-0degrees * from090-0to112-5degrees * from112-5to135-0degrees * from135-0to157-5degrees * from157-5to180-0degrees * from180-0to202-5degrees * from202-5to225-0degrees * from225-0to247-5degrees * from247-5to270-0degrees * from270-0to292-5degrees * from292-5to315-0degrees * from315-0to337-5degrees * from337-5to360-0degrees |
| regional | Array of [J2735RegionalContent](#_J2735RegionalContent) | Regional content is NOT currently implemented. |

Table 22 - J2735EventDescription (1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| priority | Integer | The urgency of the message | N/A | 0 | 7 |
| typeEvent | Integer | A code from the list of ITIS.ITIScodes | N/A | 0 | 65535 |

Table 23 - J2735EventDescription (2)

## J2735TrailerData

Provides a means to describe trailers pulled by a motor vehicle and/or other equipped devices. The span of use is intended to cover use cases from simple passenger vehicles with trailers to class 8 vehicles hauling one or more trailers and dollies. The information in this data frame (along with the BSM message in which it is sent) can be used to determine various aspects of the sender. These include the path of the vehicle and its trailer(s) under various maneuvering conditions (lane matching) as well as the rear of the final trailer, which is often useful in signal control optimization and in intersection safety. This data frame is typically used in the BSM Part II content.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| sspRights | Integer | Index to CERT rights. The SSP index is used to control the data elements that follow the occurrence of the index. | N/A | 0 | 31 |

Table 24 - J2735TrailerData (1)

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| connection | [J2735PivotPointDescription](#_J2735PivotPointDescription) | Offset connection point details from the hauling vehicle to the first trailer unit. |
| units | Array of [J2735TrailerUnitDescription](#_J2735TrailerUnitDescription) | One of more Trailer or Dolly Descriptions (each called a unit). |

Table 25 - J2735TrailerData (2)

## J2735VehicleClassification

This data frame is a structure with a composite set of common classification systems used in ITS and DSRC work. There are any number of such 'types' that can be used to classify a vehicle based on different systems and needs. A given use case will typically use only a subset of the items noted below.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| fuelType | String | One of the following enumeration constants:   * ***unknownFuel***, // FuelType::= 0 -- Gasoline Powered * ***gasoline***, // FuelType::= 1 * ***ethanol***, // FuelType::= 2 -- Including blends * ***diesel***, // FuelType::= 3 -- All types * ***electric***, // FuelType::= 4 * ***hybrid***, // FuelType::= 5 -- All types * ***hydrogen***, // FuelType::= 6 * ***natGasLiquid***, // FuelType::= 7 -- Liquefied * ***natGasComp***, // FuelType::= 8 -- Compressed * ***propane*** // FuelType::= 9 |
| hpmsType | String | One of the following enumeration constants:   * ***none***, * ***unknown***, * ***special***, * ***moto***, * ***car***, * ***carOther***, * ***bus***, * ***axleCnt2***, * ***axleCnt3***, * ***axleCnt4***, * ***axleCnt4Trailer***, * ***axleCnt5Trailer***, * ***axleCnt6Trailer***, * ***axleCnt5MultiTrailer***, * ***axleCnt6MultiTrailer***, * ***axleCnt7MultiTrailer*** |
| responderType | String | One of the following enumeration constants:   * ***emergency\_vehicle\_units***, * ***federal\_law\_enforcement\_units***, * ***state\_police\_units***, * ***county\_police\_units***, * ***local\_police\_units***, * ***ambulance\_units***, * ***rescue\_units***, * ***fire\_units***, * ***hAZMAT\_units***, * ***light\_tow\_unit***, * ***heavy\_tow\_unit***, * ***freeway\_service\_patrols***, * ***transportation\_response\_units***, * ***private\_contractor\_response\_units*** |

Table 26 - J2735VehicleClassification (1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| iso3883 | Integer | Iso3833VehicleType data element represents the value domain provided by ISO 3833 for general vehicle types. It is a European list similar to the list used for the Highway Performance Monitoring System (HPMS) in the US region. In this standard, the HPMS list is used in the data concept named VehicleType. | N/A | 0 | 100 |
| keyType | Integer | The BasicVehicleRole data element provides a means to indicate the current role that a DSRC device is playing. | N/A | 0 | 255 |

Table 27 - J2735VehicleClassification (2)

## J2735VehicleData

This data structure is used to convey additional data about the vehicle not found in the BSM Part I data frame.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| height† | decimal | The height of the vehicle, measured from the ground to the highest surface, excluding any antenna(s) | Meter | 0 | 6.35 |
| mass | Integer | Represents the estimated weight of the vehicle over a span of stepwise linear values. See J2735 spec for details. | N/A | 0 | 255 |
| trailerWeight† | Integer | A data element re-used from the SAE J1939 standard. Also see SPN 180, PGN reference 65258 | Kg | 0 | 128,510 |

Table 28 - J2735VehicleData (1)

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| bumpers | [J2735BumperHeights](#_J2735BumperHeights) | Conveys the height of the front and rear bumper of the vehicle or object (can also be used with trailers). |

Table 29 - J2735VehicleData (2)

## J2735WeatherReport

Used to convey weather measurements made by the sending device.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| isRaining | string | **enum** {***PRECIP***, ***NOPRECIP***, ***ERROR***} |
| precipSituation | string | **enum** {***OTHER***, ***UNKNOWN***, ***NOPRECIPITATION***, ***UNIDENTIFIEDSLIGHT***, ***UNIDENTIFIEDMODERATE***, ***UNIDENTIFIEDHEAVY***, ***SNOWSLIGHT***, ***SNOWMODERATE***, ***SNOWHEAVY***, ***RAINSLIGHT***, ***RAINMODERATE***, ***RAINHEAVY***, ***FROZENPRECIPITATIONSLIGHT***, ***FROZENPRECIPITATIONMODERATE***, ***FROZENPRECIPITATIONHEAVY***} |

Table 30 - J2735WeatherReport (1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| rainRate† | decimal | 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. | g/square meters | 0.0 | 6553.4 |
| solarRadiation | integer | The direct solar radiation integrated over the 24 hours preceding the observation. | Joules/ square meters | 0 | 65534 |
| friction | integer | Indicates measured coefficient of friction in percent. The value 101 shall indicate an error condition or missing value. | None | 0 | 101 |
| roadFriction† | decimal | Coefficient of Friction of an object, typically a wheel in contact with the ground. This data element is typically used in sets where the value at each wheel is provided in turn as a measure of relative local traction. | micro | 0.00 | 1.00 |

Table 31 - J2735WeatherReport (2)

## J2735WeatherProbe

The J2735WeatherProbe data frame provides basic data on the air temperature and barometric pressure experienced by a vehicle, as well as the current status of the wiper systems on the vehicle, including front and rear wiper systems (where equipped) to indicate coarse rainfall levels.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| weatherAirPres† | integer | Used to relate the measured Ambient Pressure (Barometric Pressure) from a vehicle or other device. | hectopascals (hPa) | 580 | 1088 |
| weatherAirTemp† | integer | Used to relate the measured Ambient Air Temperature from a vehicle or other device. | Centigrade (Celcius) | -40 | +150 |
| rainRates | [J2735WiperSet](#_J2735WiperSet) | Provides the current status of the wiper systems on the subject vehicle, including front and rear wiper systems (where equipped). | See section 5.21 | N/A | N/A |

Table 32 - J2735WeatherProbe

## J2735WiperSet

The J2735WiperSet data frame provides the current status of the wiper systems on the subject vehicle, including front and rear wiper systems (where equipped).

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| statusFront | string | **enum** {***UNAVAILABLE***, ***OFF***, ***INTERMITTENT***, ***LOW***, ***HIGH***, ***WASHERINUSE***, ***AUTOMATICPRESENT***} |
| statusRear | string | **enum** {***UNAVAILABLE***, ***OFF***, ***INTERMITTENT***, ***LOW***, ***HIGH***, ***WASHERINUSE***, ***AUTOMATICPRESENT***} |

Table 33 - J2735WiperSet (1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| rateFront | integer | The current rate at which wiper sweeps are taking place on the subject vehicle, in units of sweeps per minute. A value of 1 is used for any sweep rate with a period greater than 60 seconds. | Sweeps/ minute | 0 | 127 |
| rateRear | integer | The current rate at which wiper sweeps are taking place on the subject vehicle, in units of sweeps per minute. A value of 1 is used for any sweep rate with a period greater than 60 seconds. | Sweeps/ minute | 0 | 127 |

Table 34 - J2735WiperSet (2)

## J2735ObstacleDetection

Used to relate basic location information about a detect obstacle or a road hazard in a vehicles path.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| obDist | integer | 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. | meters | 0 | 32767 |
| obDirect† | decimal | 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 perspective of the vehicle detecting and reporting the obstacle. | degrees | 0.0000 | 359.9875 |
| description | integer | ITIS.ITIScodes(523..541) | ITIS code | 523 | 541 |
| locationDetails | String | An ITIS enumeration commonly referred to as "Generic Locations." The code is assigned the upper byte value of [31] (which provides for value ranges from 7936 to 8191, inclusive). | Generic Location IT IS enumeration | Enum for 7936 | Enum for 8191 |

Table 35 - J2735ObstacleDetection (1)

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| dateTime | [J2735DDateTime](#_J2735DDateTime) | 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+)" |
| vertEvent | [J2735BitString](#_J2735BitString) | A dictionary (name/value pair) of boolean values enumerating when a preset threshold for vertical acceleration is exceeded at each wheel. Set of names include:  notEquipped, -- Not equipped or off  leftFront, -- Left Front Event  leftRear, -- Left Rear Event  rightFront, -- Right Front Event  rightRear -- Right Rear Event |

Table 36 - J2735ObstacleDetection (2)

## J2735DDateTime

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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| year | Integer | Year according to the Gregorian calendar date system. | Years | 1 | 4095 |
| month | Integer | Month within a year. | Months | 1 | 12 |
| day | Integer | Day of the month | Days | 1 | 31 |
| hour | Integer | Hours within a day. The range 24 to 30 is used in some transit applications to represent schedule adherence. | Hours | 0 | 30 |
| minute | Integer | Minutes within an hour. | Minutes | 0 | 59 |
| second | Integer | Milliseconds within a minute. A leap second is represented by the value range 60000 to 60999. The values from 61000 to 65534 are reserved. | Seconds | 0 | 65534 |
| offset† | Integer | The DSRC (time zone) offset consists of a signed integer representing an hour and minute value set from -14:00 to +14:00, representing all the world’s local time zones in units of minutes. The value of zero (00:00) may also represent an unknown value. Note some time zones are do not align to hourly boundaries. | Minutes from UTC time | -840 | +840 |

Table 37 - J2735DDateTime

## J2735DisabledVehicle

The J2735DisabledVehicle data frame provides a means for a vehicle (or other equipped device) to describe its operational status and gross location to others using a subset of the ITIS codes.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| statusDetails | integer | ITIS.ITIScodes(523..541) | ITIS code | 523 | 541 |
| locationDetails | String | An ITIS enumeration commonly referred to as "Generic Locations." The code is assigned the upper byte value of [31] (which provides for value ranges from 7936 to 8191, inclusive). | Generic Location IT IS enumeration | Enum for 7936 | Enum for 8191 |

Table 38 - J2735DisabledVehicle

## J2735SpeedProfile

The J2735SpeedProfile data frame supports connected vehicles which will be collecting and parsing BSMs as they travel: these consist of speed data reported from the opposite direction. Each equipped vehicle collects the reported BSM speeds from the vehicles traveling in the opposite direction and store the average speed of these vehicles every 100 meters. The BSM tempID will be used to prevent duplicates. The opposite direction is considered to be the collecting vehicle's current direction +170 through 190 degrees. Up to 20 readings of average speed can be transmitted by the SpeedProfile. The SpeedProfile is added to the BSM Part II content, thus making it available to vehicles traveling in the opposite direction for whom it provides an up to 2 km SpeedProfile of the traffic on their road ahead. Should the vehicle collecting the SpeedProfile make a turn greater than 70°, then the SpeedProfile currently stored would be deleted. Further details of these operational concepts can be found in relevant standards.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| speedReports | Array of integers | Represents the average measured or reported speed of a series of objects traveling in the same direction over a period of time. The value 30 shall be used for speeds of 30 m/s or greater (67.1 mph) -- The value 31 shall indicate that the speed is unavailable | m/s | 0 | 31 |

## J2735RTCMPackage

The J2735RTCMPackage data frame is used to convey RTCM messages which deal with differential corrections between users from one mobile device to another. Encapsulated messages are those defined in RTCM Standard 10403.1 for Differential GNSS (Global Navigation Satellite Systems) Services - Version 3 adopted on July 1st 2011 and its successors.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| rtcmHeader | [J2735RTCMheader](#_J2735RTCMheader) | Precise antenna position and noise data for a rover. |
| msgs | Array of HEX Strings | The RTCMmessage data element contains the stream of octets of the actual RTCM message that is being sent. The message’s contents are defined in RTCM Standard 10403.1 and in RTCM Standard 10402.1 and its successors. Note that most RTCM messages are considerably smaller than the size limit defined here, but that some messages may need to be broken into smaller messages (as per the rules defined in the RTCM work) in order to be transmitted over DSRC. |

Table 39 - J2735RTCMPackage

## J2735RTCMheader

The J2735RTCMheader data frame is a collection of data values used to convey RTCM information between users. It is not required or used when sending RTCM data from a corrections source to end users (from a base station to devices deployed in the field which are called rovers).

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| offsetSet | [J2735AntennaOffsetSet](#_J2735AntennaOffsetSet) | A collection of three offset values in an orthogonal coordinate system which describe how far the electrical phase center of an antenna is in each axis from a nearby known anchor point in units of 1 cm. When the antenna being described is on a vehicle, the signed offset shall be in the coordinate system defined in section 11.4 of J2735 spec |
| status | [J2735BitString](#_J2735BitString) | A dictionary of boolean (true or false) name/value pairs used to relate the current state of a GPS/GNSS rover or base 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. A GNSS set with unknown health and no tracking or corrections would be represented by setting the unavailable bit to one. A value of zero shall be used when a defined data element is unavailable. The term "GPS" in any data element name in this standard does not imply that it is only to be used for GPS-type GNSS systems. Set of names include:   * unavailable, -- Not Equipped or unavailable * isHealthy, * isMonitored, * baseStationType, -- Set to zero if a moving base station,   + or if a rover device (an OBU),   + set to one if it is a fixed base station * aPDOPofUnder5, -- A dilution of precision greater than 5 * inViewOfUnder5, -- Less than 5 satellites in view * localCorrectionsPresent, -- DGPS type corrections used * networkCorrectionsPresent -- RTK type corrections used |

Table 40 - J2735RTCMheader

## J2735AntennaOffsetSet

The J2735AntennaOffsetSet data frame is a collection of three offset values in an orthogonal coordinate system which describe how far the electrical phase center of an antenna is in each axis from a nearby known anchor point in units of 1 cm. When the antenna being described is on a vehicle, the signed offset shall be in the coordinate system defined in section 11.4 of J2735 spec.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| antOffsetX† | decimal | Delta offset in X, Y or Z direction from some known point. For non-vehicle centric coordinate frames of reference, non-vehicle centric coordinate frames of reference, offset is positive to the East (X) and to the North (Y) directions. | meters | -20.47 | +20.47 |
| antOffsetY† | decimal | Delta offset in X, Y or Z direction from some known point. For non-vehicle centric coordinate frames of reference, offset is positive to the East (X) and to the North (Y) directions. | meters | -2.55 | +2.55 |
| antOffsetZ† | decimal | Delta offset in X, Y or Z direction from some known point. For non-vehicle centric coordinate frames of reference, offset is positive to the East (X) and to the North (Y) directions. | meters | -5.11 | +5.11 |

Table 41 - J2735AntennaOffsetSet

## J2735FullPositionVector

J2735FullPositionVector is a complete report of the vehicle's position, speed, and heading at an instant in time.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| utcTime | [J2735DDateTime](#_J2735DDateTime) | Date and Time |
| position | [OdePosition3D](#_OdePosition3D) | Vehicle position |
| heading† | decimal | Vehicle heading in  Degrees:  0-359.9875 |
| speed | [J2735TransmissionAndSpeed](#_J2735TransmissionAndSpeed) | The speed of the vehicle and the state of the transmission |
| posAccuracy | [J2735PositionalAccuracy](#_J2735PositionalAccuracy) | Various parameters of quality used to model the accuracy of the positional determination with respect to each given axis |
| timeConfidence | string | Provide the 95% confidence level for the currently reported value of time. One enumeration constant from   * ***UNAVAILABLE***, * ***TIME\_100\_000***, * ***TIME\_050\_000***, * ***TIME\_020\_000***, * ***TIME\_010\_000***, * ***TIME\_002\_000***, * ***TIME\_001\_000***, * ***TIME\_000\_500***, * ***TIME\_000\_200***, * ***TIME\_000\_100***, * ***TIME\_000\_050***, * ***TIME\_000\_020***, * ***TIME\_000\_010***, * ***TIME\_000\_005***, * ***TIME\_000\_002***, * ***TIME\_000\_001***, * ***TIME\_000\_000\_5***, * ***TIME\_000\_000\_2***, * ***TIME\_000\_000\_1***, * ***TIME\_000\_000\_05***, * ***TIME\_000\_000\_02***, * ***TIME\_000\_000\_01***, * ***TIME\_000\_000\_005***, * ***TIME\_000\_000\_002***, * ***TIME\_000\_000\_001***, * ***TIME\_000\_000\_000\_5***, * ***TIME\_000\_000\_000\_2***, * ***TIME\_000\_000\_000\_1***, * ***TIME\_000\_000\_000\_05***, * ***TIME\_000\_000\_000\_02***, * ***TIME\_000\_000\_000\_01***, * ***TIME\_000\_000\_000\_005***, * ***TIME\_000\_000\_000\_002***, * ***TIME\_000\_000\_000\_001***, * ***TIME\_000\_000\_000\_000\_5***, * ***TIME\_000\_000\_000\_000\_2***, * ***TIME\_000\_000\_000\_000\_1***, * ***TIME\_000\_000\_000\_000\_05***, * ***TIME\_000\_000\_000\_000\_02***, * ***TIME\_000\_000\_000\_000\_01*** |
| posConfidence | [J2735PositionConfidenceSet](#_J2735PositionConfidenceSet) | Represents the confidence level about the accuracy of position and elevation. |
| speedConfidence | [J2735SpeedandHeadingandThrottleConfidence](#_J2735SpeedandHeadingandThrottleConf) | Represents the confidence level about the accuracy of speed, heading and throttle. |

Table 42 - J2735FullPositionVector

## J2735TransmissionAndSpeed

The J2735TransmissionAndSpeed data frame expresses the speed of the vehicle and the state of the transmission. The transmission state of 'reverse' can be used as a sign value for the speed element when needed.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| transmisson | string | An enumeration value of {   * ***NEUTRAL***, // Neutral, speed relative to the vehicle alignment * ***PARK***, // Park, speed relative the to vehicle alignment * ***FORWARDGEARS***, // Forward gears, speed relative the to vehicle alignment * ***REVERSEGEARS***, // Reverse gears, speed relative the to vehicle alignment * ***RESERVED1***, ***RESERVED2***, ***RESERVED3***, * ***UNAVAILABLE***; // not-equipped or unavailable value} |
| speed† | decimal | Reports vehicle velocity in meters per second in a range of 0 – 163.82 m/s |

Table 43 - J2735TransmissionAndSpeed

## J2735PositionConfidenceSet

The J2735PositionConfidenceSet data frame combines multiple related bit fields into a single concept.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| pos | string | An enumeration value of   * ***UNAVAILABLE***, * ***A500M***, * ***A200M***, * ***A100M***, * ***A50M***, * ***A20M***, * ***A10M***, * ***A5M***, * ***A2M***, * ***A1M***, * ***A50CM***, * ***A20CM***, * ***A10CM***, * ***A5CM***, * ***A2CM***, * ***A1CM*** |
| elevation | string | An enumeration value of   * ***UNAVAILABLE***, * ***ELEV\_500\_00***, * ***ELEV\_200\_00***, * ***ELEV\_100\_00***, * ***ELEV\_050\_00***, * ***ELEV\_020\_00***, * ***ELEV\_010\_00***, * ***ELEV\_005\_00***, * ***ELEV\_002\_00***, * ***ELEV\_001\_00***, * ***ELEV\_000\_50***, * ***ELEV\_000\_20***, * ***ELEV\_000\_10***, * ***ELEV\_000\_05***, * ***ELEV\_000\_02***, * ***ELEV\_000\_01*** |

Table 44 - J2735PositionConfidenceSet

## J2735SpeedandHeadingandThrottleConfidence

The J2735SpeedHeadingThrottleConfidence data frame is a single data frame combining multiple related bit fields into one concept.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| heading | string | One of enumeration values:   * ***UNAVAILABLE***, * ***PREC10DEG***, * ***PREC05DEG***, * ***PREC01DEG***, * ***PREC0\_1DEG***, * ***PREC0\_05DEG***, * ***PREC0\_01DEG***, * ***PREC0\_0125DEG*** |
| speed | string | One of enumeration values:   * ***UNAVAILABLE***, * ***PREC100MS***, * ***PREC10MS***, * ***PREC5MS***, * ***PREC1MS***, * ***PREC0\_1MS***, * ***PREC0\_05MS***, * ***PREC0\_01MS*** |
| throttle | string | One of enumeration values:   * ***UNAVAILABLE***, * ***PREC10PERCENT***, * ***PREC1PERCENT***, * ***PREC0\_5PERCENT*** |

## J2735PathHistoryPoint

The J2735PathHistoryPoint data frame is used to convey a single point in the path of an object (typically a motor vehicle) described as a sequence of such position points. The sequence and number of these points (defined in another data frame) is selected to convey the desired level of accuracy and precision required by the application.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| latOffset† | decimal | Delta offset in latitude direction from the last point | degrees | -0.0131071 | +0.0131071 |
| lonOffset† | decimal | Delta offset in longitude direction from the last point | degrees | -0.0131071 | +0.0131071 |
| elevationOffset† | decimal | Vertical delta offset in the Z direction from the last point | Meters vertical | -204.7 | +204.7 |
| timeOffset† | decimal | Offset backwards in time | seconds | 0.01 | 655.34 |
| speed† | decimal | Speed over the reported period | m/s | 0 | 163.82 |
| posAccuracy | [J2735PositionalAccuracy](#_J2735PositionalAccuracy) | The accuracy of position values. See section 5.5. | N/A | N/A | N/A |
| heading† | decimal | Overall coarse heading | degrees | 0.0 | 358.5 |

Table 45 - J2735PathHistoryPoint

## J2735PrivilegedEvents

The J2735PrivilegedEvents data frame provides a means to describe various public safety events. The information in this data frame (along with the BSM message in which it is sent) can be used to determine various aspects about the sender.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| sspRights | integer | CERT SSP Privilege Details. The SSP index is used to control the data elements that follow the occurrence of the index. | N/A | 0 | 31 |

Table 46 - J2735PrivilegedEvents (1)

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| events | [J2735BitString](#_J2735BitString) | The active event list. A Boolean dictionary of the following indicators:   * peUnavailable -- Not Equipped or unavailable * peEmergencyResponse -- The vehicle is a properly authorized public safety vehicle, is engaged in a service call, and is currently moving or is within the roadway. Note that lights and sirens may not be evident during any given response call * Emergency and Non Emergency Lights related   + peEmergencyLightsActive   + peEmergencySoundActive   + peNonEmergencyLightsActive   + peNonEmergencySoundActive |

Table 47 - J2735PrivilegedEvents (2)

## J2735PivotPointDescription

The J2735PivotPointDescription data frame is used to describe the geometric relationship between a vehicle and a trailer; or a dolly and another object to which it is connected.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| pivotOffset† | decimal | This gives a +- 10m range from the edge of the outline measured from the edge of the length of this unit a negative value is offset to inside the units a positive value is offset beyond the unit | meters | -10.23 | +10.23 |
| pivotAngle† | decimal | Measured between the center-line of this unit and the unit ahead which is pulling it. This value is required to project the units relative position. | degrees | 0 | 359.9875 |
| pivots | Boolean | *true* if this unit can rotate about the pivot connection point. | N/A | false | true |

Table 48 - J2735PivotPointDescription

## J2735TrailerUnitDescription

The J2735TrailerUnitDescription data frame provides a physical description for one trailer or a dolly element (called a unit), including details of how it connects with other elements fore and aft.

|  |  |  |
| --- | --- | --- |
| **Name** | **Type** | **Description** |
| isDolly | Boolean | If false this is a trailer |
| bumperHeights | [J2735BumperHeights](#_J2735BumperHeights) | Conveys the height of the front and rear bumper of the trailers. |
| frontPivot | [J2735PivotPointDescription](#_J2735PivotPointDescription) | Offset connection point details from the hauling vehicle to the first trailer unit. |
| rearPivot | [J2735PivotPointDescription](#_J2735PivotPointDescription) | Offset connection point details from the hauling vehicle to the first trailer unit. |
| positionOffset | [J2735Node\_XY](#_J2735Node_XY) | Current Position relative to the hauling Vehicle – x-y axis offset |
| elevationOffset† | decimal | Current Position relative to the hauling Vehicle – z-axis offset |
| crumbData | Array of [J2735TrailerHistoryPoint](#_J2735TrailerHistoryPoint) | Past Position history relative to the hauling Vehicle. |

Table 49 - J2735TrailerUnitDescription (1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| width | integer | Vehicle width | cm | 0 | 1023 |
| length | integer | Vehicle length | cm | 0 | 4095 |
| height† | decimal | Vehicle height | meters | 0 | 6.35 |
| mass† | integer | Trailer mass | kg | 0 | 127,500 |
| centerOfGravity† | decimal | Vehicle center of gravity | meters | 0 | 6.35 |
| rearWheelOffset† | decimal | Rear wheel pivot point center-line offset measured from the rear of the above length | meters | -20.47 | +20.47 |
| elevationOffset† | decimal | Current Position relative to the hauling Vehicle – z-axis offset | meters | -6.3 | +6.3 |

Table 50 - J2735TrailerUnitDescription (2)

## J2735BumperHeights

The J2735BumperHeights data frame conveys the height of the front and rear bumper of the vehicle or object (can also be used with trailers).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| front† | decimal | The height of the front bumper from ground surface. | meters | 0.00 | 1.27 |
| rear† | decimal | The height of the rear bumper from ground surface. | meters | 0.00 | 1.27 |

Table 51 - J2735BumperHeights

## J2735TrailerHistoryPoint

The J2735TrailerHistoryPoint data frame contains a single position point for a trailer, expressed relative to the vehicle’s BSM positional estimate at the same point in time.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| pivotAngle† | decimal | Angle with respect to the lead unit | degrees | 0 | 359.9875 |
| timeOffset† | decimal | offset backwards in time | seconds | 0 | 655.34 |
| positionOffset | [J2735Node\_XY](#_J2735Node_XY) | Current Position relative to the hauling Vehicle – x-y axis offset | N/A | N/A | N/A |
| elevationOffset† | decimal | Current Position relative to the hauling Vehicle – z-axis offset | meters | -6.3 | +6.3 |
| heading† | decimal | Overall coarse heading | degrees | 0.0 | 358.5 |

Table 52 - J2735TrailerHistoryPoint

## J2735Node\_XY

The J2735Node\_XY data frame represents offset values from the last point in X and Y.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Description** | **Units** | **Valid Min** | **Valid Max** |
| x† | decimal | X axis offset | meters | -20.47 | +20.47 |
| y | decimal | Y axis offset | meters | -20.47 | +20.47 |

Table 53 - J2735Node\_XY

# Sample Data

## Sample TIM Data

### Broadcast TIM

This is sample TIM broadcast request message by received from TMC. A TIM broadcast request is translated into a J2735 XER encoded TravelerInformation message, then encoded into ASN.1 binary Unaligned Packed Encoding Rule (UPER) format and finally deposited on to RSUs or SDW.

{

"metadata": {

"payloadType": "us.dot.its.jpo.ode.model.OdeMsgPayload",

"serialId": {

"streamId": "e4cc2366-0450-4052-83df-ca11f5dbd080",

"bundleSize": 1,

"bundleId": 0,

"recordId": 0,

"serialNumber": 0

},

"odeReceivedAt": "2018-04-20T20:19:24.925Z[UTC]",

"schemaVersion": 4,

"sanitized": false

},

"payload": {

"dataType": "us.dot.its.jpo.ode.plugin.j2735.J2735TravelerInformationMessage",

"data": {

"msgCnt": 1,

"index": 3,

"timeStamp": "2018-04-18T18:38:52.914Z",

"packetID": "0000002316f1b0eed3",

"urlB": "null",

"dataframes": [

{

"sspTimRights": 1,

"frameType": "advisory",

"msgId": {

"roadSignID": {

"position": {

"latitude": 40.573068,

"longitude": -105.049016

},

"viewAngle": "1111111111111111",

"mutcdCode": "warning"

}

},

"startDateTime": "2018-04-18T11:20-06:00",

"durationTime": 2000,

"priority": 5,

"sspLocationRights": 1,

"regions": [

{

"name": "southbound\_Timberline\_20\_30\_RSU-192.168.0.100",

"regulatorID": 0,

"segmentID": 0,

"anchorPosition": {

"latitude": 40.573068,

"longitude": -105.049016

},

"laneWidth": 327,

"directionality": 3,

"closedPath": false,

"direction": "1111111111111111",

"description": "path",

"path": {

"scale": 0,

"type": "xy",

"nodes": [

{

"delta": "node-LatLon",

"nodeLat": 40.572429,

"nodeLong": -105.047355

},

{

"delta": "node-LatLon",

"nodeLat": 40.572228,

"nodeLong": -105.046844

},

{

"delta": "node-LatLon",

"nodeLat": 40.572113,

"nodeLong": -105.04659

},

{

"delta": "node-LatLon",

"nodeLat": 40.57191,

"nodeLong": -105.046243

},

{

"delta": "node-LatLon",

"nodeLat": 40.571675,

"nodeLong": -105.045936

},

{

"delta": "node-LatLon",

"nodeLat": 40.571422,

"nodeLong": -105.045674

},

{

"delta": "node-LatLon",

"nodeLat": 40.571131,

"nodeLong": -105.04545

},

{

"delta": "node-LatLon",

"nodeLat": 40.570724,

"nodeLong": -105.045235

},

{

"delta": "node-LatLon",

"nodeLat": 40.570293,

"nodeLong": -105.045113

},

{

"delta": "node-LatLon",

"nodeLat": 40.569848,

"nodeLong": -105.045087

}

]

}

}

],

"sspMsgTypes": 1,

"sspMsgContent": 1,

"content": "Advisory",

"items": [

"4868",

"text test"

],

"url": "null"

}

]

}

}

}

### Received TIM

ODE receives TIM messages from OBU via RSU in binary ANS.1 UPER encoded format. ODE decodes the message into JSON and publishes it to the relevant topics for consumption by client applications. Below is a sample JSON decoded TIM message received by ODE.

{

"metadata": {

"securityResultCode": "success",

"recordGeneratedBy": "OBU",

"receivedMessageDetails": {

"locationData": {

"elevation": 1494,

"heading": 15.2375,

"latitude": 40.4729599,

"speed": 10.56,

"longitude": -104.9715557

},

"rxSource": "RSU"

},

"schemaVersion": 4,

"payloadType": "us.dot.its.jpo.ode.model.OdeTimPayload",

"serialId": {

"recordId": 2,

"serialNumber": 0,

"streamId": "d6e0515e-9e23-4e3d-93b3-c6c39c0d6357",

"bundleSize": 1,

"bundleId": 4

},

"sanitized": false,

"recordGeneratedAt": "2017-09-11T22:35:48.721Z[UTC]",

"recordType": "rxMsg",

"logFileName": "rxMsg\_TIMOnly.bin",

"odeReceivedAt": "2018-04-20T20:15:48.74Z[UTC]"

},

"payload": {

"data": {

"MessageFrame": {

"messageId": 31,

"value": {

"TravelerInformation": {

"packetID": "00000000003616371F",

"dataFrames": {

"TravelerDataFrame": {

"regions": {

"GeographicalPath": {

"closedPath": {

"false": ""

},

"anchor": {

"elevation": 4096,

"lat": 404793681,

"long": -1049659468

},

"laneWidth": 1600,

"directionality": {

"both": ""

},

"description": {

"path": {

"offset": {

"xy": {

"nodes": {

"NodeXY": [

{

"delta": {

"node-LatLon": {

"lon": -1049687145,

"lat": 404793929

}

}

},

{

"delta": {

"node-LatLon": {

"lon": -1049633993,

"lat": 404794114

}

}

}

]

}

}

}

}

},

"direction": 1111111111111111

}

},

"duratonTime": 10080,

"sspMsgRights1": 1,

"sspMsgRights2": 1,

"sspTimRights": 1,

"startYear": 2017,

"sspLocationRights": 1,

"frameType": {

"advisory": ""

},

"msgId": {

"roadSignID": {

"viewAngle": 1111111111111111,

"mutcdCode": {

"regulatory": ""

},

"position": {

"elevation": 4096,

"lat": 404793681,

"long": -1049659468

}

}

},

"startTime": 359511,

"priority": 6,

"content": {

"advisory": {

"SEQUENCE": {

"item": {

"itis": 4885

}

}

}

}

}

},

"msgCnt": 1

}

}

}

},

"dataType": "TravelerInformation"

}

}

## Sample Driver Alert

{

"metadata": {

"receivedMessageDetails": {

"locationData": {

"latitude": "40.4739938",

"longitude": "-104.9692256",

"elevation": "1507",

"speed": "1.02",

"heading": "330.8375"

},

"rxSource": "NA"

},

"logFileName": "driverAlert.bin",

"recordType": "driverAlert",

"securityResultCode": "unknown",

"payloadType": "us.dot.its.jpo.ode.model.OdeDriverAlertPayload",

"serialId": {

"streamId": "445a35c5-5685-40b3-b4a8-30ab77121123",

"bundleSize": 1,

"bundleId": 2,

"recordId": 2,

"serialNumber": 0

},

"odeReceivedAt": "2018-04-20T19:54:01.746Z[UTC]",

"schemaVersion": 4,

"recordGeneratedAt": "2017-10-05T15:09:37.627Z[UTC]",

"recordGeneratedBy": "OBU",

"sanitized": false

},

"payload": {

"alert": "DNPW"

}

}

## Sample BSM Data

### BSM TX

The following is a sample BSM message received by the ODE generated by the Ego Vehicle (EV) .

{

"metadata": {

"bsmSource": "EV",

"logFileName": "bsmTx.bin",

"recordType": "bsmTx",

"securityResultCode": "unknown",

"payloadType": "us.dot.its.jpo.ode.model.OdeBsmPayload",

"serialId": {

"streamId": "9bd3174f-3baa-4084-8f9d-7e60c756717f",

"bundleSize": 1,

"bundleId": 5,

"recordId": 2,

"serialNumber": 0

},

"odeReceivedAt": "2018-04-20T20:30:38.979Z[UTC]",

"schemaVersion": 4,

"recordGeneratedAt": "2017-08-10T20:40:54.299Z[UTC]",

"recordGeneratedBy": "OBU",

"sanitized": false

},

"payload": {

"dataType": "us.dot.its.jpo.ode.plugin.j2735.J2735Bsm",

"data": {

"coreData": {

"msgCnt": 95,

"id": "24EF0000",

"secMark": 54300,

"position": {

"latitude": 40.4740215,

"longitude": -104.9691438,

"elevation": 1496.7

},

"accelSet": {

"accelLong": -0.04,

"accelYaw": 0

},

"accuracy": {

"semiMajor": 9.65,

"semiMinor": 12.7

},

"transmission": "NEUTRAL",

"speed": 0,

"heading": 51.2,

"brakes": {

"wheelBrakes": {

"leftFront": false,

"rightFront": false,

"unavailable": true,

"leftRear": false,

"rightRear": false

},

"traction": "unavailable",

"abs": "unavailable",

"scs": "unavailable",

"brakeBoost": "unavailable",

"auxBrakes": "unavailable"

},

"size": {}

},

"partII": [

{

"id": "VehicleSafetyExtensions",

"value": {

"pathHistory": {

"crumbData": [

{

"elevationOffset": 2.5,

"latOffset": 0.0000544,

"lonOffset": 0.0000692,

"timeOffset": 618.57

}

]

},

"pathPrediction": {

"confidence": 50,

"radiusOfCurve": 0

}

}

},

{

"id": "SupplementalVehicleExtensions",

"value": {

"classDetails": {

"fuelType": "unknownFuel",

"hpmsType": "none",

"keyType": 0,

"regional": [],

"role": "basicVehicle"

},

"weatherProbe": {},

"regional": []

}

}

]

}

}

}

### BSM RX

The following is a sample BSM message received by the ODE generated by a Remote Vehicle (EV) .

{

"metadata": {

"bsmSource": "RV",

"logFileName": "rxMsg\_BSMOnly.bin",

"recordType": "rxMsg",

"securityResultCode": "success",

"payloadType": "us.dot.its.jpo.ode.model.OdeBsmPayload",

"serialId": {

"streamId": "84cf4b83-a342-4f53-b328-3b6df37c20f4",

"bundleSize": 1,

"bundleId": 6,

"recordId": 2,

"serialNumber": 0

},

"odeReceivedAt": "2018-04-20T20:32:34.812Z[UTC]",

"schemaVersion": 4,

"recordGeneratedAt": "2017-10-25T22:38:59.592Z[UTC]",

"recordGeneratedBy": "OBU",

"sanitized": false

},

"payload": {

"dataType": "us.dot.its.jpo.ode.plugin.j2735.J2735Bsm",

"data": {

"coreData": {

"msgCnt": 20,

"id": "FDCC0000",

"secMark": 59600,

"position": {

"latitude": 40.4739056,

"longitude": -104.9691985,

"elevation": 1491.2

},

"accelSet": {

"accelLong": -0.16,

"accelYaw": 0

},

"accuracy": {

"semiMajor": 1.8,

"semiMinor": 2.3

},

"transmission": "NEUTRAL",

"speed": 0,

"heading": 239.6,

"brakes": {

"wheelBrakes": {

"leftFront": false,

"rightFront": false,

"unavailable": true,

"leftRear": false,

"rightRear": false

},

"traction": "unavailable",

"abs": "unavailable",

"scs": "unavailable",

"brakeBoost": "unavailable",

"auxBrakes": "unavailable"

},

"size": {

"width": 200,

"length": 570

}

},

"partII": [

{

"id": "VehicleSafetyExtensions",

"value": {

"pathHistory": {

"crumbData": [

{

"elevationOffset": -1.9,

"latOffset": -0.0000988,

"lonOffset": -0.0000876,

"timeOffset": 49.47

},

{

"elevationOffset": -1.8,

"latOffset": -0.0001286,

"lonOffset": -0.0001209,

"timeOffset": 51.18

},

{

"elevationOffset": -1.5,

"latOffset": -0.0001883,

"lonOffset": -0.0001243,

"timeOffset": 52.96

},

{

"elevationOffset": -0.4,

"latOffset": -0.0002436,

"lonOffset": -0.0000382,

"timeOffset": 55.07

},

{

"elevationOffset": 1.3,

"latOffset": -0.0002961,

"lonOffset": 0.0000591,

"timeOffset": 56.97

},

{

"elevationOffset": 2.3,

"latOffset": -0.0003643,

"lonOffset": 0.0000707,

"timeOffset": 58.38

},

{

"elevationOffset": 2.7,

"latOffset": -0.0004526,

"lonOffset": 0.0000096,

"timeOffset": 60.18

},

{

"elevationOffset": 2.8,

"latOffset": -0.0006399,

"lonOffset": -0.0002805,

"timeOffset": 63.28

},

{

"elevationOffset": 2.7,

"latOffset": -0.0011683,

"lonOffset": -0.0013867,

"timeOffset": 70.96

}

]

},

"pathPrediction": {

"confidence": 50,

"radiusOfCurve": 0

}

}

},

{

"id": "SupplementalVehicleExtensions",

"value": {

"classDetails": {

"fuelType": "unknownFuel",

"hpmsType": "none",

"keyType": 0,

"regional": [],

"role": "basicVehicle"

},

"vehicleData": {

"height": 1.9

},

"weatherProbe": {},

"regional": []

}

}

]

}

}

}

# References

Booz Allen Hamilton. (2018). *ODE Users Guide*. Retrieved from https://github.com/usdot-jpo-ode/jpo-ode

SAE International. (2016, 03 30). Retrieved from https://www.sae.org/standards/content/j2735\_201603/

1. Midnight will be represented as 0:00 for all time fields [↑](#endnote-ref-1)
2. This field’s value is represented differently from the raw J2735 representation. The raw J2735 binary representation has been transformed to the J2735 described customary unit of measure or format without any loss of accuracy or precision. [↑](#endnote-ref-2)