JMCROTA

Connected Vehicle Message Builder

User Guide v1.4

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Introduction

The Connected Vehicle Message Builder (CVMB) accepts Extended XML Encoding Rules (EXER) messages and generates Unaligned Packed Encoding Rules (UPER) encoded messages based on user inputs. CVMB also is able to accept UPER encoded messages and convert them to XML. All messages are based on the ASN.1 schema for the Roadside Safety Message (RSM) and the SAE J2735 (March 2016) data dictionary.

This edition of the guide illustrates an example using an EXER-encoded message as input to support a Reduced Speed Zone Warning (RSZW) application. Future revisions of this user guide may include support for additional applications. Software user instructions and runtime interface descriptions can be found in Appendix D.

Note: E-XER extends XER, for example, allowing standard XML style comments to be included. In the text that follows XER may be indicated for brevity.

Using XML to Formulate a Message

This section provides information on how an EXER-encoded message is formulated. The XML, formulated by proper user input of values corresponding to XML tags, is an EXER encoded message compliant with the ASN.1 definitions (See Appendices B and C).

The CVMB supports building messages that may include the Reduced Speed Zone (RSZ) container. The RSZ is used to build messages supporting a class of applications known as RSZW applications. The Work Zone Warning application is one example, and other applications may be created in the future. The CVMB also supports building messages that may include the Curve Container, which supports the Curve Speed Warning (CSW) application.

In the next section, information about modifiable objects may be provided in tables with headings defined as follows:

- EXER Tag – The object name in the XML, which matches the ASN.1 object name (note: this one-to-one relationship will change with subsequent CVMB revisions that include XML preprocessing)
- Value / Units – Information about the valid values for an object, and units if applicable
- ASN.1 type reference – The corresponding ASN.1-defined object (see Appendices B and C)
- ASN.1 data type – The data type as defined in the ASN.1. If data type is SEQUENCE or CHOICE, the object contains a sequence of available child objects or one of the available child objects, respectively.
- ASN.1 Constraints – Information about the valid range of values
- Req? – Indicates if the object is mandatory (M), or optional (O). If an optional object (a parent object) contains other objects (child objects), child objects may be conditionally mandatory (C) if they are required when the parent object is included, or optional (O) if they are not. A parent object is a typically a J2735 data frame, and child objects can be J2735 data frames or data elements.

Note: This version of the CVMB supports the Roadside Safety Message (RSM) as defined in Appendix B. A sample XML representation generated from the ASN.1 definition of the RSM can be found in Appendix A. The XML in Appendix A is representative of a RSM message, however it does not include

every possible element or combination of elements. Refer to the ASN.1 schema for the complete definition for RSM. The ASN.1 definition for J2735 can be found in the SAE J2735 MAR2016 standard. Appendix C contains descriptions and examples of how to encode latitude, longitude and elevation.

XML Message Representation Detail

In the XML, editable fields are highlighted in `green`.

Per SAE J2735, all messages including the RoadsideSafetyMessage are encapsulated by a frame of type MessageFrame. The messageId assigned to the RoadsideSafetyMessage is decimal 33.

```
<?xml version="1.0" encoding="UTF-8"?>
<MessageFrame>
  <messageId>33</messageId>
  <value>
    <RoadsideSafetyMessage>
      <version>1</version>
      <commonContainer>
```

version contains message versioning information. **eventID** is the randomly assigned ID for this event.

In the case where a RSZ is very long and requires more nodes than a single message can support, a RoadsideSafetyMessage may be defined by multiple message segments. In this case the optional **msgSegmentInfo** element would be included to indicate the number of message segments defined and the segment number for this message. When **msgSegmentInfo** is included, the **totalMsgSegments** and **thisSegmentNum** elements are required. Also note that all message segments corresponding to the same event must have the same **eventID** in **EventInfo**. In the example below, two segments are needed, and this message is the first of two segments.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
version	version info	Version	INTEGER	(0..255)	M
eventID	hex string	TemporaryID	OCTET STRING	(SIZE(4))	M
msgSegmentInfo	segment info	MsgSegmentInfo	SEQUENCE		O
totalMsgSegments	num of segments	SegmentCount	INTEGER	(1..127)	C
thisSegmentNum	this segment num	SegmentCount	INTEGER	(1..127)	C

```
      <eventInfo>
        <eventID>F7010000</eventID> [Randomly generated hex string]
        <msgSegmentInfo>
          <totalMsgSegments>2</totalMsgSegments>
          <thisSegmentNum>1</thisSegmentNum>
        </msgSegmentInfo>
```

startDateTime is the start or detection date and time of the event. If the message configuration changes, then **startDateTime** can be changed to indicate that a change to the message has occurred. **endDateTime** is the end date and time of the event. Note that **offset** is not applicable to

endDateTime. **year**, **month** and **day** are specified as optional in the J2735 ASN.1, however for applications using the RSM, they are mandatory as indicated in the table below.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
startDateTime		DDateTime	SEQUENCE		M
endDateTime		DDateTime	SEQUENCE		M
year	Start year or years of duration	DYear	INTEGER	(0..4095)	M
month	Start month or months of duration	DMonth	INTEGER	(0..12)	M
day	Start day or days of duration	DDay	INTEGER	(0..31)	M
hour	Start hour or hours of duration	DHour	INTEGER	(0..31)	O
minute	Start minute or minutes of duration	DMinute	INTEGER	(0..60)	O
second	Start second or seconds of duration	DSecond	INTEGER	(0..65535)	O
offset	Minutes from UTC	DOffset	INTEGER	(-840..840)	O

```
<startDateTime>
   <year>0</year>
   <month>0</month>
   <day>0</day>
   <hour>0</hour>
   <offset>-840</offset>
</startDateTime>
<endDateTime>
   <year>0</year>
   <month>0</month>
   <day>0</day>
   <hour>0</hour>
</endDateTime>
```

eventRecurrence may be used to provide additional information about applicable time periods during which an event is active. Up to five instances of **eventRecurrence** may be included. Specific days of the week may be indicated, for example, if an event is active only on the weekends then **saturday** and **sunday** may be set to true, and tags for the remaining days may be set to false (or simply omitted). Similarly, specific start and end dates and times may be indicated. Additionally, the element **exclusion** may be used to negate the settings. In the previous example, if **exclusion** were set to true, then the applicable period would be the weekdays **monday** through **friday**. If **exclusion** is omitted, false is assumed.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req ?
eventRecurrence		EventRecurrence	SEQUENCE	(1..5)	O
startTime		DTime	SEQUENCE		O
endTime		DTime	SEQUENCE		O
hour	start or end hour	DHour	INTEGER	(0..31)	C
minute	start or end minute	DMinute	INTEGER	(0..60)	C
startDate		DDate	SEQUENCE		O
endDate		DDate	SEQUENCE		O
year	start or end year	DYear	INTEGER	(0..4095)	C
month	start or end month	DMonth	INTEGER	(0..12)	C
day	start or end day	DDay	INTEGER	(0..31)	C
offset	Minutes from UTC	DOffset	INTEGER	(-840..840)	O
monday	true or false		BOOLEAN		C
tuesday	true or false		BOOLEAN		C
wednesday	true or false		BOOLEAN		C
thursday	true or false		BOOLEAN		C
friday	true or false		BOOLEAN		C
saturday	true or false		BOOLEAN		C
sunday	true or false		BOOLEAN		C
exclusion	true: the period defined is excluded false: the period defined is not excluded		BOOLEAN		O

```xml
<eventRecurrence>
  <EventRecurrence>  [Up to five of these allowed]
    <startTime>
      <hour>0</hour>
      <minute>0</minute>
    </startTime>
    <endTime>
      <hour>0</hour>
      <minute>0</minute>
    </endTime>
    <startDate>
      <year>0</year>
      <month>0</month>
      <day>0</day>
    </startDate>
    <endDate>
      <year>0</year>
      <month>0</month>
      <day>0</day>
    </endDate>
    <monday><false/></monday>
    <tuesday><false/></tuesday>
    <wednesday><false/></wednesday>
    <thursday><false/></thursday>
    <friday><false/></friday>
    <saturday><true/></saturday>
    <sunday><true/></sunday>
```

```
        <exclusion><false/></exclusion>
    </EventRecurrence>
```

causeCode and **subCauseCode** define the type of event. The value of **subCauseCode** is application dependent. The values for **causeCode** are defined in ETSI EN 302 637-3.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
causeCode	As follows:	CauseCode	INTEGER	(0..255)	M
	0	reserved			
	1	trafficCondition			
	2	accident			
	3	roadworks			
	6	adverseWeatherCondition-Adhesion			
	9	hazardousLocation-SurfaceCondition			
	10	hazardousLocation-ObstacleOnTheRoad			
	11	hazardousLocation-AnimalOnTheRoad			
	12	humanPresenceOnTheRoad			
	14	wrongWayDriving			
	15	rescueAndRecoveryWorkInProgress			
	17	adverseWeatherCondition-ExtremeWeatherCondition			
	18	adverseWeatherCondition-Visibility			
	19	adverseWeatherCondition-Precipitation			
	26	slowVehicle			
	27	dangerousEndOfQueue			
	91	vehicleBreakdown			
	92	postCrash			
	93	humanProblem			
	94	stationaryVehicle			
	95	emergencyVehicleApproaching			
	96	hazardousLocation-DangerousCurve			
	97	collisionRisk			
	98	signalViolation			
	99	dangerousSituation			
subCauseCode		SubCausecode	INTEGER	(0..255)	O

```
        <causeCode>3</causeCode>
        <subCauseCode>0</subCauseCode>
    </eventInfo>
```

applicableHeading is the applicable direction of travel for the event. The message applies to vehicles with a heading within +/- of the **tolerance** the **applicableHeading**.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
applicableHeading		ApplicableHeading	SEQUENCE		M
heading	1 degree increments	Heading	INTEGER	(0..360)	C
tolerance	1 degree increments	Tolerance	INTEGER	(0..360)	C

```
<regionInfo>
  <applicableHeading>
    <heading>0</heading>
    <tolerance>0</tolerance>
  </applicableHeading>
```

referencePoint nominally defines the location of the beginning of an event, and it is used as the point from which other dimensions and geometries associated with the event are referenced. Alternatively, **referencePoint** may define an arbitrary point somewhere within the event's applicable region. The element **referencePointType** should be set accordingly. When **referencePointType** is not provided, *startOfEvent* is assumed. When using **roadwayGeometry** to define lanes, **referencePoint** is expected to represent the location of the beginning of the event. See Appendix C for a detailed description of how the elements of **referencePoint** are encoded. Also note the case in which multiple message segments are needed to define a very long zone so it may be desirable to have the same **referencePoint** value in each segment.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
referencePoint		Position3D	SEQUENCE		M
lat	0.1 micro degrees	Latitude	31 bit INTEGER	See Appendix C	C
long	0.1 micro degrees	Longitude	32 bit INTEGER	See Appendix C	C
elevation	0.1 meter	Elevation	16 bit INTEGER	See Appendix C	O
referencePointType	startOfEvent or arbitrary	ReferencePointType	ENUMERATED		O
descriptiveName	human readable name	DescriptiveName	IA5String	(SIZE(1..63))	O

```
<referencePoint>
  <lat>-900000000</lat>
  <long>-1799999999</long>
  <elevation>-4096</elevation>
</referencePoint>
<referencePointType><startOfEvent/></referencePointType>
<descriptiveName>0</descriptiveName>
```

speedLimit establishes the regulated speed limit at the reference position. **type** is the type of regulatory speed that follows, and for the reduced speed zone warning applications, it is recommended to be set to

the enumerated value **vehicleMaxSpeed**. The recommended speed value is contained in **speed** with units defined in **speedUnits**.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
speedLimit		RSMSpeedLimit	SEQUENCE		O
type	As follows:	SpeedLimitType	ENUMERATED	See J2735	C
	unknown				
	maxSpeedInSchoolZone				
	maxSpeedInSchoolZoneWhenChildrenArePresent				
	maxSpeedInConstructionZone				
	vehicleMinSpeed				
	vehicleMaxSpeed (*default value*)				
	vehicleNightMaxSpeed				
	truckMinSpeed				
	truckMaxSpeed				
	truckNightMaxSpeed				
	vehiclesWithTrailersMinSpeed				
	vehiclesWithTrailersMaxSpeed				
	vehiclesWithTrailersNightMaxSpeed				
speed	Value of the speed limit, see units below	Speed	INTEGER	(0..8191)	C
speedUnits	As follows:	SpeedUnits	ENUMERATED		C
	mph (miles per hour)				
	kph (kilometers per hour)				
	mpsXpt02 (0.02 meters per second)				

```
<speedLimit>
  <type>< vehicleMaxSpeed/></type>
  <speed>25</speed>
  <speedUnits><mph/></speedUnits>
</speedLimit>
```

eventLength is length of the event in meters (distance of travel)from the reference point.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
eventLength	meters	EventLength	INTEGER	(0.. 65535)	O

```
<eventLength>1500</eventLength>
```

approachRegion define the lanes that approach an event reference point. One to ten approach lanes may be defined. **approachRegion** uses **RsmGeometry** to define the lanes. **RsmGeometry** is also used in the **rszContainer** and **curveContainer** frames.

lanePosition values are an ordered list starting from the leftmost lane to the rightmost lane. If the lane geometry is simple and does not require any detail to define it, a simple **laneID** and **lanePosition** may be provided. **laneWidth** is the absolute width of the lane in 1 cm increments (e.g., 1200 = 12 m). If the lane is complex or has multiple attributes, then **nodeSet** may be included to describe lane geometry in greater detail. Up to ten lanes may be defined (add additional instances of **RSMLane** to define additional lanes).

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
scale	scale factor	RsmScale	INTEGER	(1..100)	O
laneID		LaneID	INTEGER	(0..255)	C
lanePosition		LanePosition	INTEGER	(1..15)	O
laneName	human readable name	DescriptiveName	IA5String	(SIZE(1..63))	O
laneWidth	1 cm	LaneWidth	INTEGER	(0..32767)	C
lat	0.1 micro degrees	Latitude	31 bit INTEGER	See Appendix C	C
long	0.1 micro degrees	Longitude	32 bit INTEGER	See Appendix C	C
elevation	0.1 meter	Elevation	16 bit INTEGER	See Appendix C	O

```
<approachRegion>
  <roadwayGeometry>
    <scale>10</scale>[Applies to all RSMLanes in approachRegion]
      <rsmLanes>
        <RSMLane>  [Start of approach lane 1 definition]
          <laneID>0</laneID>
          <lanePosition>1</lanePosition>
          <laneName>0</laneName>
          <laneWidth>0</laneWidth>
          <connectsTo>
            <LaneID>0</LaneID>
            <LaneID>0</LaneID>
          </connectsTo>
        </RSMLane>    [End of approach lane 1]
        <RSMLane>   [This is the start of approach lane 2]
          <laneID>0</laneID>
          <lanePosition>2</lanePosition>
          <laneName>0</laneName>
          <nodeSet> [This lane includes an optional nodeSet]
            <NodeLLE>
              <nodePoint>
                <node-3Dabsolute>
                  <lat>-900000000</lat>
                  <long>-1799999999</long>
                  <elevation>-4096</elevation>
                </node-3Dabsolute>
              </nodePoint>
              <nodeAttributes> [These are optional]
                <speedLimit>
                  <type><vehicleMaxSpeed/></type>
                  <speed>0</speed>
                  <speedUnits><mph/></speedUnits>
                </speedLimit>
                <width>0</width>
                <taperLeft><false/></taperLeft>
```

```xml
                    <taperRight><false/></taperRight>
                    <laneClosed><false/></laneClosed>
                    <peoplePresent><false/></peoplePresent>
                  </nodeAttributes>
               </NodeLLE>
               <NodeLLE>
                  <nodePoint>
                    <node-3Dabsolute>
                       <lat>-900000000</lat>
                       <long>-1799999999</long>
                       <elevation>-4096</elevation>
                    </node-3Dabsolute>
                  </nodePoint>    [Note absence of optional attributes]
               </NodeLLE>
            </nodeSet>
            <connectsTo>
               <LaneID>0</LaneID>
               <LaneID>0</LaneID>
            </connectsTo>
         </RSMLane>    [End of approach lane 2]
      </rsmLanes>            </roadwayGeometry>
    </approachRegion>
  </regionInfo>
</commonContainer>
```

The **rszContainer** is used to define an area of the roadway that includes one or more reduced speed zones. This information is used, for example, in work zone warning applications.

 <rszContainer>

laneStatus indicates the number of lanes in the road and that are open or closed. Up to 10 lanes can be included and are ordered from the leftmost to rightmost lane. There is one **LaneInfo** instance for each defined lane. **laneStatus** is not used if **rszGeometry** is used (the lane status can be defined at each node when **rszGeometry** is used). Set **laneClosed** to true to indicate the lane is closed, false to indicate the lane is open. In the example shown below, assume a six-lane road. Lanes 1 – 3 are open, lane 4 is closed, and lanes 5 and 6 are open. Optionally **laneCloseOffset** can be included and indicates the distance in meters from the reference point (found in CommonContainer) to the start of the lane closure.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
lanePosition	lane number where lane 1 is leftmost lane	LanePosition	INTEGER	(0..15)	M
laneClosed	true: lane closed false: lane open	LaneClosed	BOOLEAN		M
laneCloseOffset	meters	ObstacleDistance	INTEGER	(0..32767)	O

```xml
    <laneStatus>
      <LaneInfo>
        <lanePosition>1</lanePosition>
```

```
        <laneClosed><false/></laneClosed>
      </LaneInfo>
      <LaneInfo>
        <lanePosition>2</lanePosition>
        <laneClosed><false/></laneClosed>
      </LaneInfo>
      <LaneInfo>
        <lanePosition>3</lanePosition>
        <laneClosed><false/></laneClosed>
      </LaneInfo>
      <LaneInfo>
        <lanePosition>4</lanePosition>
        <laneClosed><true/></laneClosed>
        <laneCloseOffset>0</laneCloseOffset>
      </LaneInfo>
      <LaneInfo>
        <lanePosition>5</lanePosition>
        <laneClosed><false/></laneClosed>
      </LaneInfo>
      <LaneInfo>
        <lanePosition>6</lanePosition>
        <laneClosed><false/></laneClosed>
      </LaneInfo>

    </laneStatus>
```

peoplePresent indicates the presence of people (e.g., workers) in the reduced speed zone. This information applies to the entire zone. Additionally, individual lanes may include information about the presence of people in the zone, described below in **RSMLane**.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
peoplePresent	true: people are present false: people are not present	PeoplePresent	BOOLEAN		O

```
    <peoplePresent><true/></peoplePresent>
```

speedLimit may be included here if it is not included in **rszGeometry** (see below). If included here, it applies to the entire event. **speedLimit** is described in detail above, see **CommonContainer**.

```
    <speedLimit>
      <type><vehicleMaxSpeed/></type>
      <speed>0</speed>
      <speedUnits><mph/></speedUnits>
    </speedLimit>
```

roadClosureDescription provides the reason for the road closure and is defined in SAE J2540/2. **roadWorkDescription** indicates the type of road work and is defined in SAE J2540/2.

flagman indicates whether a person is present and directing traffic. **trucksEnteringLeaving** indicates that construction trucks are entering or leaving the workzone.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
roadClosureDescription		ITIS.ITIScodes(769..895)	ENUMERATED		O
roadWorkDescription		ITIS.ITIScodes(1025..1061)	ENUMERATED		O
flagman		PublicSafetyDirectingTrafficSubType	BIT STRING		O
trucksEnteringLeaving			BOOLEAN		O

```
<roadClosureDescription>769</roadClosureDescription>
<roadWorkDescription>1025</roadWorkDescription>
<flagman>1111111</flagman>
<trucksEnteringLeaving><false/></trucksEnteringLeaving>
```

rszGeometry describes the configuration of the reduced speed zone, lane by lane. Up to 10 lanes may be described. Each lane may be defined using **RSMLane** (add additional instances of **RSMLane** to describe additional lanes). **scale** may be used to modify the units for nodes, i.e., latitude, longitude and elevation. For example the default units specified for latitude and longitude are tenths of microdegrees. A **scale** value set to 10 causes the units to be converted to microdegrees. The scale factor is also applied to the elevation if present, and so in this example tenths of meters would be converted to meters. If **scale** is present then it applies to all of the lanes (and their respective nodes) defined in the **rszGeometry** or **curveGeometry** elements. **scale** is used as a divisor (i.e., new units = default units/scale). A **scale** value of '1' has no effect on the units, in this case **scale** should be omitted all together.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
scale	scale factor	RsmScale	INTEGER	(1..100)	O
laneID		LaneID	INTEGER	(0..255)	C
lanePosition	lane pos where lane 1 is always leftmost lane	LanePosition	INTEGER	(1..15)	O
laneName	human readable name	DescriptiveName	IA5String	(SIZE(1..63))	O
laneWidth	1 cm	LaneWidth	INTEGER	(0..32767)	C
lat	0.1 micro degrees	Latitude	31 bit INTEGER	See Appendix C	C
long	0.1 micro degrees	Longitude	32 bit INTEGER	See Appendix C	C
elevation	0.1 meter	Elevation	16 bit INTEGER	See Appendix C	O

```
<rszRegion>
  <roadwayGeometry>
    <scale>10</scale>
    <rsmLanes>
      <RSMLane> [Start of lane 1 definition]
        <laneID>123</laneID>
        <lanePosition>1</lanePosition>
```

```
                    <laneName>Start of workzone leftmost lane</laneName>
                    <laneWidth>0</laneWidth>
                    <laneGeometry>
                        <nodeSet>
```

At minimum two nodes are required to define a lane. Each node is defined by a **nodePoint**.

```
            <NodeLLE>        [First of two nodes]
                <nodePoint>
                    <node-3Dabsolute>
                        <lat>-900000000</lat>
                        <long>-1799999999</long>
                        <elevation>-4096</elevation>
                    </node-3Dabsolute>
                </nodePoint>
```

nodeAttributes defines optional attributes that pertain to a lane definition. **speedLimits** and **peoplePresent** have already been described. Each **nodePoint** may include attributes as shown below. Lane **width** may be provided in centimeters. If the lane is tapering or closing to the left from this **nodePoint,** then set **taperLeft** to true. Use **taperRight** in similar fashion. An example showing the tapering lanes concept follows. Lane open or closed (using **laneClosed**) and people (e.g., workers) present (using **peoplePresent**) can also be indicated. In the example below, the node represented by the yellow dot uses **nodeAttributes** to indicate that the lane tapers right, is closed and that workers are present. The node represented by the green dot uses **nodeAttributes** to indicate that the lane tapers left, is open and that workers are not present.
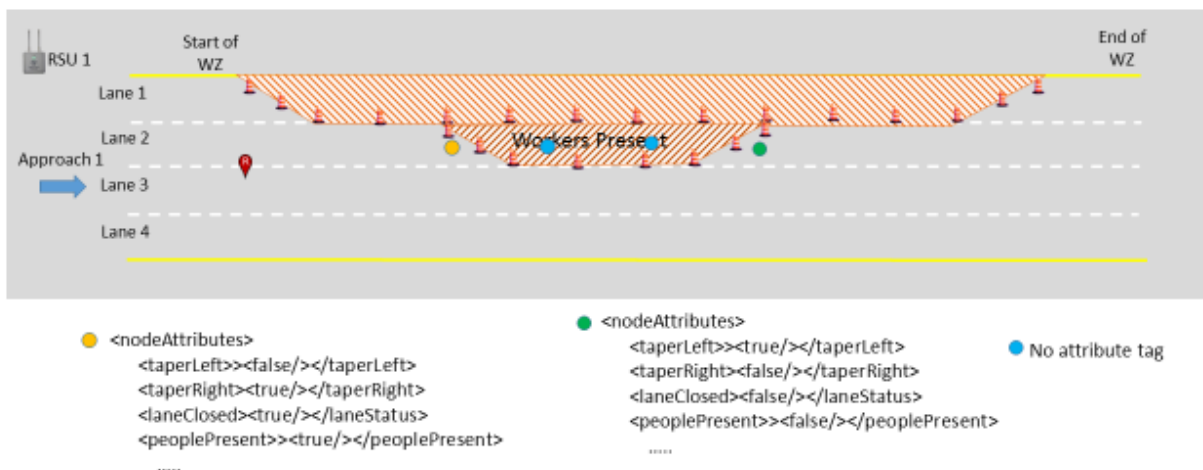
EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
width	1 cm	LaneWidth	INTEGER	(0..32767)	O
taperLeft	true: lane tapers left false: lane does not taper left	TaperLeft	BOOLEAN		O
taperRight	true: lane tapers right false: lane does not taper right	TaperRight	BOOLEAN		O
laneClosed	true: lane is closed false: lane is not closed	LaneClosed	BOOLEAN		O

peoplePresent	true: people are present false: people are not present	PeoplePresent	BOOLEAN		O

```xml
            <nodeAttributes> [Attributes belong to first node]
              <speedLimit>
                <type><vehicleMaxSpeed/></type>
                <speed>0</speed>
                <speedUnits><mph/></speedUnits>
              </speedLimit>
              <width>0</width>
              <taperRight><true/></taperRight>
              <laneClosed><true/></laneClosed>
              <peoplePresent><true/></peoplePresent>
            </nodeAttributes>
          </NodeLLE>
          <NodeLLE> [Second of two nodes for lane 1]
            <nodePoint>
              <node-3Dabsolute>
                <lat>-900000000</lat>
                <long>-1799999999</long>
                <elevation>-4096</elevation>
              </node-3Dabsolute>
            </nodePoint>
          </NodeLLE>
        </nodeSet>
      </laneGeometry>
```

width contains the absolute width of the lane in centimeters.

connectsTo identifies other lanes which connect to the work zone lanes. Up to 16 connecting lanes may be defined. **LaneID** identifies the **LaneID** of another defined lane, to which this lane connects to.

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
LaneID		LaneID	INTEGER	(0.. 255)	C

```xml
        <connectsTo>
          <LaneID>100</LaneID>
          <LaneID>101</LaneID>
        </connectsTo>
      </RSMLane>    [End of lane 1 definition]
```

The following XML is an example of the second of a possible ten instances of **RSMLane**. In this example, the lane in position 2 is defined based on the lane geometry of the lane in position 1, identified by setting **referenceLane** to laneID 123. (See the rszGeometry description and corresponding example XML above for the laneID 123 definition.) When using **referenceLane** to determine the **laneGeometry** of the **RSMLane** being defined, each node in the **RSMLane** corresponds to the shortest distance between each

node in the referenceLane and the center of the **RSMLane** being defined. **laneWidth** is required when using **referenceLane**.

```
<RSMLane>   [Start of lane 2 definition]
  <laneID>124</laneID>
  <lanePosition>2</lanePosition>
  <laneName>0</laneName>
  <laneWidth>0</laneWidth>
  <laneGeometry> [Geometry same as lane 1 (laneID 123)]
    <referenceLane>123</referenceLane>
  </laneGeometry>
  <connectsTo>
    <LaneID>0</LaneID>
  </connectsTo>
</RSMLane>
        </rsmLanes>
      </roadwayGeometry>
    </rszRegion>
</rszContainer>
```

The **curveContainer** is used to define a curved section of a roadway, information that is used in the curve speed warning application. The **curveContainer** optionally contains **curveRegion**, which is an instantiation of **AreaType** and is already described as part of the **rszContainer** above.

```
<curveContainer>
```

EXER Tag	Value / Units	ASN.1 type reference	ASN.1 data Type	ASN.1 Constraints	Req?
advisorySpeed	0.1 m/s	SpeedAdvice	INTEGER	(0..500)	M
frictCoef	0 to 100 in increments of 0.01	FrictCoef	INTEGER	(0..100)	O
surfaceCondition	(0) dry (1) moist (2) wet (3) flowing (4) ice (5) snow (6) frost	SurfaceCondition	ENUMERATION		O
Material	(0) asphalt (1) concrete (2) gravel (3) brushdConcrete	Material	ENUMERATION		O
minRadius	meters	Radius	INTEGER	(0..1023)	O
bankAngle	degrees	BankAngle	INTEGER	(-63..-64)	O
obstaclePresent	true: obstacle present	Activity	BOOLEAN		O
reducedVisibility	true: reduced visibility	Activity	BOOLEAN		O
roadwayGeometry		RsmGeometry			O

```
<advisorySpeed>0</advisorySpeed>
<frictCoef>0</frictCoef>
<surfaceCondition><dry/></surfaceCondition>
```

```xml
<material><asphalt/></material>
<minRadius>0</minRadius>
<bankAngle>-63</bankAngle>
<obstaclePresent><true/></obstaclePresent>
<reducedVisibility><true/></reducedVisibility>
<curveRegion>
  <roadwayGeometry>
    <scale>1</scale>
    <rsmLanes>
      <RSMLane>
        <laneID>0</laneID>
        <lanePosition>1</lanePosition>
        <laneName>0</laneName>
        <laneWidth>0</laneWidth>
        <laneGeometry>
          <nodeSet>
            <NodeLLE>
              <nodePoint>
                <node-3Dabsolute>
                  <lat>-900000000</lat>
                  <long>-1799999999</long>
                  <elevation>-4096</elevation>
                </node-3Dabsolute>
              </nodePoint>
              <nodeAttributes>
                <speedLimit>
                  <type><vehicleMaxSpeed/></type>
                  <speed>0</speed>
                  <speedUnits><mph/></speedUnits>
                </speedLimit>
                <width>0</width>
                <taperLeft><false/></taperLeft>
                <taperRight><false/></taperRight>
                <laneClosed><false/></laneClosed>
                <peoplePresent><false/></peoplePresent>
              </nodeAttributes>
            </NodeLLE>
            <NodeLLE>
              <nodePoint>
                <node-3Dabsolute>
                  <lat>-900000000</lat>
                  <long>-1799999999</long>
                  <elevation>-4096</elevation>
                </node-3Dabsolute>
              </nodePoint>
            </NodeLLE>
          </nodeSet>
        </laneGeometry>
        <connectsTo>
          <LaneID>0</LaneID>
          <LaneID>0</LaneID>
        </connectsTo>
```

```xml
          </RSMLane>
          <RSMLane>
            <laneID>0</laneID>
            <lanePosition>1</lanePosition>
            <laneName>0</laneName>
            <laneWidth>0</laneWidth>
            <laneGeometry>
              <referenceLane>0</referenceLane>
            </laneGeometry>
            <connectsTo>
              <LaneID>0</LaneID>
            </connectsTo>
          </RSMLane>
        </rsmLanes>
      </roadwayGeometry>
    </curveRegion>
  </curveContainer>
```

Use of Optional Fields

In many cases it is desirable to use fields that are optional, but if the fields are not used or have not changed, they should be omitted from the message. For example, when using `RSMLane`, it may be desirable to indicate at one node that workers are present using `peoplePresent` in `nodeAttributes`. A node attribute need not be included for every instance of `NodeLLE`; it is only necessary to include the attribute if its value has changed from the previous node.

In the case of optional fields of ASN.1 type `BOOLEAN`, it is typically not necessary to include the field if the value is `false`. In many XML examples provided in this document, `BOOLEAN` types are included for instructional purposes, but would be omitted in practice if `false`.

Installation and Operating Instructions

See Appendix D.

Appendix A: Example XML Representation of the RSM

The following represents an example of a possible XML structure based on the RSM ASN.1 schema. Note the following does not maximize all possible instances of XML structure (e.g., the XML shows two instances of **connectsTo** while more than two are possible.) Default values are used in most cases. This XML does not include all of the available containers. It does not include the regional extensions available in the **RoadsideSafetyMessage** or in node definitions. This text may be used to copy/paste into any editor.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<MessageFrame>
  <messageId>33</messageId>
  <value>
    <RoadsideSafetyMessage>
      <version>1</version>
      <commonContainer>
        <eventInfo>
          <eventID>00000000</eventID>
          <msgSegmentInfo>
            <totalMsgSegments>2</totalMsgSegments>
            <thisSegmentNum>1</thisSegmentNum>
          </msgSegmentInfo>
          <startDateTime>
            <year>0</year>
            <month>0</month>
            <day>0</day>
            <hour>0</hour>
            <minute>0</minute>
            <offset>-840</offset>
          </startDateTime>
          <endDateTime>
            <year>0</year>
            <month>0</month>
            <day>0</day>
            <minute>0</minute>
            <offset>-840</offset>
          </endDateTime>
          <eventRecurrence>
            <EventRecurrence>
              <startTime>
                <hour>0</hour>
                <minute>0</minute>
                <second>0</second>
                <offset>-840</offset>
              </startTime>
              <endTime>
                <hour>0</hour>
                <minute>0</minute>
                <second>0</second>
                <offset>-840</offset>
              </endTime>
```

```xml
      <startDate>
        <year>0</year>
        <month>0</month>
        <day>0</day>
      </startDate>
      <endDate>
        <year>0</year>
        <month>0</month>
        <day>0</day>
      </endDate>
      <monday><false/></monday>
      <tuesday><false/></tuesday>
      <wednesday><false/></wednesday>
      <thursday><false/></thursday>
      <friday><false/></friday>
      <saturday><false/></saturday>
      <sunday><false/></sunday>
      <exclusion><false/></exclusion>
    </EventRecurrence>
    <EventRecurrence>
      <startTime>
        <hour>0</hour>
        <minute>0</minute>
        <second>0</second>
      </startTime>
      <endTime>
        <hour>0</hour>
        <minute>0</minute>
        <second>0</second>
        <offset>-840</offset>
      </endTime>
      <startDate>
        <year>0</year>
        <month>0</month>
        <day>0</day>
      </startDate>
      <endDate>
        <year>0</year>
        <month>0</month>
        <day>0</day>
      </endDate>
      <monday><false/></monday>
      <tuesday><false/></tuesday>
      <wednesday><false/></wednesday>
      <thursday><false/></thursday>
      <friday><false/></friday>
      <saturday><false/></saturday>
      <sunday><false/></sunday>
      <exclusion><false/></exclusion>
    </EventRecurrence>
  </eventRecurrence>
  <causeCode>0</causeCode>
```

```xml
          <subCauseCode>0</subCauseCode>
</eventInfo>
<regionInfo>
  <applicableHeading>
    <heading>0</heading>
    <tolerance>0</tolerance>
  </applicableHeading>
  <referencePoint>
    <lat>-900000000</lat>
    <long>-1799999999</long>
    <elevation>-4096</elevation>
  </referencePoint>
  <referencePointType><startOfEvent/></referencePointType>
  <descriptiveName>0</descriptiveName>
  <speedLimit>
    <type><vehicleMaxSpeed/></type>
    <speed>0</speed>
    <speedUnits><mph/></speedUnits>
  </speedLimit>
  <eventLength>0</eventLength>
  <approachRegion>
    <roadwayGeometry>
      <scale>10</scale>
      <rsmLanes>
        <RSMLane>
          <laneID>123</laneID>
          <lanePosition>1</lanePosition>
          <laneName>Lane 1</laneName>
          <laneWidth>0</laneWidth>
          <laneGeometry>
            <nodeSet>
              <NodeLLE>
                <nodePoint>
                  <node-3Dabsolute>
                    <lat>-900000000</lat>
                    <long>-1799999999</long>
                    <elevation>-4096</elevation>
                  </node-3Dabsolute>
                </nodePoint>
                <nodeAttributes>
                  <speedLimit>
                    <type><vehicleMaxSpeed/></type>
                    <speed>0</speed>
                    <speedUnits><mph/></speedUnits>
                  </speedLimit>
                  <width>0</width>
                  <taperLeft><false/></taperLeft>
                  <taperRight><false/></taperRight>
                  <laneClosed><false/></laneClosed>
                  <peoplePresent><false/></peoplePresent>
                </nodeAttributes>
              </NodeLLE>
```

```xml
                    <NodeLLE>
                      <nodePoint>
                        <node-3Dabsolute>
                          <lat>-900000000</lat>
                          <long>-1799999999</long>
                          <elevation>-4096</elevation>
                        </node-3Dabsolute>
                      </nodePoint>
                    </NodeLLE>
                  </nodeSet>
                </laneGeometry>
                <connectsTo>
                  <LaneID>0</LaneID>
                  <LaneID>0</LaneID>
                </connectsTo>
              </RSMLane>
              <RSMLane>
                <laneID>124</laneID>
                <lanePosition>2</lanePosition>
                <laneName>Lane 2</laneName>
                <laneWidth>0</laneWidth>
                <laneGeometry>
                  <referenceLane>123</referenceLane>
                </laneGeometry>
                <connectsTo>
                  <LaneID>0</LaneID>
                </connectsTo>
              </RSMLane>
            </rsmLanes>
          </roadwayGeometry>
        </approachRegion>
      </regionInfo>
    </commonContainer>
    <rszContainer>
      <laneStatus>
        <LaneInfo>
          <lanePosition>1</lanePosition>
          <laneClosed><false/></laneClosed>
          <laneCloseOffset>0</laneCloseOffset>
        </LaneInfo>
        <LaneInfo>
          <lanePosition>1</lanePosition>
          <laneClosed><false/></laneClosed>
          <laneCloseOffset>0</laneCloseOffset>
        </LaneInfo>
      </laneStatus>
      <peoplePresent><false/></peoplePresent>
      <speedLimit>
        <type><vehicleMaxSpeed/></type>
        <speed>0</speed>
        <speedUnits><mph/></speedUnits>
      </speedLimit>
```

```xml
<roadClosureDescription>769</roadClosureDescription>
<roadWorkDescription>1025</roadWorkDescription>
<flagman>1111111</flagman>
<trucksEnteringLeaving><false/></trucksEnteringLeaving>
<rszRegion>
  <roadwayGeometry>
    <scale>10</scale>
    <rsmLanes>
      <RSMLane>
        <laneID>0</laneID>
        <lanePosition>1</lanePosition>
        <laneName>0</laneName>
        <laneWidth>0</laneWidth>
        <laneGeometry>
          <nodeSet>
            <NodeLLE>
              <nodePoint>
                <node-3Dabsolute>
                  <lat>-900000000</lat>
                  <long>-1799999999</long>
                  <elevation>-4096</elevation>
                </node-3Dabsolute>
              </nodePoint>
              <nodeAttributes>
                <speedLimit>
                  <type><vehicleMaxSpeed/></type>
                  <speed>0</speed>
                  <speedUnits><mph/></speedUnits>
                </speedLimit>
                <width>0</width>
                <taperLeft><false/></taperLeft>
                <taperRight><false/></taperRight>
                <laneClosed><false/></laneClosed>
                <peoplePresent><false/></peoplePresent>
              </nodeAttributes>
            </NodeLLE>
            <NodeLLE>
              <nodePoint>
                <node-3Dabsolute>
                  <lat>-900000000</lat>
                  <long>-1799999999</long>
                  <elevation>-4096</elevation>
                </node-3Dabsolute>
              </nodePoint>
            </NodeLLE>
          </nodeSet>
        </laneGeometry>
        <connectsTo>
          <LaneID>0</LaneID>
          <LaneID>0</LaneID>
          <LaneID>0</LaneID>
          <LaneID>0</LaneID>
```

```xml
          </connectsTo>
        </RSMLane>
        <RSMLane>
          <laneID>0</laneID>
          <lanePosition>1</lanePosition>
          <laneName>0</laneName>
          <laneWidth>0</laneWidth>
          <laneGeometry>
            <referenceLane>0</referenceLane>
          </laneGeometry>
          <connectsTo>
            <LaneID>0</LaneID>
          </connectsTo>
        </RSMLane>
      </rsmLanes>
    </roadwayGeometry>
  </rszRegion>
</rszContainer>
<curveContainer>
  <advisorySpeed>0</advisorySpeed>
  <frictCoef>0</frictCoef>
  <surfaceCondition><dry/></surfaceCondition>
  <material><asphalt/></material>
  <minRadius>0</minRadius>
  <bankAngle>-63</bankAngle>
  <obstaclePresent><false/></obstaclePresent>
  <reducedVisibility><false/></reducedVisibility>
  <curveRegion>
    <roadwayGeometry>
      <scale>1</scale>
      <rsmLanes>
        <RSMLane>
          <laneID>0</laneID>
          <lanePosition>1</lanePosition>
          <laneName>0</laneName>
          <laneWidth>0</laneWidth>
          <laneGeometry>
            <nodeSet>
              <NodeLLE>
                <nodePoint>
                  <node-3Dabsolute>
                    <lat>-900000000</lat>
                    <long>-1799999999</long>
                    <elevation>-4096</elevation>
                  </node-3Dabsolute>
                </nodePoint>
                <nodeAttributes>
                  <speedLimit>
                    <type><vehicleMaxSpeed/></type>
                    <speed>0</speed>
                    <speedUnits><mph/></speedUnits>
                  </speedLimit>
```

```xml
                  <width>0</width>
                  <taperLeft><false/></taperLeft>
                  <taperRight><false/></taperRight>
                  <laneClosed><false/></laneClosed>
                  <peoplePresent><false/></peoplePresent>
                </nodeAttributes>
              </NodeLLE>
              <NodeLLE>
                <nodePoint>
                  <node-3Dabsolute>
                    <lat>-900000000</lat>
                    <long>-1799999999</long>
                    <elevation>-4096</elevation>
                  </node-3Dabsolute>
                </nodePoint>
              </NodeLLE>
            </nodeSet>
          </laneGeometry>
          <connectsTo>
            <LaneID>0</LaneID>
            <LaneID>0</LaneID>
          </connectsTo>
        </RSMLane>
        <RSMLane>
          <laneID>0</laneID>
          <lanePosition>1</lanePosition>
          <laneName>0</laneName>
          <laneWidth>0</laneWidth>
          <laneGeometry>
            <referenceLane>0</referenceLane>
          </laneGeometry>
          <connectsTo>
            <LaneID>0</LaneID>
          </connectsTo>
        </RSMLane>
      </rsmLanes>
    </roadwayGeometry>
  </curveRegion>
  </curveContainer>
  </RoadsideSafetyMessage>
  </value>
</MessageFrame>
```

Appendix B: RSM ASN.1 Definition

Note: this ASN.1 file contains additions that may not apply to the RSZ and CSW applications. These were added to accommodate other potential users of the RSM.

```
RSM DEFINITIONS AUTOMATIC TAGS ::=
BEGIN

-- Roadside Safety Message is abbreviated as RSM in type definitions and comments below
RoadsideSafetyMessage ::= SEQUENCE {
    version              Version DEFAULT 1,    -- Message versioning info, DEFAULT to version 1

    -- This mandatory container describes generic information about the event.
    commonContainer         CommonContainer,

    -- The following application containers describe use-case specific
    -- information about the event.
    rszContainer            ReducedSpeedZoneContainer  OPTIONAL,
    curveContainer          CurveContainer             OPTIONAL,

    -- The following container definitions provided by SwRI
    staticSignageContainer StaticSignageContainer     OPTIONAL, --
    situationalContainer   SituationalContainer       OPTIONAL, -- this is a catch-all until some content is
moved to higher frames
    dynamicInfoContainer   DynamicInfoContainer       OPTIONAL, -- traditional "DMS"-type display
    incidentsContainer     IncidentsContainer         OPTIONAL, -- merge with WorkZone

    regional             SEQUENCE
        (SIZE(1..4)) OF DSRC.RegionalExtension {{REGION.Reg-RoadsideSafetyMessage}} OPTIONAL,
    ...
}

-- CommonContainer is mandatory and applies to all RSMs
CommonContainer ::= SEQUENCE {
    eventInfo          EventInfo,                     -- New container includes eventID, start/end
date/times, eventRecurrance, causeCodes
    regionInfo         RegionInfo,                    -- This is new, includes referencePoint,
applicableHeding, roadWidth (pathWidth), approachLanes (approachRegion)
    ...
}

-- Contains info related to event start/end date/times, recurrance, cause codes (moved here from top level
of CommonContainer)
EventInfo ::= SEQUENCE {
    eventID            DSRC.TemporaryID,              -- Randomly assigned ID for this event
    msgSegmentInfo     MsgSegmentInfo      OPTIONAL,  -- Info about message segments for this event
    startDateTime      DSRC.DDateTime,                -- Event start date and time
    endDateTime        DSRC.DDateTime      OPTIONAL,  -- Event end date and time (applies to current message
instance).
                                                      -- endDateTime can be omitted if indefinite or
unknown,
                                                      -- Can be used to calculate the validity time duration
of the message.
    eventRecurrence    SEQUENCE                       -- Indicates the date/time periods for which an event
is active.
        (SIZE(1..5, ...)) OF EventRecurrence OPTIONAL, -- Up to 5 periods may be defined.
    causeCode          CauseCode,                     -- List of possible events
    subCauseCode       SubCauseCode        OPTIONAL,  -- List of possible events (use-case specific)
    ...
}

-- Note: All message segments corresponding to the same event must have the same eventID in EventInfo
MsgSegmentInfo ::= SEQUENCE {
    totalMsgSegments  SegmentCount,            -- Number of message segments for this event
    thisSegmentNum    SegmentCount             -- Segment number for this message
}

SegmentCount ::= INTEGER(1..127)
```

```
-- Contains info related to event heading, location, reference point, length, speed (moved here from top
level of CommonContainer)
RegionInfo ::= SEQUENCE {
    applicableHeading  ApplicableHeading,               -- Provide so map matching algs can easily determine
direction of travel
    referencePoint     DSRC.Position3D,                 -- Reference position, may be start of event
(default) or arbitrary location.
    referencePointType ReferencePointType   OPTIONAL,   -- startOfEvent or arbitrary. If not provided,
default to startOfEvent.
    descriptiveName    DSRC.DescriptiveName OPTIONAL,   -- Plain text (human readable) name of roadway or
region (might be IA5String)
    speedLimit         RSMSpeedLimit        OPTIONAL,   -- Speed limit at the reference position
    eventLength        EventLength          OPTIONAL,   -- Len of event in meters (dist of travel)
    approachRegion     AreaType             OPTIONAL,   -- Note: approachLanes has been replaced with
AreaType
    ...
}

-- Provides choice of methods to describe a region, i.e., lane based or other more general region
definitions (e.g. polygon, etc.)
AreaType ::= CHOICE {
    broadRegion         BroadRegion,            -- Polygon or Circle
    roadwayGeometry     RsmGeometry,            -- Sequence of lanes with attributes
    paths               PathList,               -- One or more coarse "lanes" (or roads) with a width
    ...
}

BroadRegion ::= CHOICE {
    polygon           Polygon,
    circle            DSRC.Circle,
    ...
}

Polygon ::= SEQUENCE (SIZE(3..50)) OF NodePointLLE -- May be defined by abs lat/lon/elev or offsets

PathList ::= SEQUENCE (SIZE(1..10)) OF Path

Path ::= SEQUENCE {
    pathWidth         INTEGER (0..1000), -- width of the above Path in units of 10cm
    pathPoints        PathPoints,
    ...
}

PathPoints ::= SEQUENCE (SIZE(2..50)) OF DSRC.Position3D

-- Optional container describing a zone where reduced speed is required, maybe a workzone or other type of
zone (e.g., school).
-- Abbreviated as rsz or RSZ in various comments and type definitions below.
--
-- If geometry is available, then the zone may be fully defined using rszRegion+rsmGeometry and associated
supplemental attributes elements.
-- If geometry is not available, then the zone may be defined using the laneStatus, peoplePresent and
speedLimit elements.
-- The peoplePresent and speedLimit elements may also be used if they are not included in
rszRegion+rsmGeometry.
ReducedSpeedZoneContainer ::= SEQUENCE {
    laneStatus                SEQUENCE
      (SIZE(1..10, ...)) OF LaneInfo              OPTIONAL, -- Lane status (open/closed) and closure
offset from ref point
    peoplePresent             PeoplePresent                OPTIONAL, -- TRUE: people are present, FALSE: people
are not present
    speedLimit                RSMSpeedLimit                OPTIONAL, -- Speed limit assoc with event if not spec
in rsmGeometry (supplementalAttributes)
    roadClosureDescription ITIS.ITIScodes(769..895)   OPTIONAL, -- J2540 DE_Closures
    roadWorkDescription    ITIS.ITIScodes(1025..1061) OPTIONAL, -- J2540 DE_Roadwork
    flagman                   DSRC.PublicSafetyDirectingTrafficSubType OPTIONAL,
    trucksEnteringLeaving  BOOLEAN                      OPTIONAL,
    rszRegion                 AreaType                     OPTIONAL, -- Describes region of reduced speed zone
    ...
}
```

```
-- For each lane, status (open/closed) and closure offset from reference point
LaneInfo ::= SEQUENCE {
    lanePosition     LanePosition,                    -- Where lanePosition 1 is always the leftmost lane
    laneClosed       LaneClosed,                       -- TRUE:lane closed, FALSE:lane open
    laneCloseOffset  DSRC.ObstacleDistance OPTIONAL,   -- Distance from ref point to lane closure in meters
    ...
}

-- Optional container describing conditions that may be present in a curve of the roadway
CurveContainer ::= SEQUENCE {
    advisorySpeed      DSRC.SpeedAdvice,                 -- Recommended speed limit for the curve
    frictCoef          FrictCoef          OPTIONAL,      -- Coefficient of kinetic friction
    surfaceCondition   SurfaceCondition   OPTIONAL,      -- Enum value describing current road condition
    material           Material           OPTIONAL,      -- Enum value describing material type
    minRadius          Radius             OPTIONAL,      -- Minimum radius of the curve in meters
    bankAngle          BankAngle          OPTIONAL,      -- Bank angle present at min radius of the curve
    obstaclePresent    Activity           OPTIONAL,      -- TRUE: obstacle present, FALSE: no info avail
    reducedVisibility  Activity           OPTIONAL,      -- TRUE: reduced visibility, FALSE: no info avail
    curveRegion        AreaType           OPTIONAL,      -- Describes geometry of lanes or polygon in the
curve
    ...
}

-- Describes the geometry of a reduced speed zone or a curve (or any other set of lanes that may be required
in the future).
RsmGeometry ::= SEQUENCE {
    scale            RsmScale           OPTIONAL,   -- If scaling of nodelist is desired (applies to all
rsmLanes)
    rsmLanes         SEQUENCE
        (SIZE(1..10, ...)) OF RSMLane,               -- Lane specific information for from 1 to 10 lanes
    ...
}

-- RSMLane replaces J2735's GenericLane
RSMLane ::= SEQUENCE {
    laneID           DSRC.LaneID,                      -- The unique ID number assigned to this lane
    lanePosition     LanePosition         OPTIONAL,    -- Lane number, where lane 1 is leftmost lane
    laneName         DSRC.DescriptiveName OPTIONAL,    -- Human readable, typically used for debug use only
    laneWidth        DSRC.LaneWidth       OPTIONAL,    -- Absolute width of lane in 1 cm increments (e.g.,
1200 = 12 m). When using referenceLane laneWidth required.
    laneGeometry     LaneGeometry         OPTIONAL,    -- Choice between the referenceLane method or the
nodeset method
    connectsTo       SEQUENCE
        (SIZE(1..16, ...)) OF DSRC.LaneID  OPTIONAL,  -- A list of other lanes connecting to RSM lanes
    ...
}

-- Choose how the lane geometry is described: explitly defined using nodes, or identify another lane with
the same geometry.
-- TODO: Add some text discussing how to describe a curved lane using the referenceLane approach.
LaneGeometry ::= CHOICE {
    referenceLane    DSRC.LaneID,    -- Use node definitions from the lane identified by referenceLane
    nodeSet          NodeSetLLE,     -- Use the nodes specified in a node set to describe lane geometry
    ...
}

-- Replaces J2735's NodeSetXY in the RSM
-- Spatial path and attribute information along the node path
NodeSetLLE ::= SEQUENCE (SIZE(2..63)) OF NodeLLE

-- Replaces J2735's NodeXY in the RSM
NodeLLE ::= SEQUENCE {
    nodePoint        NodePointLLE,                     -- A choice of using absolute lat/long/elev or
offsets
    nodeAttributes   NodeAttributeSetLLE  OPTIONAL,    -- Any optional Attributes which are needed
    ...
}

-- Replaces J2735's NodeOffsetPointXY in the RSM
NodePointLLE ::= CHOICE {
    -- Nodes with lat/long/elev content
```

```
        node-3Dabsolute   DSRC.Position3D,  -- Absolute lat/long/elevation
        node-3Doffset     Offset3D,          -- Offsets of fractional deg (lat/long) and meters (elev)
        ...
}

-- Provides lat/long/elev offsets from the previous node in the node set
Offset3D ::= SEQUENCE {
    lat-offset        LatOffset,           -- Offset from previous node latitude
    long-offset       LongOffset,          -- Offset from previous node longitude
    elev-offset       ElevOffset,          -- Offset from previous node elevation
    ...
}

-- Use scale (Zoom) to to modify the units for nodes' latitude and longitude (but not elevation).
-- For example the default units specified for latitude and longitude are tenths of microdegrees.
-- A scale value set to 10 causes the units to be converted to microdegrees.
-- The scale factor is not applied to the elevation if present.
-- Offset units are recommended as follows, set scale appropriately:
-- For reduced speed zone: microdegrees, providing approx. 100 cm resolution (scale=10).
-- For curves: 0.1 microdegrees, providing approx. 10 cm resolution (scale=1)
LatOffset  ::= INTEGER (-16384..16383) -- Offset in microdegrees (rsz) or 0.1 microdegrees (curves)
LongOffset ::= INTEGER (-16384..16383) -- Offset in microdegrees (rsz) or 0.1 microdegrees (curves)
ElevOffset ::= INTEGER (-4096..4095)   -- Offset in increments of 0.1 meters (scale not applied)

-- Include any optional attributes needed to further describe a lane.
NodeAttributeSetLLE ::= SEQUENCE {
    speedLimit     RSMSpeedLimit  OPTIONAL,  -- Reference regulatory speed limit used in this lane
    width          DSRC.LaneWidth OPTIONAL,  -- Absolute width of lane in 1 cm increments (e.g., 1200 = 12
m)
    taperLeft      TaperLeft      OPTIONAL,  -- Used when lane is closing or shifting to the left
    taperRight     TaperRight     OPTIONAL,  -- Used when lane is closing or shifting to the right
    laneClosed     LaneClosed     OPTIONAL,  -- TRUE if lane is closed
    peoplePresent  PeoplePresent  OPTIONAL,  -- TRUE: people are present, FALSE: people are not present
    ...
}

--
-- The following are various data frames and elements used above.
--
Activity ::= BOOLEAN                  -- TRUE: Relevant activity is occurring, FALSE: Unknown what is
happening

ApplicableHeading ::= SEQUENCE {
    heading          HeadingDeg,  -- Heading in 1 degree increments, message applies to heading +/-
tolerance
    tolerance        Tolerance,   -- Tolerance in 1 degree increments
    ...
}

BankAngle ::= INTEGER (-63..64)     -- Bank angle of the curve at the minimum radius in degrees

-- These codes defined in ETSI EN 302 637-3
-- TODO: Create new codes and define in J2735 or somewhere?
CauseCode ::= INTEGER {
    reserved (0),
    trafficCondition (1),
    accident (2),
    roadwor (3),
    adverseWeatherCondition-Adhesion (6),
    hazardousLocation-SurfaceCondition (9),
    hazardousLocation-ObstacleOnTheRoad (10),
    hazardousLocation-AnimalOnTheRoad (11),
    humanPresenceOnTheRoad (12),
    wrongWayDriving (14),
    rescueAndRecoveryWorkInProgress (15),
    adverseWeatherCondition-ExtremeWeatherCondition (17),
    adverseWeatherCondition-Visibility (18),
    adverseWeatherCondition-Precipitation (19),
    slowVehicle (26),
    dangerousEndOfQueue (27),
    vehicleBreakdown (91),
```

```
        postCrash (92),
        humanProblem (93),
        stationaryVehicle (94),
        emergencyVehicleApproaching (95),
        hazardousLocation-DangerousCurve (96),
        collisionRisk (97),
        signalViolation (98),
        dangerousSituation (99)
} (0..255)

-- Unsigned 16-bit integer representing zone length in meters
EventLength ::= INTEGER (0..65535)

-- Defines applicable periods for an event.
EventRecurrence ::= SEQUENCE {
        startTime   DSRC.DTime  OPTIONAL,  -- Time of day this period starts
        endTime     DSRC.DTime  OPTIONAL,  -- Time of day this period ends
        startDate   DSRC.DDate  OPTIONAL,  -- Date this period starts
        endDate     DSRC.DDate  OPTIONAL,  -- Date this period ends
        -- Define days of the week for applicable periods (used by EventRecurrence)
        monday      BOOLEAN,
        tuesday     BOOLEAN,
        wednesday   BOOLEAN,
        thursday    BOOLEAN,
        friday      BOOLEAN,
        saturday    BOOLEAN,
        sunday      BOOLEAN,
        -- exclusion: TRUE: The period defined here is excluded, i.e., the period is NOT applicable to the event
        exclusion   BOOLEAN     OPTIONAL,
        ...
}

FrictCoef ::= INTEGER (0..100)

HeadingDeg ::= INTEGER (0..360)  -- Heading in 1 degree increments

LaneClosed ::= BOOLEAN          -- TRUE: Lane is closed, FALSE: lane is not closed

LanePosition ::= INTEGER (1..15) -- Lane position where lane 1 is always leftmost lane

Material ::= ENUMERATED {
        asphalt         (0),
        concrete        (1),
        gravel          (2),
        brushedConcrete (3),
        ...
}

-- Indicates the presence of people in a reduced speed zone or a curve
PeoplePresent ::= BOOLEAN       -- TRUE: Indicates people are present, FALSE: People are not present

Radius ::= INTEGER (0..1023)    -- Minimum radius of the curve in meters

RsmScale ::= INTEGER (1..100)   -- Scale factor (zoom) applied to node offsets

-- New DF for RSM, replaces J2735's RegulatorySpeedLimit
RSMSpeedLimit ::= SEQUENCE {
        type        DSRC.SpeedLimitType DEFAULT vehicleMaxSpeed, -- The type of regulatory speed which follows
        speed       Speed,                                       -- The speed in units chosen below
        speedUnits  SpeedUnits DEFAULT mph,                      -- Units of speed, e.g., mph, kph, 0.02 m/sec
        ...
}

-- Speed limit value, units specified elsewhere (see SpeedUnits)
-- If units selected is mpsXpt02 (0.02 m/sec), then max speed is approx. 365 MPH
Speed ::= INTEGER (0..8191)

-- Use this to determine units to be applied to speed value.
SpeedUnits ::= ENUMERATED {
        mph,            -- Miles per hour
        kph,            -- Kilometers per hour
```

```
    mpsXpt02,       -- 0.02 meters per second (reads as mps times point 02)
    ...
}

-- Unsigned 8-bit integer value, application dependent
SubCauseCode ::= INTEGER (0..255)

SurfaceCondition ::= ENUMERATED {
    dry        (0),
    moist      (1),
    wet        (2),
    flowing    (3),
    ice        (4),
    snow       (5),
    frost      (6),
    ...
}

ReferencePointType ::= ENUMERATED {
    startOfEvent (0),
    arbitrary    (1),
    ...
}

Tolerance ::= INTEGER (0..360)  -- In 1 degree increments

TaperLeft ::= BOOLEAN           -- TRUE: Lane is closing or shifting to the left

TaperRight ::= BOOLEAN          -- TRUE: Lane is closing or shifting to the right

Version ::= INTEGER (0..255)    -- Eight bits of version info

--
-- The following use-case specific container definitions
--

StaticSignageContainer ::= SEQUENCE {
    speedLimit              RSMSpeedLimit          OPTIONAL,
    mileMarker              REAL                   OPTIONAL,
    itisGenericSign         DSRC.GenericSignage    OPTIONAL, -- Restrict (or recommend) J2540 sign
sequences (ITIS phrases)
    mutcdCode               DSRC.MUTCDCode         OPTIONAL, -- "regulatory", "warning", "guide", etc
(typically implied/derived by sign designation below)
    mutcdSignDesignation    IA5String(SIZE(1..120)) OPTIONAL, -- Alphanumeric MUTCD sign designation
    -- Identify nominal subset of all signs, minimal subset to support
    ...
}

SituationalContainer ::= CHOICE {
    obstructions            Obstructions,       -- Location, size, lanes, etc
    overheightVehicle       OverheightVehicle,  -- Clearance location, clearance height, location/path,
measured height of vehicle
    travelTime              TravelTime,         -- Start/end, typical/actual
    roadClosure             RoadClosure,        -- Merge with CAMP RSZW
    railCrossing            RailCrossing,       -- Activity (gate/signal/train), duration
    ...
}

DynamicInfoContainer ::= SEQUENCE {
    priority                ENUMERATED {low-priority (0), medium-priority (1), high-priority (2),
critical (3)},
    typeOfInfo              TypeOfDynamicInfo,
    dmsSignString           IA5String(SIZE(1..100)) OPTIONAL,
    congestionInfo          SEQUENCE
        (SIZE(1..30)) OF CongestionInfo         OPTIONAL,
    situationalInfo         SituationalContainer  OPTIONAL, -- For work zone, travel time, etc... info
    incidentsInfo           IncidentsContainer    OPTIONAL, -- For incidents info
    ...
}

IncidentsContainer ::= SEQUENCE {
```

```
    description                 ITIS.ITIScodes(513..531),        -- J2540 DE_AccidentsAndIncidents
    responderType               SEQUENCE
        (SIZE(1..5)) OF ITIS.ResponderGroupAffected OPTIONAL,
    affectedLanes               RegionInfo          OPTIONAL,
    advisorySpeed               DSRC.AdvisorySpeed  OPTIONAL,
    congestionInfo              CongestionInfo      OPTIONAL, -- Include DynamicInfoContainer?
    ...
}

--
-- Start of Data Frames and elements used by use-case specific containers
--

CongestionInfo ::= SEQUENCE {
    queueAheadWarning           BOOLEAN,
    associatedLane              RSMLane                  OPTIONAL, --Single roadsegment with which queue info
is associated; omit if defining for all lanes
    startOfQueue                RegionInfo,
    lengthOfQueue               DSRC.ObstacleDistance   OPTIONAL, -- TODO: Technically wrong DE to use, but
is the only J2735 element with sufficient length (GrossDistance max is 1km)
                                                        -- Should define new, more generic,
distance element
    speedLimit                  RSMSpeedLimit           OPTIONAL,
    averageVehicleSpeed         DSRC.Velocity           OPTIONAL,
    normalConditions            BOOLEAN                 OPTIONAL,
    unexpectedConditionDesc     IA5String(SIZE(1..100)) OPTIONAL, -- Text description of unexpected event or
ITIS Code
    ...
}

ManyDayOfWeek ::= SEQUENCE (SIZE(1..7)) OF AddGrpB.DayOfWeek --An 'array' of time and day of week or date
when repeating event is active

Obstructions ::= SEQUENCE {
    detection                   DSRC.ObstacleDetection,
    roadSegmentID               DSRC.RoadSegmentReferenceID,        -- link to outside map
    description                 ITIS.ITIScodes(1282..1319) OPTIONAL, -- J2540 DE_Obstructions
    location                    ITIS.ITIScodes(7937..8030) OPTIONAL, -- J2540 DE_GenericLocations
    affectedLanes               RegionInfo              OPTIONAL,
    reducedspeed                DSRC.AdvisorySpeed      OPTIONAL,
    affectedvehicles            DSRC.DisabledVehicle    OPTIONAL,
    ...
}

OverheightVehicle ::= SEQUENCE {
    roadSegmentID               DSRC.RoadSegmentReferenceID,
    point                       DSRC.Position3D,
    intersection                DSRC.IntersectionReferenceID OPTIONAL,
    vehicleHeight               DSRC.VehicleHeight          OPTIONAL, --Limited Range, consider expanding
    clearanceHeight             DSRC.VehicleHeight,                  --Limited Range
    heightViolation             ENUMERATED {not-in-violation (0), in-violation (1), less-than-15-cm (2),
unknown (3)},
    ...
}

RailCrossing ::= SEQUENCE {
    crossingSignalOn            BOOLEAN                      OPTIONAL,
    crossingGateDown            BOOLEAN                      OPTIONAL,
    approachingTrain            BOOLEAN                      OPTIONAL,
    trainCrossingInProgress     BOOLEAN,
    durationTime                DSRC.MinutesDuration    OPTIONAL, --Estimated duration of crossing
    durationDescription         ITIS.ITIScodes(1537..1543) OPTIONAL, -- J2540 DE_DelayStatusCancellation
    ...
}

RoadClosure ::= SEQUENCE {
    description                 ITIS.ITIScodes(769..895),       -- J2540 DE_Closures
    affectedLanes               RegionInfo,
    temporaryClosureDuration    DSRC.MinutesDuration OPTIONAL,
    indefiniteClosure           BOOLEAN                 OPTIONAL, -- Moved to TimeInfoContainer (TODO: comment
seems unclear)
```

```
    ...
}

TravelTime ::= SEQUENCE {
    travelOrigin            RegionInfo,
    travelDestination       RegionInfo,
    distanceToDestination   DSRC.ObstacleDistance,        --Only J2735 element with sufficient length
(GrossDistance max is 1km)
    typicalDuration         DSRC.MinutesDuration   OPTIONAL,
    actualDuration          DSRC.MinutesDuration   OPTIONAL,
    dmsSignString           IA5String(SIZE(1..80)) OPTIONAL, --Simple string as may appear on DMS Sign
    ...
}

TypeOfDynamicInfo ::= ENUMERATED {
    road-work       (0),
    road-closure    (1),
    travel-time     (2),
    congestion      (3),
    incident        (4),
    obstruction     (5),
    weather-alert   (6),
    special-event   (7),
    ...
}

END
```

Appendix C: Latitude, Longitude and Elevation encoding.

The data elements for latitude, longitude and elevation are encoded in a specific way within J2735 and are described in the following text.

- Latitude is expressed in $1/10^{th}$ integer microdegrees (10^{-7}), as a 31 bit value. The value 900000001 is used when latitude is unavailable. J2735 specifies the ASN.1 for Latitude as follows:

  Latitude ::= INTEGER (-900000000..900000001)
  -- LSB = 1/10 micro degree
  -- Providing a range of plus-minus 90 degrees

  For example latitude + 42.6523253 degrees is represented as 426523253. Up to 7 significant digits are supported. Note that units must be maintained even if less precision is available. For example the latitude value +42.652 is represented as 426520000.

- Longitude is expressed in $1/10^{th}$ integer microdegrees (10^{-7}) as a 32 bit value. The value 1800000001 is used when longitude is unavailable. J2735 specifies the ASN.1 for Longitude as follows:

  Longitude ::= INTEGER (-1799999999..1800000001)
  -- LSB = 1/10 micro degree
  -- Providing a range of plus-minus 180 degrees

  For example longitude -83.2388033 degrees is represented as   -832388033. Up to 7 significant digits are supported. Note that units must be maintained even if less precision is available. For example the longitude value -83.23 is represented as -832300000.

- Elevation represents the geographic position above or below the reference ellipsoid (typically WGS-84). The number has a resolution of 1 decimeter and represents an asymmetric range of positive and negative values. Any elevation higher than +6143.9 meters is represented as +61439. Any elevation lower than -409.5 meters is represented as -4095. The value -4096 is used when longitude is unavailable. J2735 specifies the ASN.1 for Elevation as follows:

  Elevation ::= INTEGER (-4096..61439)
  -- In units of 10 cm steps above or below the reference ellipsoid
  -- Providing a range of -409.5 to + 6143.9 meters

  For example an elevation of 277.5 meters is represented as 2775.

An example of the XML for reference point found in the common container, using the example values above follows:

```
<referencePoint>
  <lat>426523253</lat>
  <long>-832388033</long>
  <elevation>2775</elevation>
</referencePoint>
```

Appendix D: Software installation and operating instructions for CVMsgBuilder

Installation and operating instructions for CVMsgBuilder v1.4 (distribution date 5/31/2018)

Note: The following instructions apply to PCs running the Windows operating system. These instructions may be adapted to other platforms as required, e.g., MAC.

System requirements

- JRE 7 or later must be installed on the target machine

Installation

- Store the distribution .zip file in any desired folder
- Extract the contents of the .zip file

To run the software:
- Open a command window by running cmd.exe
- Use cd command to navigate to the distribution folder
- Type the following:

  java -jar dist\CVMsgBuilder.jar

- Diagnostic output is written to the command window. Diagnostic output can be redirected to a file by appending " > diagout.txt" to the command line. Diagnostic output can be suppressed completely by appending " > NUL". Examples follow:

  java -jar dist\CVMsgBuilder.jar > diagout.txt
  java -jar dist\CVMsgBuilder.jar > NULL

- If the software launched successfully, the following will be displayed:
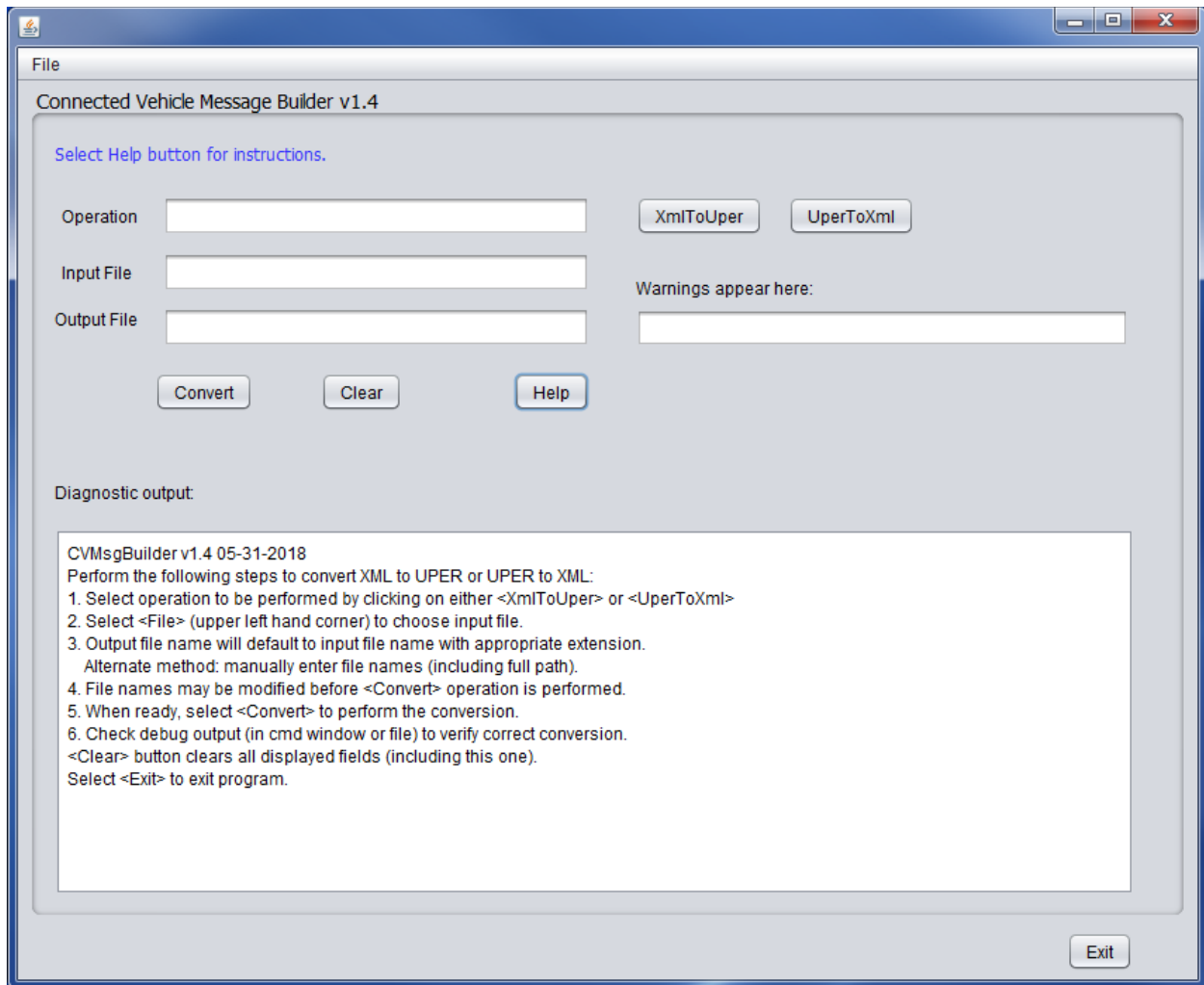
Click on the Help button to see usage instructions displayed in the output area.

Appendix E: J2735 editing instructions

The following are instructions for updating the standard J2735 ASN.1 file (J2735_201603DA.asn) to include support for the **RoadsideSafetyMessage**.

Applications decoding UPER PDUs generated by CVMsgBuilder v1.2 must include the following changes to the standard J2735 ASN.1 schema. Three lines must be added.

For each, the previous (existing) line from the J2735 ASN.1 file is shown, followed by the new line to be added.

The first two changes occur in the DSRC module:

```
{ PersonalSafetyMessage IDENTIFIED BY personalSafetyMessage } |
{ RSM.RoadsideSafetyMessage IDENTIFIED BY roadsideSafetyMessage } |


personalSafetyMessage          DSRCmsgID ::=  32 -- PSM
roadsideSafetyMessage          DSRCmsgID ::=  33 -- RSM
```

The third change occurs in the REGION module:

```
Reg-PersonalSafetyMessage  DSRC.REG-EXT-ID-AND-TYPE ::= { ... }
Reg-RoadsideSafetyMessage  DSRC.REG-EXT-ID-AND-TYPE ::= { ... }
```

Be sure to include the RSM ASN.1 file (e.g., rsmv5.1.asn for CVMsgBuilder v1.4) to the list of included files within your ASN.1 compiler environment and recompile.