BASIC INFRASTRUCTURE MESSAGE DEVELOPMENT AND STANDARDS SUPPORT FOR CONNECTED VEHICLES APPLICATIONS

Task 4
"Basic Infrastructure Message Standards Input"

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Connected Vehicle Pooled Fund Study

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1.   INTRODUCTION

This input was developed as part of the Connected Vehicle Pooled Fund Study project "Basic Infrastructure Message Development and Standards Support for Connected Vehicles Applications."

1.1   Project Background

In a connected vehicle (CV) environment, vehicles which are equipped with Dedicated Short-Range Communication (DSRC) devices broadcast Basic Safety Messages (BSMs), and a standard such as SAE J2735 has been well defined for what information is in the BSM. On the other hand, from the infrastructure side, which infrastructure information will be or needs to be broadcast is not as well defined in a consistent manner yet.

Current standards and pilot deployments have included many of the infrastructure related information such as Signal Phase and Timing (SPaT) message and messages that contain intersection geometry (known as MAP messages), and to a lesser extent infrastructure information such as curve speed warnings, static and dynamic signage, and work zone information. While Map and SPaT are fairly well understood, they are considered a different application domain from other infrastructure information. Additional infrastructure information could be transmitted that may benefit CVs applications and would benefit from having a common and consistent high-level message structure that could be followed, such as:

- speed limit (particularly where that might be variable)
- standard static signage (representation of physical signs)
- presence of school zones
- work zones and lane closures
- messages displayed on variable messages signs or highway advisory radios
- travel times and routing information
- traffic conditions (particularly anomalies such as incidents and unexpected congestion)
- and others

With this background, it was recently suggested that a corollary message to the BSM from the infrastructure, a Basic Infrastructure Message (BIM), needs to be investigated. Having a standard BIM would help the Original Equipment Manufacturers (OEMs) and third-party application providers to understand that there will be some infrastructure for them to rely on, and will give them some basis for the kind of message they can expect from the infrastructure. At the same time, this will also help the public transportation agencies to know what kind of information to broadcast from their Road Side Equipment (RSE).

Once a standard BIM is developed, the next step would be to work with the appropriate standards development organization and committee to get the BIM standard message under consideration as a standard. Likewise, there is an urgent need for the public agencies (actual operators and maintainers of the infrastructure) to be able to influence the decisions related to the standards for vehicular data, such as BSM, as well. For a variety of reasons (budget, expertise, travel constraints, time availability, etc.), the operating agency personnel have not engaged in these standards development exercises, but have an important interest in their outcomes. Also, many of the states are not even fully aware of what standards exist or what the status of them is. With that being said, it is important to establish a means with which the Connected Vehicle Pooled Fund Study team can track standards related activities and influence the development of these standards.

1.2   Project Goals

The goals of this project are:
- Develop a BIM.
- Establish a means to collaborate with the relevant standards development organizations.

1.3   Purpose of this Document

For purposes of this document, the concept is referred to as the "BIM"; however, it is expected that the version that ultimately is proposed for inclusion into the SAE DSRC standards (specifically J2735 and likely J2945/4, and possibly others) will be called the Roadside Safety Message (RSM).

One of the transportation infrastructure operator's objectives is to provide information to drivers and vehicles on their road networks. While there is an incredible wealth of information available from the infrastructure, there are constant challenges in providing this information to end users. These challenges include, but are not limited to:

- Aggregating heterogeneous data from many sources, often external to the entity responsible for providing information to roadway users.
- Ensuring accuracy and completeness of information.
- Ensuring information timeliness.
- Ensuring geographic applicability of information.
- Providing information in a succinct manner.
- Providing a variety of different information in a consistent format.

The user needs below reflect the high level and detailed needs of the BIM scenarios provided in Task 2. These scenarios are described at a high level in Table 1. Additional scenarios, not immediately relevant to the BIM, are described in Table 2. These additional scenarios are included for completeness sake, as they were identified during the course of this project; however, they are not expected to be included as content for the anticipated BIM. Where appropriate, they will be further developed and provided as input to other standards activities, presumably other SAE DSRC Task Force groups.

Table 1: Use Case High Level Description – BIM Scenarios

Event	High Level Description
Static Signage	Digital representations of physical signs and placards.
Dynamic Traveler Information	Information that would be displayed dynamically to drivers in a region would be transmitted digitally through BIMs. Connected vehicles could then display this information to drivers. This information would typically be displayed on Dynamic Message Signs (DMS).
Roadway Obstructions	Obstructions on the roadway may be intentional (barricades to direct or deter traffic), debris that affects the flow of traffic, or even stalled vehicles in or adjacent to a lane of travel.
Oversize Clearance	Information on clearance restrictions at a specific point or along a length of roadway. This is most commonly related to height clearance of bridges and overpasses, but also applies to width and weight restrictions.
Work Zones	Work zones are often dynamic and may change or affect the drivable roadway in some manner, including changing lane widths, changing lane paths, closing lanes, reducing the speed limit, and may have non-standard traffic entering or exiting the driving lanes.

Event	High Level Description
School Zones	School zone activity is typically on a repeating schedule and coincides with an increase in pedestrian activity in a defined area. They may also reduce the speed limit and restrict driving maneuvers (i.e., restricting an otherwise allowed 'right turn on red' intersection movement).
Rail Grade Crossing	Information specifying rail grade crossing activity, highlighting potential points of conflict between trains and roadway vehicles.
Travel Times	Information on the currently measured or expected time to travel along a route between two points.
Road Surface Conditions	Information on the condition or the drivable roadway at a specific point or along a route. This generally includes weather-related conditions (i.e., snow or ice, standing water, etc.), but may also include physical changes to the road surface such as temporary changes as a result of resurfacing/repaving, grooving or the road surface, and oil or other material spills.
Special Events	Information related to changes in the typical driving patterns in an area as a result of special events (sporting events, conferences, parades, etc.) that restrict certain types or classes of vehicles along certain routes, or change the standard roadway use (i.e., reversing direction of travel of lanes or whole roads).
Parking Information	Information regarding the availability of parking in an area. This can include type (on street, garage), pricing, restrictions (permits, size, customer only), and time restrictions.
Contraflow	Information regarding contraflow activities, typically used during evacuations. This can include local evacuations for HAZMAT and other incident response activities, or large-scale evacuations for weather events, including hurricanes and wildfires.
Incidents	Occurrences that are localized, unplanned events, or disturbances and may require authorities to respond. This information generally implies a need for increased awareness by the driver.
Emergency Vehicle Operations	Information about emergency response vehicles that are operating on a roadway are provided to vehicles. The infrastructure can provide advanced warning of approaching response vehicles before the vehicles themselves are in communications range to alert other drivers.

Table 2: Use Case High Level Description – Additional Scenarios

Event	High Level Description
Map Information	Information pertaining to the localization and navigation of an area, including any adjustments to the typical driving pattern. This includes highways, intersections, lane adjustments, road closures and route changes.
Limited Access	Restrictions for vehicles operating in specific roadway areas. This also includes limited access and controlled access roads or lanes such as HOV and tolling lanes.

Event	High Level Description
Data Collection Requests	Vehicles have data that can be useful when aggregated, such as local detection of traffic conditions and environmental responses (wind-shield wipers, traction control activation, temperature, etc.) This data can be aggregated and anonymized in order to provide contextual information to a traffic authority.
Vehicle Enforcement	Enforcement of laws or restrictions on specific vehicles in a particular roadway area. Perform wireless roadside inspections or insurance/registration checks for vehicles.
Driver Safety/Assistance/Support	Vehicles that have to stop along a roadway can rapidly and accurately provide information regarding a loss of safety or capability to an authorized authority.
Intersection	Potential vehicle interaction between vehicles and between infrastructure and vehicles at cross-roads and intersections including indications of dilemma zones are communicated to vehicles through a BIM.

2.   USER NEEDS

Deliver information to drivers (and/or vehicles), at a defined time, in a defined location using information such as:

- Text
- Graphics
- Audio
- Vehicle control (potentially)

2.1   Common User Needs

2.1.1   Time information

Vehicles need to know when a single event occurs or starts.

Vehicles need to know when an event is expected to end or in the case of an unplanned event, such as an incident, will end or if the end time is unknown.

Vehicles need to know the type and frequency of a scheduled repeating event like work and school zones.

2.1.2   Region Information

Vehicles need to be provided with relevant event location data.

Vehicles need to know when they are approaching an event.

Vehicles need to know the location and/or geometry of the event itself.

Regions need to support representation along a roadway, either with lane level details or centerline of the roadway in one or both directions of travel.

Regions need to support representation as broad areas which may or may not have an associated direction of applicability.

2.1.3   Content Information

Vehicles need a high-level description of the information in lieu of processing further details.

The message needs flexible frames that can support multiple use cases with similar information.

This content can be used to provide a general notification, such as a weather event, without specifying details. This content allows for backwards compatibility, such as when detailed messages cannot be decoded by an out-of-date receiver.

2.2   Use-case Specific User Needs (BIM Scenarios)

The following section focuses on user needs for scenarios that are considered as possible additions to the BIM. Other identified scenarios that are not immediately applicable to the BIM are in a later section.

2.2.1   Static Signage

The driver needs to receive information about the location and content of nearby signs to help fill gaps in persistent information, address memory and attention of drivers, address information overload, and provide validation of sensor capability or sign accuracy for autonomous vehicles.

Static signage content needs to support signage that is considered common between regions and jurisdictions, such as speed limit signs.

Static signage needs to support mile markers or other agency supported measurement along a roadway.

Static signage needs to support flexible, but not unlimited, descriptions of other signage.

2.2.2   Dynamic Traveler Information

The driver needs to receive information about the location and content of nearby dynamic signs to help lower latency between information and operator awareness and address information overload and memory or attention of drivers.

Dynamic traveler information needs to support representing common DMS messages (i.e., 3-4 lines of text, potentially two phases/pages).

Dynamic traveler information may need to include or link to other content or messages with more detailed or explicit information.

2.2.3   Situational Awareness

The driver needs to receive up to date contextual information about the environment and situations along their route which may affect their navigation of an area, like weather conditions and special events.

The situational awareness information needs to include the ability to reference multiple other data containers, which have information containing overlapping or related content.

2.2.4   Incidents

The driver needs information about the location and timeframe of nearby incidents to help them understand and respond to incidents along their route, such as unplanned events or disturbances.

Incident information needs to include a general description of the incident, such as a collision, debris on the road, HAZMAT related, and others.

Incident information needs to indicate the type of responders involved or anticipated, if any.

Incident information needs to include recommended changes in the applicable speed limit.

2.2.5   Local or Regional Notifications

Drivers should be provided with city or region-wide notification, as well as ongoing or future events.

Examples of broad area notifications include Amber/Silver/Blue Alerts and related, evacuation information, and other public service announcements.

2.2.6   Map Information

The driver needs to be provided with information about the geometry, distances, and roadway network to address awareness of routing or lane changes and provide knowledge for making adjustments to the typical driving pattern, such as road closures.

2.2.7   Limited Access

The driver needs to receive information about the region and timeframe of relevant limited access areas to help drivers understand and allow the access restrictions along their route.

Limited access information may include toll lane information, HOV restrictions, HAZMAT restrictions, and other information which may vary based on vehicle type, occupancy, or registration.

2.2.8   Data Collection Requests

The infrastructure needs to be able to request specific information be provided from vehicles. NOTE: Although originating from the infrastructure, this falls under the Probe Data Collection.

2.2.9   Vehicle Enforcement

Enforcement authorities need to receive information about the vehicles traveling in an area to allow roadside inspections and checks.

Enforcement authorities need to indicate what information needs to be reported.

Authorities need to indicate the location and time at which information is expected to be reported.

2.2.10 Driver Safety/Assistance/Support

The driver needs to be able to request support from the roadway authority.

The roadway authority needs a mechanism of providing more detailed information to the driver with regards to the availability and timeliness of support.

2.2.11 Emergency Vehicle Operations

The driver needs to receive information about the location and nature of nearby or approaching emergency vehicles to help understand and respond to their presence or approach.

The infrastructure operator needs to be able to indicate a planned or anticipated route of the vehicle(s).

The infrastructure operator needs to be able to indicate the type (or types) of response vehicles.

The infrastructure operator needs to be able to indicate the expected time of arrival at the destination and any of the points along the route.

2.2.12 Intersection

The driver needs to receive information about the geometry, status, and potential interactions with other vehicles at roadway intersections to help drivers gain additional insight about intersections along their paths. The vehicles should be alerted regarding potential future interactions and provide intersection

vehicle detection indication. NOTE: this is primarily covered under the Map/SPaT needs and use cases and is not included in detail here.

3.   DATA EXCHANGE AND OPERATIONAL ENVIRONMENT REQUIREMENTS

This section contains requirements associated with the user needs. Some user needs may not be possible to accommodate in every case, for example, if a curve does not have surface condition sensors. In these cases, the requirements are made conditional on the information being available. In other cases, the level detail of available information may vary (e.g., minimum curve radius versus complete road geometry).

3.1   General Needs Requirements

The following requirements apply to all use cases in this document.

3.1.1   Time Information

3.1.2   Start Time

Vehicles need to be provided the start time of an event, like planned maintenance or an incident.

3.1.3   Duration Time

Vehicles need to be provided with the end time of an event. The end time of the event can be provided literally, or calculated from the start time with a provided duration.

3.1.4   Scheduled Repeating Event Information

Information regarding schedules of repeating events and their frequency (e.g., days, weeks, months) should be communicated to the vehicles.

3.1.5   Event Type

Vehicles need to be provided the type of scheduled repeating event (e.g., school zone, work zone).

3.1.6   Region Information

3.1.7   Point

Provide the lat/lon position associated with the information.

3.1.8   Polygon

Communicate area on a map that can be defined by three or more points.

3.1.9   Path

Provide location associated with a particular route or roadway, from a start point to an end point.

3.1.10   Roadway Name

Provide the common name of the roadway.

3.1.11   Heading

If applicable, provide the heading of the information contained in the message. Can be used to filter applicability of the message, as if for all vehicles headed toward (or away from) a defined point (e.g., towards an incident location).

3.2   Use-case Specific Requirements

The following requirements outline the use-case specific requirements of the message.

3.2.1   Static Signage Data Exchange

3.2.2   Speed Limit Information

Broadcast messages shall include static and variable speed limit information.

3.2.3   Roadway Placards

The broadcast message shall include information on roadway placards.

3.2.4   Mile Markers

The broadcast message shall include information on mile markers.

3.2.5   Other Common MUTCD Encoded/Defined Signs and Text

The broadcast message shall include common MUTCD encoded signs.

3.2.6   Locally Defined MUTCD Signs

The broadcast message shall include MUTCD signs that are locally defined.

3.2.7   Guide Sign Information

The broadcast message shall include guide sign information.

3.2.8   Service Sign Information

The broadcast message shall include service sign information, potentially with branded icons.

3.2.9   Combination Sign Information

The broadcast message shall include combination sign information, where multiple MUTCD signs are on the same pole.

3.2.10 Dynamic Traveler Information Data Exchange

3.2.11 Priority

The message shall include the priority of the information in this container.

3.2.12 General Information

The broadcast message shall include the content of DMS variable-message signs.

3.2.13 Public Safety Announcements

The broadcast message shall include public safety announcements.

3.2.14 Congestion Information

The broadcast message shall include congestion information, to include expected and unexpected congestion.

3.2.15 Alerts

The broadcast message shall include amber/silver/blue alerts and associated information.

3.2.16 Map Information Data Exchange

3.2.17 Route Changes

The broadcast message shall include route change and detour information.

3.2.18 Lane Shifts

The broadcast message shall include lane shift information.

3.2.19 MAP Message

The broadcast message shall include MAP message details.

3.2.20 Situational Awareness Data Exchange

3.2.21 Non-fixed Objects/Obstructions

Broadcast information on the presence of bicycle, pedestrian, debris, stalled vehicles, or animals in the roadway.

3.2.22 Route Changes

Message to include possible route/map changes that are a result of the situation.

3.2.23 Wrong Way Drivers

The broadcast message shall include a notification warning of a wrong-way driver in the vicinity. The message shall also warn the wrong way driver of their prohibited movement.

3.2.24 Erratic Drivers

The broadcast message shall include a notification warning of an erratic driver in the vicinity. The message shall warn the erratic driver of their dangerous behavior.

3.2.25 Overheight (oversize) Vehicles

The broadcast message shall include a notification warning approaching vehicles of an oversize vehicle in the vicinity. The message shall warn the oversize vehicle driver of their situation.

3.2.26 Work Zones

3.2.26.1 Construction Vehicles Entering

Message to indicate construction vehicles actively entering/exiting a work zone.

3.2.26.2 Flagman

Message to indicate the presence of a flagman.

3.2.26.3 Beacons

Message to indicate lit beacons, or flashing amber on various signs, to highlight the importance of said sign, or indicate that an accompanying static message is active when these are lit.

3.2.26.4 Reduced Speed

Message to warn of a reduced speed limit in the work zone.

3.2.27 Travel Times

Message to indicate the time in transit to a major intersection or POI via a specific roadway.

3.2.28 Weather Alerts

Weather alerts and other related information shall be communicated to warn of changes in road/driving conditions, such as heavy rain or fog.

3.2.29 Road/Driving Condition

3.2.29.1 Ice

Message to indicate the presence of ice on road.

3.2.29.2 Snow

Message to indicate the presence of snow on road.

3.2.29.3 Standing Water

Message to indicate the presence of standing water on roadway and risk of hydroplaning .

3.2.29.4 Low Visibility (fog, dust, smoke)

Message to indicate a low visibility situation, related to conditions such as fog, dust, or smoke.

3.2.30 Road Closures

3.2.30.1 Temporary

Broadcast message shall indicate temporary road closures due to events such as railroad crossings, flooding, or an event (e.g., parade). Message shall indicate extended road closures, such as for road work.

3.2.31 Railroad Grade Crossing

Message to indicate a railroad grade crossing.

3.2.32 School Zones

Message to indicate school zones. Such zones are planned and repeating but intermittent.

3.2.33 Special Events

Message shall indicate whether a special event is occurring. Message shall indicate the type of special event.

3.2.34 Parking Information

Message shall include relevant parking information.

3.2.35 Contraflow

Message will indicate the presence and arrangement of a contraflow lane or lanes.

3.2.36 Limited Access Data Exchange

3.2.37 HOV lanes

Message will indicate the location, timeframe of any access limitations, and appropriate restrictions of an HOV lane.

3.2.38 AV Lanes

Message will indicate the location, timeframe of any access limitations, and appropriate restrictions of lanes dedicated to autonomous vehicles.

3.2.39 Alternate Flow

Message will indicate the location and timeframe of any access limitations of alternate flow lanes and appropriate restrictions.

3.2.40 Restricted Access

Message will indicate if a roadway has restricted access.

3.2.41 HOT Lanes

Message will indicate the location and timeframe of any access limitations of HOT lanes and appropriate restrictions. May indicate availability to, and any applicable tolls for, non-exempt vehicles.

3.2.42 EZ-Pass or Other Tolling Lanes

Message will indicate the location and timeframe of any access limitations of EZ-Pass or other tolling lanes and appropriate restrictions.

3.2.43 Time of Day Pricing

Message to provide time of day pricing information for a roadway.

3.2.44 HAZMAT Routes

Message will contain information on HAZMAT routes.

3.2.45 Data Collection Requests Data Exchange

3.2.46 Environmental Data

Environmental data messages from vehicles or outside sources may be collected and aggregated to provide contextual information to a traffic authority. Data collection is done on a voluntary basis and only with the consent of the user.

3.2.47 Traffic Data

Traffic data messages from vehicles or outside sources may be collected and aggregated to provide contextual information to a traffic authority. Data collection is done on a voluntary basis and only with the consent of the user.

3.2.48 Incidents Data Exchange

Message will provide actionable information about incidents.

3.2.49 Local or regional

3.2.50 Events

Message will provide information on ongoing or future incidents or events that affect a neighborhood/city/region.

3.2.51 Vehicle Enforcement Data Exchange

3.2.52 Wireless Roadside Inspection

Message will contain vehicle information for wireless roadside inspections/screening for vehicles. Users opt in to transmit these messages as they see fit, as a matter of convenience. Criminal enforcement is not an application of the BIM.

3.2.53 Insurance/Registration/Etc.

Message will contain vehicle information for wireless roadside insurance/registration checks for vehicles. Users opt in to transmit these messages as they see fit, as a matter of convenience. Criminal enforcement is not an application of the BIM.

3.2.54 Driver Safety/Assistance/Support Data Exchange

3.2.55 Mayday

Message will have mayday request and response information to be used by disabled or stranded vehicles and remote incidents.

3.2.56 Emergency Vehicle Operations Data Exchange

3.2.57 Advanced Warning of Emergency Response Vehicles

3.2.57.1 Driver Approaching Response Vehicles

Message will alert drivers of emergency vehicles at a scene along their path.

3.2.57.2 Response Vehicles Approaching an Area

Message will alert drivers of emergency vehicles en-route along their path.

3.2.58 Intersection Data Exchange

3.2.59 Notification for Vehicle Detection at Signalized Intersections

Message will provide vehicle detection at intersection and assist with signal timing optimization.

3.2.60 Dilemma Zone Advisory

Message will provide dilemma zone advisory and assist with collision avoidance, warnings, and provide intersection movement assist.

4.   OBJECT DEFINITIONS

A basic information message (BIM) is defined in this section to satisfy the requirements defined in Section 3. As described above, the BIM consists of a common container and a context container. In this section, the common container and twelve application containers are defined. An application container is specified for each special case in Section **3.2**.

Common container elements are listed alongside the use-case specific containers in Table 3, and the corresponding ASN.1 representation is provided in Sections 4.1.1 through 4.2.57 and UPER encoding is used to encode the ASN.1. Whenever possible, existing SAE J2735 data structures are used; however, some of the items require new data structures.

Table 3 – Common and Use-case Specific Container Overviews

Information Data Frame	Type	Specific Type	Standard	Description
CommonContainer	**Message**	**Message**	**BIM**	**Contains all common elements**
msgCnt	MsgCount	Integer	SAE J2735	The MsgCount data element is used to provide a sequence number within a stream of messages with the same DSRCmsgID and from the same sender.
startTime	MinuteOfTheYear	Integer	SAE J2735	The MinuteOfTheYear data element expresses the number of elapsed minutes of the current year in the time system being used (typically UTC time).
durationTime	MinutesDuration	Integer	SAE J2735	Can figure end time from duration.
path	OffsetSystem	Object	SAE J2735	Lat/Long offsets with lane width.
geometry	GeometricProjection	Object	SAE J2735	Circle (point and radius).
id	IntersectionReferenceID	Object	SAE J2735	Reference object for a map.
regionPointSet	Polygon/RegionPointSet	Object	SAE J2735	Ordered set of closed convex points.
StaticSignage	**Message**	**Message**		**(compare to TravelerDataFrame)**
timestamp	MinuteOfTheYear	Integer	SAE J2735	The MinuteOfTheYear data element expresses the number of elapsed minutes of the current year in the time system being used (typically UTC time).
position	Position3D	Object		
		Latitude	SAE J2735	
		Longitude	SAE J2735	
		Elevation	SAE J2735	
		Sequence of RegionalExtension	SAE J2735	Optional
content	CHOICE	Object	SAE J2735	Possibly also use EnabledLaneList and RevocableLane.

Information Data Frame	Type	Specific Type	Standard	Description
CommonContainer	**Message**	**Message**	**BIM**	**Contains all common elements**
		item CHOICE { itis ITIS.ITIScodes,	SAE J2735	This element describes a category and an item from that category all ITS standards use the same types here to explain the type of the alert / danger / hazard involved.
		text ITIStextPhrase		provide message/information.
Dynamic Traveler Information				
dynamicContent	Choice	Object		Message specific details.
Map Information				
mapContent	Choice	Object		Map Context (construction, typical, etc.) Message specific details.
Situational Awareness				
situationalAwarenessContent	Choice	Object		Message specific details.
Limited Access				
limitedAccessContent	Choice	Object		Message specific details.
Data Collection Request				
id	dataCollectionID	Integer	SAE J2735	-- the unique value .
packet	dataCollectionPacket	Object		
Incidents				
incidentContext	Choice	Object		Message specific details.
Vehicle Enforcement				
id	vehicleEnforcementID	Integer	SAE J2735	-- the unique value.
packet	vehicleEnforcementPacket	Object		
Driver Support				
startTime	MinuteOfTheYear	Integer	SAE J2735	The MinuteOfTheYear data element expresses the number of elapsed minutes of the current year in the time system being used (typically UTC time).
position	Position3D	Object	SAE J2735	
driverSupportContext	DriverSupportContext	Object		

Information Data Frame	Type	Specific Type	Standard	Description
CommonContainer	**Message**	**Message**	**BIM**	**Contains all common elements**
Emergency Vehicle Operations				
emergencyVehicleContext	Choice	Object		Message specific details.
Intersection				
id	IntersectionReferenceID	Object	SAE J2735	Reference object for a map.
intersectionContext	IntersectionContext	Object		Railroad Crossings (Not provided for in standard), School Crossings, etc.

Table 4 – Static Signage Container Overview

Data Frame	Type	Specific Type	Standard	Description
speedLimit	RegulatorySpeedLimit	Object	SAE J2735	Speed limit type and value.
mileMarker	Real	Real	BIM	Mile marker value.
Placard	Placard	Object	BIM	Placards describing HAZMAT, NFPA Fire Diamond, and others.
itisGenericSign	GenericSignage	Object	SAE J2735	ITIS codes describing generic signage.
mutcdCode	MUTCDCode	Object	SAE J2735	MUTCD codes describing a specific sign.
mutcdSignDesignation	IA5 String	String	n/a (asn.1 primitive)	MUTCD sign designation.

Table 5 – Dynamic Traveler Information Container Overview

Data Frame	Type	Specific Type	Standard	Description
priority	Enumerated	Enumeration	BIM	Priority of the information message.
typeOfInfo	TypeOfDynamicInfo	Enumeration	BIM	Type of information being provided.
dmsSignString	IA5 String	String	n/a (asn.1 primitive)	DMS sign content represented as string.
congestionInfo	CongestionInfo	Object	BIM	Roadway congestion and lane queue information.
situationalContainer	SituationalContainer	Object	BIM	Reference to situational awareness container.

Data Frame	Type	Specific Type	Standard	Description
incidentsContainer	IncidentsContainer	Object	BIM	Reference to incidents container.

Table 6 – Situational Awareness Container Overview

Data Frame	Type	Specific Type	Standard	Description
wwd	WWD	Object	BIM	Sequence of observed points and relevant information of wrong way driver.
obstructions	Obstructions	Object	BIM	Information regarding obstructions, debris, and objects on roadway.
overheightVehicle	OverheightVehicle	Object	BIM	Notification for overheight vehicle.
workZone	WorkZone	Object	BIM	Relevant work zone information .
travelTime	TravelTime	Object	BIM	Time and distance for travel between two points along roadway.
weatherAlerts	WeatherAlerts	Object	BIM	Weather-related alerts informing of potentially adverse driving conditions.
roadConditions	RoadConditions	Object	BIM	Generic alerts informing of potentially adverse driving conditions.
roadClosure	RoadClosure	Object	BIM	Road closure information.
railCrossing	RailCrossing	Object	BIM	Grade rail crossing and approaching train information and warning.
schoolZone	SchoolZone	Object	BIM	School zone information.
specialEvents	SpecialEvents	Object	BIM	Special event information.
parkingInfo	ParkingInfo	Object	BIM	Parking availability and pricing information.
contraflow	Contraflow	Object	BIM	Roadway where traffic has been temporarily altered to flow in opposite direction.

Table 7 – Limited Access Container Overview

Data Frame	Type	Specific Type	Standard	Description
hovLanes	HOVLanes	Object	BIM	Information and restrictions for high-occupancy vehicle lanes.
avLanes	AVLanes	Object	BIM	Information and restrictions for lanes reserved for autonomous vehicles.
alternateFlow	AlternateFlow	Object	BIM	Roadway where traffic flow has been temporarily altered.
restrictedAccess	RestrictedAccess	Object	BIM	Roadway where access is restricted.

Data Frame	Type	Specific Type	Standard	Description
hotLanes	HOTLanes	Object	BIM	Information and restrictions for high-occupancy toll lanes.
tollLanes	TollLanes	Object	BIM	Information and restrictions for toll vehicle lanes.
timeOfDayPricing	TimeOfDayPricing	Object	BIM	Information and restrictions for charges and pricing issued at a certain time of day.
hazmatRoutes	HAZMATRoutes	Object	BIM	Information providing for HAZMAT routes.

Table 8 – Incidents Container Overview

Data Frame	Type	Specific Type	Standard	Description
description	ITIScodes	Object	SAE J2540	Description of incidents with ITIS codes.
responderType	ResponderGroupAffected	Sequence/Object	SAE J2540	Informs of types of responders acting to an incident.
affectedLanes	RoadSegmentList	Object	SAE J2735	Describes the lanes affected by the incident.
advisorySpeed	AdvisorySpeed	Object	SAE J2735	Advisory speed through affected area.
congestionInfo	CongestionInfo	Object	BIM	Reference to congestion information container describing congestion information through affected area.

Table 9 – Emergency Vehicle Operations Container Overview

Data Frame	Type	Specific Type	Standard	Description
notification	ITIScodes	Sequence/Object	J2540	ITIS code notifications of emergency vehicle operation.
description	EventDescription	Object	J2735	Description of event for emergency vehicle operation.

Data Frame	Type	Specific Type	Standard	Description
emergencyDetails	EmergencyDetails	Object	J2735	Details of and reason for emergency vehicle operation.
destination	RegionInfoContainer	Object	BIM	Destination of emergency vehicle(s).

4.1   Messages

There is one message defined in this document. This is anticipated to be added to the list of top level messages currently defined in SAE J2735.

4.1.1   Message: MSG_BasicInfrastructureMessage

Use: The I2V Basic Infrastructure Message (BIM) provides a message format that enables the transmission of all required data elements for I2V Safety Applications in a single message. The message format is extensible to support other event based applications for both I2V and V2V in the future. A container concept is used. The common container is always present in the BIM. The application containers described in this version of the standard are optional, and additional containers may be defined in future versions of the standard.

ASN.1 Representation:

```
BasicInfrastructureMessage  ::= SEQUENCE {
    commonContainer               CommonContainer,
    staticSignageContainer        StaticSignageContainer OPTIONAL,
    situationalContainer          SituationalContainer OPTIONAL,
    dynamicInfoContainer          DynamicInfoContainer OPTIONAL,
    limitedAccessContainer        LimitedAccessContainer OPTIONAL,
    incidentsContainer            IncidentsContainer OPTIONAL,
    emergencyVehicleContainer     EmergencyVehicleContainer OPTIONAL,
    -- mapInfoContainer           MapInfoContainer OPTIONAL,
    -- dataCollectionContainer    DataCollectionContainer OPTIONAL,
    -- localNotificationsContainer LocalNotificationsContainer OPTIONAL,
    -- enforcementContainer       EnforcementContainer OPTIONAL,
    -- driverSafetyContainer      DriverSafetyContainer OPTIONAL,
    -- intersectionContainer      IntersectionContainer OPTIONAL,
       ...
}
```

4.2   Data Frames

This section defines the proposed structure of data frames utilized by the BasicInfrastructureMessage. Data frames are components of a higher level message or frame and contain one or more individual elements.

4.2.1   Data frame: DF_CommonContainer
Use: The BIM includes a mandatory common container which contains generic information about the event or situation that is being described.

ASN.1 representation:

```
CommonContainer            ::= SEQUENCE {
    timeInfo                    TimeInfoContainer,
    regionInfo                  RegionInfoContainer,
    ...
}
```

Used by: DF_CommonContainer is a mandatory data frame used in <u>Message: MSG_BasicInformationMessage</u>.

4.2.2   Data frame: DF_StaticSignageContainer
Use: The Static Signage container is an optional container for use-case specific applications. This container should be used when including information about static signage such as guide signs, speed limits, mile markers, and other guide and regulatory signage.

ASN.1 representation:

```
StaticSignageContainer     ::= SEQUENCE {
      speedLimit                 DSRC.RegulatorySpeedLimit OPTIONAL,
      mileMarker                 REAL OPTIONAL,
      placard                    Placard OPTIONAL,
      itisGenericSign            DSRC.GenericSignage OPTIONAL,
      mutcdCode                  DSRC.MUTCDCode OPTIONAL,
      mutcdSignDesignation       IA5String(SIZE(1..120))  OPTIONAL,--Alphanumeric  MUTCD  sign
designation
      ...
}
```

Used by: DF_StaticSignageContainer is an optional data frame used in <u>Message: MSG_BasicInformationMessage</u>.

4.2.3   Data frame: DF_DynamicInfoContainer
Use: The Dynamic Traveler Information container is an optional container for use-case specific applications. This container should be used when including dynamic information, such as congestion information and the content of DMS sings.

ASN.1 representation:

```
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,
      situationalContainer     SituationalContainer OPTIONAL, --for work zone, travel time,
etc... info
      incidentsContainer       IncidentsContainer OPTIONAL, --for incidents info
      ...
}
```

Used by: DF_DynamicInfoContainer is an optional data frame used in <u>Message: MSG_BasicInformationMessage</u>.

4.2.4   Data frame: DF_MapInfoContainer - TBD
Use: The Map Information container is an optional container for use-case specific applications.

ASN.1 representation: - TBD

Used by: DF_MapInfoContainer is an optional data frame used in <u>Message: MSG_BasicInformationMessage</u>.

4.2.5   Data frame: DF_SituationalContainer

Use: The Situational Awareness container is an optional container for use-case specific applications. This container should be used when broadcasting a wide array of situational information, to include alerts for and information about wrong way drivers, information about road and school zones, road and weather conditions, and travel times.

ASN.1 representation:

```
SituationalContainer            ::= CHOICE {
     wwd                        WWD,
     obstructions               Obstructions,
     overheightVehicle          OverheightVehicle,
     workZone                   WorkZone, --consider changing name as 'WorkZone' exists in
J2735?
     travelTime                 TravelTime,
     weatherAlerts              WeatherAlerts,
     roadConditions             RoadConditions,
     roadClosure                RoadClosure,
     railCrossing               RailCrossing,
     schoolZone                 SchoolZone,
     specialEvents              SpecialEvents,
     parkingInfo                ParkingInfo,
     contraflow                 Contraflow,
     ...
}
```

Used by: DF_SituationalContainer is an optional data frame used in Message: MSG_BasicInformationMessage.

4.2.6   Data frame: DF_LimitedAccessContainer

Use: The Limited Access container is an optional container for use-case specific applications. This container should be used to communicate information about special access lanes and roadways, such as HOV and toll lanes.

ASN.1 representation:

```
LimitedAccessContainer     ::= CHOICE {
     hovLanes                   HOVLanes,
     avLanes                    AVLanes,
     alternateFlow              AlternateFlow,
     restrictedAccess           RestrictedAccess,
     hotLanes                   HOTLanes,
     tollLanes                  TollLanes,
     timeOfDayPricing           TimeOfDayPricing,
     hazmatRoutes               HAZMATRoutes
}
```

Used by: DF_LimitedAccessContainer is an optional data frame used in Message: MSG_BasicInformationMessage.

4.2.7   Data frame: DF_DataCollectionContainer - TBD

Use: The Data Collection Requests container is an optional container for use-case specific applications.

ASN.1 representation: - TBD

Used by: DF_DataCollectionContainer is an optional data frame used in Message: MSG_BasicInformationMessage.

4.2.8   Data frame: DF_IncidentsContainer

Use: The Incidents container is an optional container for use-case specific applications. This container should be used when including information about incidents such as auto accidents.

ASN.1 representation:

```
  IncidentsContainer            ::= SEQUENCE {
description                     ITIS.ITIScodes(513..531), -- J2540 DE_AccidentsAndIncidents
      responderType            SEQUENCE  (SIZE(1..5))  OF  ITIS.ResponderGroupAffected
OPTIONAL,
      affectedLanes            DSRC.RoadSegmentList OPTIONAL,
      advisorySpeed            DSRC.AdvisorySpeed OPTIONAL,
      congestionInfo           CongestionInfo OPTIONAL,
      ...
  }
```

Used by: DF_IncidentsContainer is an optional data frame used in Message: MSG_BasicInformationMessage.

4.2.9   Data frame: DF_LocalNotificationsContainer - TBD

Use: The Local and Regional Notifications container is an optional container for use-case specific applications.

ASN.1 representation: - TBD

Used by: DF_LocalNotificationsContainer is an optional data frame used in Message: MSG_BasicInformationMessage.

4.2.10 Data frame: DF_EnforcementContainer - TBD

Use: The Vehicle Enforcement container is an optional container for use-case specific applications.

ASN.1 representation: - TBD

Used by: DF_EnforcementContainer is an optional data frame used in Message: MSG_BasicInformationMessage.

4.2.11 Data frame: DF_DriverSafetyContainer - TBD

Use: The Driver Safety container is an optional container for use-case specific applications.

ASN.1 representation: - TBD

Used by: DF_DriverSafetyContainer is an optional data frame used in Message: MSG_BasicInformationMessage.

4.2.12 Data frame: DF_EmergencyVehicleContainer

Use: The Emergency Vehicle Operations container is an optional container for use-case specific applications. This container should be used when the infrastructure operators have knowledge of the anticipated route and/or destination of response vehicles that can be shared with other roadway users prior to the responses vehicles reaching a location.

ASN.1 representation:

```
  EmergencyVehicleContainer ::= SEQUENCE {
      notification             SEQUENCE  (SIZE(1..10))  OF  ITIS.ITIScodes(7425..7453),  --
J2540 DE_AdviceInstructionsMandatory
      description              DSRC.EventDescription,
      emergencyDetails         DSRC.EmergencyDetails,
      --eva                    DSRC.EmergencyVehicleAlert,
      destination              RegionInfoContainer OPTIONAL,
      ...
  }
```

Used by: DF_EmergencyVehicleContainer is an optional data frame used in Message: MSG_BasicInformationMessage.

4.2.13 Data frame: DF_IntersectionContainer

Use: The Intersection container is an optional container for use-case specific applications. The desired information for the intersection container overlaps with existing use cases related to Map, SPaT, prioritization, and pre-emption applications and will likely be addressed elsewhere.

ASN.1 representation: - TBD

Used by: DF_IntersectionContainer is an optional data frame used in Message: MSG_BasicInformationMessage.

4.2.14 Data frame: DF_AlternateFlow

Use: The AlternateFlow container is an optional container for use-case specific applications. This container should be used when communicating lane information with alternate flow.

ASN.1 representation:

```
AlternateFlow                     ::= SEQUENCE {
      laneInformation             DSRC.RoadSegmentList OPTIONAL,
      --indication of direction of flow?
      ...
}
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_LimitedAccessContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.15 Data frame: DF_AVLanes

Use: The AVLanes container is an optional mandatory container for use-case specific applications. This container should be used when indicating lanes reserved exclusively for autonomous vehicles.

ASN.1 representation:

```
AVLanes                           ::= SEQUENCE {
      specialLaneInfo             SpecialLaneInfo,
      ...
}
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_LimitedAccessContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.16 Data frame: DF_CongestionInfo

Use: The CongestionInfo container is an optional container for use-case specific applications. This container should be used when communicating congestion information. When including information for a whole roadway, a single instance of this data frame is needed. When communicating lane-level information, all fields apply only to the associated lane.

ASN.1 representation:

```
CongestionInfo                    ::= SEQUENCE {
      queueAheadWarning           BOOLEAN, --Set to True to warn of a queue on the roadway ahead
      associatedLane              DSRC.RoadSegment OPTIONAL, --single roadsegment with which
queue info is associated; omit if defining for all lanes
      startOfQueue                RegionInfoContainer, --Specific location defining the start
of the queue
      lengthOfQueue               DSRC.ObstacleDistance OPTIONAL, —Length of the queue from the
start of the queue to the end
      speedLimit                  DSRC.RegulatorySpeedLimit OPTIONAL, --Speed limit of the lane
or roadway
      averageVehicleSpeed         DSRC.Velocity OPTIONAL, --Actual speed of vehicles in lane or
roadway
      normalConditions            BOOLEAN OPTIONAL, --Set to True if formation of queue is
normal; Set to False if queue presence is abnormal, such as a result of an incident or event
```

```
        unexpectedConditionDesc         IA5String(SIZE(1..100))  OPTIONAL,  --Text  description  of
unexpected event
        ...
    }
```

Used By: This entry is used directly by two other data structures in this standard, DFs called Data frame: DF_DynamicInfoContainer and Data frame: DF_IncidentsContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.17 Data frame: DF_ContraFlow - TBD
Use: The ContraFlow container is an optional container for use-case specific applications. This container should be used to communicate contraflow information.

ASN.1 representation: - TBD

```
  Contraflow                         ::= SEQUENCE {
  --Does not exist in J2735
    ...
  }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SituationalContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.18 Data frame: DF_FlatRateParking
Use: The FlatRateParking container is an optional container for use-case specific applications. This container describes parking where a single price is active at or between certain times of day or is different on different days. It should be used to describe pricing information of the associated parking location at a specific time and/or date, or as an active repeating event, where the pricing is applicable on certain days or at specific times.

ASN.1 representation:

```
  FlatRateParking                    ::= SEQUENCE {
        price                        REAL (0.00 .. 9999.00), --price in dollars or other standard
monetary unit
        activeSlot                   RepeatingFrequency, --Time, days, or dates on which this
pricing is in effect
        ...
  }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_ParkingInfo. In addition, this item may be used by data structures in other ITS standards.

4.2.19 Data frame: DF_HAZMATHeader
Use: The HAZMATHeader container is a mandatory container for use-case specific applications. This container should be used in conjunction with other HAZMAT fields for describing a HAZMAT placard.

ASN.1 representation:

```
  HAZMATHeader                       ::= ENUMERATED {
        custom                         (0),
        oxygen                         (1),
        flammablegas                   (3),
        nonflammablegas                (4),
        toxicgas                       (5),
        inhalationhazard               (6),
        fueloil                        (7),
        flammable                      (8),
        combustible                    (9),
        gasoline                       (10),
        flammablesolid                 (11),
        spontaneouslycombustible       (12),
        dangerouswhenwet               (13),
        oxidizer                       (14),
```

```
      organicperoxide                    (15),
      toxic                              (16),
      poison                             (17),
      radioactive                        (18),
      corrosive                          (19),
      miscdangerousgoods                 (20),
      dangerousmixedloads                (21),
      explosives                         (22),
      ...
   }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_HAZMATPlacards. In addition, this item may be used by data structures in other ITS standards.

4.2.20 Data frame: DF_HAZMATPlacards
Use: The HAZMATPlacards container is an optional container for use-case specific applications. This container should be used for describing HAZMAT placards.

ASN.1 representation:

```
  HAZMATPlacards                    ::= SEQUENCE {
      header                        HAZMATHeader,  --Standard  HAZMAT  header  that  describes
hazardous material
      class                         INTEGER (1..9), --HAZMAT hazard class
      unNumber                      INTEGER (1..9999) --Standardized  4-digit  number  of  HAZMAT
material
   }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_Placard. In addition, this item may be used by data structures in other ITS standards.

4.2.21 Data frame: DF_HAZMATRoutes - TBD
Use: The HAZMATRoutes container is an optional container for use-case specific applications. This information should likely be integrated into a future revision of the Map message.

ASN.1 representation: - TBD

```
  HAZMATRoutes                      ::= SEQUENCE {
      --MAP info?
      ...
   }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_LimitedAccessContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.22 Data frame: DF_HOTLanes
Use: The HOTLanes container is an optional container for use-case specific applications. This container should be used to describe specific information about HOT (high-occupancy toll) road information, including location, pricing, and restrictions.

ASN.1 representation:

```
  HOTLanes                    ::= SEQUENCE {
      specialLaneInfo             SpecialLaneInfo,
      ...
   }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_LimitedAccessContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.23 Data frame: DF_HourlyParking

Use: The HourlyParking container is an optional container for use-case specific applications. This container should be used to describe pricing information that is dictated by durations rather than day or time of day and where the durations have different rates, and the time when such pricing is in effect.

ASN.1 representation:

```
  HourlyParking                    ::= SEQUENCE {
        hourlyRate                 SEQUENCE (SIZE(1..100)) OF HourlyRate, --A set of durations,
with prices defined for each specific duration length
        activeSlot                 RepeatingFrequency, --Time of day or days of week when parking
is open
        ...
  }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_ParkingInfo. In addition, this item may be used by data structures in other ITS standards.

4.2.24 Data frame: DF_HourlyRate

Use: The HourlyRate container is an optional container for use-case specific applications. This container should be used to describe pricing information for an hourly rate that is dictated by durations rather than day or time of day, and the price that is active for that particular duration. Each sequence should contain non-overlapping DurationBegin and DurationEnd values.

ASN.1 representation:

```
  HourlyRate                       ::= SEQUENCE {
        parkingDurationBegin       DSRC.MinutesDuration,  --Duration value from which associated
pricing begins
        parkingDurationEnd         DSRC.MinutesDuration,  --Duration value for which associated
pricing ends. Example: HourlyRate[1] {parkingDurationBegin 0, parkingDurationEnd 29, price 2.00},
HourlyRate[2] {parkingDurationBegin 30, parkingDurationEnd 59, price 3.00}
        price                      REAL (0.00 .. 9999.00), --price in dollars or other standard
monetary unit for parking associated with the duration
        ...
  }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_HourlyParking. In addition, this item may be used by data structures in other ITS standards.

4.2.25 Data frame: DF_HOVLanes

Use: The HOVLanes container is an optional container for use-case specific applications. This container should be used when to describe specific information about HOV (high occupancy vehicle) road information, including location and restrictions.

ASN.1 representation:

```
  HOVLanes                         ::= SEQUENCE {
        specialLaneInfo            SpecialLaneInfo,
        ...
  }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_LimitedAccessContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.26 Data frame: DF_IceConditions

Use: The IceConditions container is an optional container for use-case specific applications. This container should be used to describe weather and road conditions related to ice.

ASN.1 representation:

```
  IceConditions                    ::= SEQUENCE {
```

```
        iceDescription            ITIS.ITIScodes(5906..5930)    OPTIONAL,    --    J2540
DE_PavementConditions
        winterIndex               ITIS.ITIScodes(6401..6406)    OPTIONAL,    --    J2540
DE_WinterDrivingIndex
        winterRestrictions        ITIS.ITIScodes(6145..6156)    OPTIONAL,    --    J2540
DE_WinterDrivingRestrictions
        ...
    }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_RoadConditions. In addition, this item may be used by data structures in other ITS standards.

4.2.27 Data frame: DF_ManyDayOfWeek

Use: The ManyDayOfWeek container is an optional container for use-case specific applications. This container describes an array of time and day of week, or dates, when a particular repeating event is active.

ASN.1 representation:

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

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_RepeatingEventActiveSlot. In addition, this item may be used by data structures in other ITS standards.

4.2.28 Data frame: DF_NFPAFireDiamond

Use: The NFPAFireDiamond container is an optional mandatory container for use-case specific applications. This container describes the NFPA Fire Diamond, specifically the NFPA 704 standard that designates a risk level and degree of hazard to a particular quality (i.e., flammability, health, chemical reactivity, and special hazards).

ASN.1 representation:

```
  NFPAFireDiamond                 ::= SEQUENCE {
        red-flammability          INTEGER (0..4), -- Risk level assigned to the flammability
field
        blue-health               INTEGER (0..4), -- Risk level addigned to the health hazard
field
        yellow-chemical           INTEGER (0..4), -- Risk level assigned to the chemical and
instability field
        white-specialcode         IA5String(SIZE(0..4)) -- Specific hazard code
  }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_Placard. In addition, this item may be used by data structures in other ITS standards.

4.2.29 Data frame: DF_Obstructions

Use: The Obstructions container is an optional container for use-case specific applications. This container should be used when communicating obstruction and obstacle information, their description, and location.

ASN.1 representation:

```
  Obstructions                    ::= SEQUENCE {
        detection                 DSRC.ObstacleDetection,  --  Obstacle  distance,  direction,
location details
        roadSegmentID             DSRC.RoadSegmentReferenceID,  --  Segment  ID  referencing
location of object
        description               ITIS.ITIScodes(1282..1319)    OPTIONAL,    --    J2540
DE_Obstructions; ITIS description
        location                  ITIS.ITIScodes(7937..8030)    OPTIONAL,    --    J2540
DE_GenericLocations ITIS location
        affectedLanes             DSRC.RoadSegmentList OPTIONAL,   --  Lanes  affected  by
obstruction
        reducedspeed              DSRC.AdvisorySpeed OPTIONAL, -- Advised reduced speed
```

```
        affectedvehicles               DSRC.DisabledVehicle OPTIONAL, -- ITIS codes for locations
and statuses of disabled vehicles
        --How to proceed,              ITIS    J2540    AdviceInstructionsMandatory      and
AdviceInstructionsRecommendations OPTIONAL
        ...
    }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SituationalContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.30 Data frame: DF_OverheightVehicle
Use: The OverheightVehicle container is an optional container for use-case specific applications. This container should be used when a vehicle height exceeds a clearance height, and includes the location of such violation.

ASN.1 representation:
```
  OverheightVehicle                 ::= SEQUENCE {
        roadSegmentID                 DSRC.RoadSegmentReferenceID,-- Location of structure by road
segment reference ID
        point                         DSRC.Position3D, -- Lat/lon coordinates of structure
        intersection                  DSRC.IntersectionReferenceID  OPTIONAL,   --   Location   of
structure by intersection ID
        vehicleHeight                 DSRC.VehicleHeight, -- Height of the vehicle exceeding the
clearance; Limited Range, consider expanding
        clearanceHeight               DSRC.VehicleHeight,  --Height/clearance  of  the  strucute;
Limited Range
        heightViolation               ENUMERATED {not-in-violation (0), in-violation (1), less-
than-15-cm   (2), unknown (3)}, -- Approximate severity of violation, whether definitive or
within a margin
        ...
    }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SituationalContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.31 Data frame: DF_ParkingInfo
Use: The ParkingInfo container is an optional container for use-case specific applications. This container should be used when communicating parking information for an area, including the operating hours, availability, and pricing information.

ASN.1 representation:
```
  ParkingInfo                       ::= SEQUENCE {
        parkingOperatingHours         RepeatingFrequency, -- Hours during which the parking area is
open and operating
        parkingInformation            SEQUENCE (SIZE(1..10))  OF  ITIS.ITIScodes(4097..4223),  --
Parking information; J2540 DE_ParkingInformation
        availableSpaces               INTEGER (0..9999) OPTIONAL, -- Number of available spaces in
the parking area; use parkingInformation descriptive ITIS codes if this exact number unknown
        prohibitedVehicles            ProhibitedVehicles  OPTIONAL,  --  Vehicles  prohibited  from
using the parking area, by type, mass, or height
        hourlyParking                 SEQUENCE (SIZE(1..100)) OF HourlyParking OPTIONAL, -- Parking
where pricing is dictated by hourly rates, where the durations have different rates
        flatRateParking               SEQUENCE  (SIZE(1..100))  OF  FlatRateParking  OPTIONAL,  --
Parking where a single price is active at or between certain times of day or is different on
different days.
        lostTicketRate                REAL (0.00 .. 9999.00) OPTIONAL, --price in dollars or other
standard monetary unit
        onStreetParkingLaneInfo       DSRC.RoadSegmentList OPTIONAL,
    ...
    }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SituationalContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.32 Data frame: DF_Path

Use: The Path container is an optional container for use-case specific applications. This container should be used when describing a path as a collection of consecutive coordinate points.

ASN.1 representation:

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

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_RegionInfoContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.33 Data frame: DF_Placard

Use: The Placard container is an optional container for use-case specific applications. This container should be used when describing placards, to include HAZMAT and NFPA Fire Diamond placards.

ASN.1 representation:

```
  Placard                           ::= SEQUENCE {
        phrases                     IA5String(SIZE(1..100)) OPTIONAL, -- Any phrases that cannot
be otherwise encoded
        hazmatPlacards              HAZMATPlacards OPTIONAL, -- HAZMAT placards and descriptions
        nfpaFireDiamond             NFPAFireDiamond  OPTIONAL,  --  NFPA  Fire  Diamond  placard
description
        disabledParking             BOOLEAN  OPTIONAL,  --  True  when  disabled  parking  placard
applies
        wideload                    BOOLEAN OPTIONAL, -- True when wide load placard applies
        ...
  }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_StaticSignageContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.34 Data frame: DF_ProhibitedVehicles

Use: The ProhibitedVehicles container is a mandatory, though in some uses optional, container for use-case specific applications. This container should be used when describing what vehicles are prohibited or restricted, whether by their type or mass.

ASN.1 representation:

```
  ProhibitedVehicles          ::= SEQUENCE {
        prohibitedVehicleTypes      SEQUENCE    (SIZE(1..50))    OF    ITIS.ITIScodes(9217..9261)
OPTIONAL, -- Vehicles prohibited by type; J2540 DE_VehicleGroupsAffected
        prohibitedVehicleMass       DSRC.VehicleMass OPTIONAL, -- Mass value above which vehicles
prohibited
        vehicleMassLimitNotApply    SEQUENCE    (SIZE(1..50))    OF    ITIS.ITIScodes(9217..9261)
OPTIONAL, -- J2540 DE_VehicleGroupsAffected; vehicles not subject to weight limit, e.g. recreational
vehicles
        ...
  }
```

Used By: This entry is used directly by three other data structures in this standard, DFs called Data frame: DF_ParkingInfo, Data frame: DF_RestrictedAccess, and Data frame: DF_SpecialLaneInfo. In addition, this item may be used by data structures in other ITS standards.

4.2.35 Data frame: DF_Polygon

Use: The Polygon container is an optional container for use-case specific applications. This container should be used to describe an area of relevance enclosed by a collection of points, where the last point joins the first point to create a complete two-dimensional plane.

ASN.1 representation:

```
  Polygon                           ::= SEQUENCE (SIZE(3..50)) OF DSRC.Position3D
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_RegionInfoContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.36 Data frame: DF_RailCrossing

Use: The RailCrossing container is an optional container for use-case specific applications. This container should be used to communicate information about grade rail crossings and approaching trains.

ASN.1 representation:

```
RailCrossing                       ::= SEQUENCE {
      crossingSignalOn             BOOLEAN OPTIONAL, -- True when train crossing signal is on
      crossingGateDown             BOOLEAN OPTIONAL, -- True when train crossing gate is down
      approachingTrain             BOOLEAN  OPTIONAL,  --  True  when  train  is  approaching
intersection
      trainCrossingInProgress      BOOLEAN,  --  True  when  train  is  currently  crossing
intersection
      durationTime                 DSRC.MinutesDuration  OPTIONAL,  --Estimated  duration  of
crossing
      durationDescription          ITIS.ITIScodes(1537..1543)      OPTIONAL,      --      J2540
DE_DelayStatusCancellation
      ...
}
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SituationalContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.37 Data frame: DF_RegionInfoContainer

Use: The RegionInfoContainer container is a mandatory, though in some uses optional, container for use-case specific applications. This container should be used when describing location or region information, whether as a point, a set of points, an area enclosed by a set of points, or by a common name.

ASN.1 representation:

```
RegionInfoContainer                ::= SEQUENCE {
      point                        DSRC.Position3D, --Lat/Lon in 1/10th integer microdegrees;
Elevation in units of 10cm;
      polygon                      Polygon OPTIONAL,
      roadwayName                  VisibleString OPTIONAL,
      path                         Path OPTIONAL,
      heading                   DSRC.Heading OPTIONAL, --Where the LSB is units of 0.0125 degrees
      -- +Circle?
      -- +RegionID/DestinationID/MapID?
      -- +RoadSegmentID?
      -- +Moving - Variable region?
      ...
}
```

Used By: This entry is used directly by five other data structures in this standard, DFs called Data frame: DF_CommonContainer, Data frame: DF_EmergencyVehicleContainer, Data frame: DF_CongestionInfo, Data frame: DF_TravelTime, and Data frame: DF_WWDSequence. In addition, this item may be used by data structures in other ITS standards.

4.2.38 Data frame: DF_RepeatingEventActiveSlot

Use: The RepeatingEventActiveSlot container is a mandatory container for use-case specific applications. This container describes the time, day of week, or date when an event is active. Specifically, a single frame describes one such time interval. To be used in a sequence to describe events that occur at multiple time intervals or at different times on different days or dates. Can be used to describe a specific date when an event takes place or more broadly for weekly/monthly/yearly events.

ASN.1 representation:

```
RepeatingEventActiveSlot            ::= SEQUENCE {
       startTime                    DSRC.DTime OPTIONAL, --start time of the event
       endTime                      DSRC.DTime OPTIONAL, --end time of the event
       dayOfWeek                    ManyDayOfWeek OPTIONAL, --use if event occurs on specific
days of the week
       yearmonthday                 DSRC.DDate OPTIONAL, --use if event applies to specific date
       monthday                     DSRC.DYearMonth OPTIONAL, --use if event falls on a specific
date within a year; implies event is yearly
       day                          DSRC.DDay OPTIONAL, --day on which event occurs, implies
occurrence of once per month on same date
       ...
}
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_RepeatingFrequency. In addition, this item may be used by data structures in other ITS standards.

4.2.39 Data frame: DF_RepeatingFrequency
Use: The RepeatingFrequency container is a mandatory, though in some uses optional, container for use-case specific applications. This container should be used to collect a set of RepeatingEventActiveSlots, that is, create an array of frames, each of which describes when an event is active or occurs, particularly if it occurs at multiple time intervals or at different times on different days or dates. Can be used to describe a specific date when an event takes place or more broadly for weekly/monthly/yearly events.

ASN.1 representation:

```
RepeatingFrequency   ::= SEQUENCE (SIZE(1..500)) OF RepeatingEventActiveSlot
```
Used By: This entry is used directly by six other data structures in this standard, a DF called Data frame: DF_FlatRateParking, Data frame: DF_HourlyParking, Data frame: DF_ParkingInfo, Data frame: DF_SpecialLaneInfo, Data frame: DF_TimeInfoContainer, and Data frame: DF_VehiclePricing. In addition, this item may be used by data structures in other ITS standards.

4.2.40 Data frame: DF_RestrictedAccess
Use: The RestrictedAccess container is an optional container for use-case specific applications. This container should be used when describing information about a restricted access, particularly when a roadway is limited or restricted to authorized vehicles, or when a specific vehicle class is restricted from using a roadway.

ASN.1 representation:

```
RestrictedAccess                    ::= SEQUENCE {
       laneInformation              DSRC.RoadSegmentList OPTIONAL, --Lanes or roadways affected
       prohibitedVehicles           ProhibitedVehicles, --vehicle classes prohibited from using
roadway
       --permit required?
       ...
}
```
Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_LimitedAccessContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.41 Data frame: DF_RoadClosures
Use: The RoadClosures container is an optional container for use-case specific applications. This container should be used to describe and provide detailed information about road closures, specifically affected roadways or lanes, the duration fo the closure, and the cause of the closure.

ASN.1 representation:

```
RoadClosure                         ::= SEQUENCE {
       description                  ITIS.ITIScodes(769..895), -- J2540 DE_Closures
       affectedLanes                DSRC.RoadSegmentList, --Lanes, road segments, or roadways
closed
```

```
        temporaryClosureDuration       DSRC.MinutesDuration   OPTIONAL,   --Closure   duration   if
temporary
        indefiniteClosure              BOOLEAN OPTIONAL, --True if closure is indefinite
    ...
    }
```

Used By: This entry is used directly by two other data structures in this standard, a DF called Data frame: DF_SituationalContainer and Data frame: DF_WorkZone. In addition, this item may be used by data structures in other ITS standards.

4.2.42 Data frame: DF_RoadConditions

Use: The RoadConditions container is an optional container for use-case specific applications. This container should be used when information about road conditions needs to be communicated, to include weather alerts and specific weather-related road conditions and situations.

ASN.1 representation:

```
  RoadConditions                    ::= SEQUENCE {
        weatherAlerts                 WeatherAlerts OPTIONAL, --General weather report, rain, sun,
wind
        iceConditions                 IceConditions  OPTIONAL,  --Ice  and  winter  weather  related
descriptions
        precipitationConditions       NTCIP.EssPrecipSituation  OPTIONAL,  --Precipitation  related
descriptions
        standingWater                 StandingWater   OPTIONAL,   --Description   of   severity   and
location of standing water on roadways
        visibilityConditions          VisibilityConditions  OPTIONAL,  --Description  as  well  as
visibility distance
        advisorySpeed                 DSRC.AdvisorySpeed  OPTIONAL,  --Advisory  speed  to  travel
during adverse weather conditions
        ...
    }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SituationalContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.43 Data frame: DF_SchoolZone

Use: The SchoolZone container is an optional container for use-case specific applications. This container should be used to describe a school zone and communicate relevant information.

ASN.1 representation:

```
  SchoolZone                        ::= SEQUENCE {
        reducedSpeed                  DSRC.RegulatorySpeedLimit, --Speed limit during active school
zone
        crossingGuards                DSRC.PublicSafetyDirectingTrafficSubType  OPTIONAL,  --To  be
set when school crossing guards are present in area
        crossingInProgress            DSRC.PersonalCrossingInProgress OPTIONAL, --To be set when a
road crossing is in progress
        flashingBeacons               BOOLEAN  OPTIONAL,  --True  when  flashing  beacons  are  present
near roadways or signs
        childrenPresent               BOOLEAN  OPTIONAL,  --True  when  children  are  present  around
school zone
    ...
    }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SituationalContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.44 Data frame: DF_SpecialEvents

Use: The SpecialEvents container is an optional container for use-case specific applications. This container should be used to communicate special event information.

ASN.1 representation:

```
SpecialEvents                          ::= SEQUENCE {
     description                  ITIS.ITIScodes(3841..3862  |   3585..3608),   --   J2540
DE_SpecialEvents and DE_SportingEvents
     reducedSpeed                 DSRC.RegulatorySpeedLimit OPTIONAL,
     trafficDisruptions          ENUMERATED {normal (0), minor-street-closures (1), major-
street-closures (2),  closed-to-all-traffic(3)} OPTIONAL, --Severity of traffic disruption caused
by event
     ...
}
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SituationalContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.45 Data frame: DF_SpecialLaneInfo

Use: The SpecialLaneInfo container is a mandatory container for use-case specific applications. This container should be used to provide detailed lane-level information about unique lanes, such as HOV and toll lanes, and any relevant information such as restricted vehicles and pricing information for their use.

ASN.1 representation:

```
SpecialLaneInfo                ::= SEQUENCE {
     laneInformation            DSRC.RoadSegmentList OPTIONAL, --Lane to which information is
being attributed to
     laneOperatingHours         RepeatingFrequency, --Hours during which the lane is open
     prohibitedVehicles         ProhibitedVehicles OPTIONAL, --Vehicles prohibited, whether
by type, mass, or height, from using the special lane
     vehiclePricing             SEQUENCE (SIZE(1..50)) OF VehiclePricing OPTIONAL, --Cost of
using the lane
     ...
}
```

Used By: This entry is used directly by four other data structures in this standard, DFs called Data frame: DF_AVLanes, Data frame: DF_HOTLanes, Data frame: DF_HOVLanes, Data frame: DF_TollLanes. In addition, this item may be used by data structures in other ITS standards.

4.2.46 Data frame: DF_StandingWater

Use: The StandingWater container is an optional container for use-case specific applications. This container should be used when describing information on water on a roadway.

ASN.1 representation:

```
StandingWater                  ::= SEQUENCE {
     description                ITIS.ITIScodes(3073..3078), -- J2540 DE_Disasters
     affectedLanes              DSRC.RoadSegmentList OPTIONAL, --Lanes affected by standing
water
     ...
}
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_RoadConditions. In addition, this item may be used by data structures in other ITS standards.

4.2.47 Data frame: DF_TimeInfoContainer

Use: The TimeInfoContainer container is a mandatory container for use-case specific applications. This container should be used to communicate relevant time information associated with other communicated information, including time, date, and repeating event information. This is used to describe when an event occurs (or has occurred) and when it will end.

ASN.1 representation:

```
TimeInfoContainer              ::= SEQUENCE {
   dateTime                     DSRC.DDateTime, --DHour 0 to 23; DSecond in millisecond;
DOffset in minutes from UTC
   durationTime                 DSRC.MinutesDuration, --Duration of the event
     repeatingEvent             DSRC.EventDescription OPTIONAL, --Description of the event
```

```
        repeatingFrequency           RepeatingFrequency OPTIONAL,  --Information  on  when  event
repeats
        ...
    }
```

Used By: This entry is used directly by two other data structures in this standard, DFs called Data frame: DF_CommonContainer, Data frame: DF_WWDSequence. In addition, this item may be used by data structures in other ITS standards.

4.2.48 Data frame: DF_TimeOfDayPricing - TBD

Use: The TimeOfDayPricing container is an optional mandatory container for use-case specific applications. This container should be used when communicating relevant information about pricing during a particular time of day.

ASN.1 representation: - TBD

```
  TimeOfDayPricing                  ::= SEQUENCE {
       -- congestion pricing e.g. entering city center. Same as toll?
       ...
  }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_LimitedAccessContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.49 Data frame: DF_TollLanes

Use: The TollLanes container is an optional container for use-case specific applications. This container should be used when communicating information about toll lanes, to include lane information, pricing, and restrictions.

ASN.1 representation:

```
  TollLanes                         ::= SEQUENCE {
       specialLaneInfo              SpecialLaneInfo, --Specific information about toll lane
       ...
  }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_LimitedAccessContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.50 Data frame: DF_TravelTime

Use: The TravelTime container is an optional container for use-case specific applications. This container should be used when communicating travel time information to drivers along a certain route, that is, the time it takes to travel from an origin to a destination along the current route.

ASN.1 representation:

```
  TravelTime                        ::= SEQUENCE {
       travelOrigin                 RegionInfoContainer, --Start position of route
       travelDestination            RegionInfoContainer, --End position of route
       distanceToDestination        DSRC.ObstacleDistance, --only J2735 element with sufficient
length (GrossDistance max is 1km), Route distance from start to end position
       typicalDuration              DSRC.MinutesDuration  OPTIONAL,  --Duration  for  route  in
unloaded or typical situation
       actualDuration               DSRC.MinutesDuration OPTIONAL, --Actual predicted duration of
trip along route
       dmsSignString                IA5String(SIZE(1..80))  OPTIONAL,  --Simple  string  as  may
appear on DMS Sign
       ...
  }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SituationalContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.51 Data frame: DF_TypeOfDynamicInfo

Use: The TypeOfDynamicInfo container is a mandatory container for use-case specific applications. This container should be used to describe the type or nature of dynamic information that is being communicated.

ASN.1 representation:

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

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_DynamicInfoContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.52 Data frame: DF_VehiclePricing

Use: The VehiclePricing container is an optional container for use-case specific applications. This container should be used to communicate pricing information for a given vehicle type and occupancy, as well as when such pricing is in effect.

ASN.1 representation:

```
VehiclePricing                      ::= SEQUENCE {
      vehicleType                   ITIS.ITIScodes(9217..9261),        --        J2540
DE_VehicleGroupsAffected
      minimumOccupancy              INTEGER (1..10), --minimum number of people in vehicle
      costOfEntry                   REAL (0.00 .. 9999.00), --price in dollars or other standard
monetary unit, charged to non-exempt
      activeSlot                    RepeatingFrequency, --Time of day or days of weeks when this
rate is in effect
      ...
}
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SpecialLaneInfo. In addition, this item may be used by data structures in other ITS standards.

4.2.53 Data frame: DF_VisibilityConditions

Use: The VisibilityConditions container is an optional container for use-case specific applications. This container should be used when describing the visibility conditions of the roadway.

ASN.1 representation:

```
VisibilityConditions                ::= SEQUENCE {
      description                   ITIS.ITIScodes(5377..5393),        --        J2540
DE_VisibilityAndAirQuality
      visibilityDistance            DSRC.GrossDistance OPTIONAL, --Visibility distance
      ...
}
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_RoadConditions. In addition, this item may be used by data structures in other ITS standards.

4.2.54 Data frame: DF_WeatherAlerts

Use: The WeatherAlerts container is an optional container for use-case specific applications. This container should be used when describing weather-related alerts or adverse driving conditions.

ASN.1 representation:

```
  WeatherAlerts                    ::= SEQUENCE {
        weatherReport              DSRC.WeatherReport OPTIONAL, --General weather report, rain,
sun, wind
        ambientTemperature         DSRC.AmbientAirTemperature OPTIONAL, --Temperature
        pressure                   DSRC.AmbientAirPressure OPTIONAL, --Pressure
        rain                       DSRC.RainSensor OPTIONAL, --Basic rain information
        sun                        DSRC.SunSensor OPTIONAL, --Basic solar information
        wind                       ITIS.ITIScodes(5121..5133) OPTIONAL, -- J2540 DE_Winds
        windForecast               ITIS.ITIScodes(5121..5133) OPTIONAL, -- J2540 DE_Winds
        --otherforecast
        --include cancellations for adverse driving conditions?
        ...
  }
```

Used By: This entry is used directly by two other data structures in this standard, DFs called Data frame: DF_SituationalContainer and Data frame: DF_RoadConditions. In addition, this item may be used by data structures in other ITS standards.

4.2.55 Data frame: DF_WorkZone

Use: The WorkZone container is an optional container for use-case specific applications. This container should be used to provide detailed information about work zones on roadways or where official personnel are present.

ASN.1 representation:

```
  WorkZone                    ::= SEQUENCE {
        roadWorkDescription        ITIS.ITIScodes(1025..1061), -- J2540 DE_Roadwork
        roadClosure                RoadClosure OPTIONAL, --Indicates roadways or lanes that are
closed or otherwise affected by the road closure
        workersPresent             DSRC.PublicSafetyAndRoadWorkerActivity     OPTIONAL,     --
Information about presence of road workers
        flagman                    DSRC.PublicSafetyDirectingTrafficSubType     OPTIONAL,     --
Information about presence of flagman
        reducedSpeed               DSRC.RegulatorySpeedLimit,  --Temporary  regulatory  reduced
speed limit
        flashingBeacons            BOOLEAN OPTIONAL, --True when flashing beacons are present in
area or signs
        trucksEnteringLeaving      BOOLEAN OPTIONAL, --True when work trucks are entering and
leaving construction zone
        ...
  }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SituationalContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.56 Data frame: DF_WWD

Use: The WWD container is an optional container for use-case specific applications. This container should be used to provide a history of wrong-way driver positions.

ASN.1 representation:

```
  WWD                       ::= SEQUENCE (SIZE(1..500)) OF WWDSequence --Array of points where
wrong way driver was spotted
  --alternative implementation use DSCR.PathHistory
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_SituationalContainer. In addition, this item may be used by data structures in other ITS standards.

4.2.57 Data frame: DF_WWDSequence

Use: The WWDSequence container is a mandatory container for use-case specific applications. This container should be used to include a single observed position and time of a wrong way driver.

ASN.1 representation:

```
WWDSequence                        ::= SEQUENCE {
      timeInfo                     TimeInfoContainer,
      regionInfo                   RegionInfoContainer,
      speed                        DSRC.Velocity OPTIONAL, --Units of 0.02 m/s
      wwdID                        DSRC.TemporaryID  OPTIONAL,  --Numerical  identification  of
wrong way driver
      ...
   }
```

Used By: This entry is used directly by one other data structure in this standard, a DF called Data frame: DF_WWD. In addition, this item may be used by data structures in other ITS standards.

A BIM ASN.1

```
-- #############
-- BIM SCHEMA
-- #############



BIM DEFINITIONS AUTOMATIC TAGS ::= BEGIN



  BasicInformationMessage      ::= SEQUENCE {
     commonContainer                   CommonContainer,
     staticSignageContainer    StaticSignageContainer OPTIONAL,
     situationalContainer             SituationalContainer OPTIONAL,
     dynamicInfoContainer       DynamicInfoContainer OPTIONAL,
     limitedAccessContainer    LimitedAccessContainer OPTIONAL,
     incidentsContainer                IncidentsContainer OPTIONAL,
     emergencyVehicleContainer  EmergencyVehicleContainer OPTIONAL,
     -- mapInfoContainer                       MapInfoContainer OPTIONAL,
     -- dataCollectionContainer        DataCollectionContainer OPTIONAL,
     -- localNotificationsContainer LocalNotificationsContainer OPTIONAL,
     -- enforcementContainer                    EnforcementContainer OPTIONAL,
     -- driverSafetyContainer       DriverSafetyContainer OPTIONAL,
     -- intersectionContainer       IntersectionContainer OPTIONAL,
        ...
  }



-- ########################### --
-- Use-Case Specific Containers --
--  These Contain Data Frames   --
-- ########################### --
  CommonContainer                       ::= SEQUENCE {
     timeInfo                           TimeInfoContainer,
     regionInfo                         RegionInfoContainer,
        ...
  }

  StaticSignageContainer      ::= SEQUENCE {
        speedLimit                           DSRC.RegulatorySpeedLimit OPTIONAL,
        mileMarker                           REAL OPTIONAL,
        placard                              Placard OPTIONAL, --may not be necessary for
BIM
        itisGenericSign               DSRC.GenericSignage OPTIONAL,
        mutcdCode                            DSRC.MUTCDCode OPTIONAL,
        mutcdSignDesignation      IA5String(SIZE(1..120)) OPTIONAL,--Alphanumeric MUTCD sign
designation
        ...
  }

  SituationalContainer                ::= CHOICE {
     wwd                                 WWD,
        obstructions               Obstructions,
        overheightVehicle          OverheightVehicle,
        workZone                           WorkZone,  --consider  changing  name  as
'WorkZone' exists in J2735
        travelTime                         TravelTime,
        weatherAlerts              WeatherAlerts,
        roadConditions                     RoadConditions,
        roadClosure                RoadClosure,
        railCrossing               RailCrossing,
        schoolZone                         SchoolZone,
        specialEvents              SpecialEvents,
        parkingInfo                ParkingInfo,
        contraflow                         Contraflow,
```

```
      ...
  }

  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,
        situationalContainer    SituationalContainer OPTIONAL, --for work zone, travel time,
etc... info
        incidentsContainer            IncidentsContainer OPTIONAL, --for incidents info
        ...
  }

  LimitedAccessContainer     ::= CHOICE {
        hovLanes                              HOVLanes,
        avLanes                               AVLanes,
        alternateFlow                 AlternateFlow,
        restrictedAccess              RestrictedAccess,
        hotLanes                              HOTLanes,
        tollLanes                             TollLanes,
        timeOfDayPricing          TimeOfDayPricing,
        hazmatRoutes              HAZMATRoutes
  }

  IncidentsContainer         ::= SEQUENCE {
        description                   ITIS.ITIScodes(513..531),          --        J2540
DE_AccidentsAndIncidents
        responderType               SEQUENCE  (SIZE(1..5))  OF  ITIS.ResponderGroupAffected
OPTIONAL,
        affectedLanes                 DSRC.RoadSegmentList OPTIONAL,
        advisorySpeed                 DSRC.AdvisorySpeed OPTIONAL,
        congestionInfo                        CongestionInfo OPTIONAL,
        ...
  }

  EmergencyVehicleContainer ::= SEQUENCE {
        notification                  SEQUENCE (SIZE(1..10)) OF ITIS.ITIScodes(7425..7453),
-- J2540 DE_AdviceInstructionsMandatory
        description                   DSRC.EventDescription,
        emergencyDetails              DSRC.EmergencyDetails,
        --eva                              DSRC.EmergencyVehicleAlert,
        destination                   RegionInfoContainer OPTIONAL,
        ...
  }



-- ########################### --
-- Start of Data Frames Within --
-- Use-Case Specific Containers --
-- ########################### --
  AlternateFlow                         ::= SEQUENCE {
        laneInformation               DSRC.RoadSegmentList OPTIONAL,
        --indication of direction of flow?
        ...
  }

  AVLanes                               ::= SEQUENCE {
        specialLaneInfo               SpecialLaneInfo,
        ...
  }

  CongestionInfo                  ::= SEQUENCE {
        queueAheadWarning             BOOLEAN,
        associatedLane                        DSRC.RoadSegment    OPTIONAL,    --single
roadsegment with which queue info is associated; omit if defining for all lanes
        startOfQueue                  RegionInfoContainer,
```

```
        lengthOfQueue                        DSRC.ObstacleDistance OPTIONAL, --Technically  wrong
DE to use, but is the only J2735 element with sufficient length (GrossDistance max is 1km)
        speedLimit                           DSRC.RegulatorySpeedLimit OPTIONAL,
        averageVehicleSpeed        DSRC.Velocity OPTIONAL,
        normalConditions               BOOLEAN OPTIONAL,
        unexpectedConditionDesc    IA5String(SIZE(1..100))  OPTIONAL,  --Text  description  of
unexpected event
        ...
  }

  Contraflow                    ::= SEQUENCE {
  -- TBD
    ...
  }

  FlatRateParking               ::= SEQUENCE {
        price                                REAL (0.00 .. 9999.00), --price in dollars or
other standard monetary unit
        activeSlot                           RepeatingFrequency,
        ...
  }

  HAZMATHeader                  ::= ENUMERATED {
        custom                               (0),
        oxygen                               (1),
        flammablegas                 (3),
        nonflammablegas              (4),
        toxicgas                             (5),
        inhalationhazard             (6),
        fueloil                              (7),
        flammable                            (8),
        combustible                  (9),
        gasoline                             (10),
        flammablesolid                       (11),
        spontaneouslycombustible     (12),
        dangerouswhenwet                     (13),
        oxidizer                             (14),
        organicperoxide              (15),
        toxic                                (16),
        poison                               (17),
        radioactive                  (18),
        corrosive                            (19),
        miscdangerousgoods           (20),
        dangerousmixedloads          (21),
        explosives                           (22),
        ...
  }

  HAZMATPlacards                ::= SEQUENCE {
        header                               HAZMATHeader,
        class                                INTEGER (1..9),
        unNumber                             INTEGER (1..9999)
  }

  HAZMATRoutes                  ::= SEQUENCE {
        --MAP info?
        ...
  }

  HOTLanes                              ::= SEQUENCE {
        specialLaneInfo               SpecialLaneInfo,
        ...
  }

  HourlyParking                         ::= SEQUENCE {
        hourlyRate                           SEQUENCE (SIZE(1..100)) OF HourlyRate,
        activeSlot                           RepeatingFrequency, --Time of day or days of
weeks when this rate is in effect
        ...
  }
```

```
HourlyRate                       ::= SEQUENCE {
      parkingDurationBegin        DSRC.MinutesDuration, -- Each sequence should contain non-
overlapping DurationBegin and DurationEnd values
      parkingDurationEnd          DSRC.MinutesDuration, --   Example:   HourlyRate[1]
{parkingDurationBegin 0, parkingDurationEnd 29, price 2.00}, HourlyRate[2] {parkingDurationBegin
30, parkingDurationEnd 59, price 3.00}
      price                       REAL (0.00 .. 9999.00), --price in dollars or
other standard monetary unit
      ...
  }

  HOVLanes                         ::= SEQUENCE {
      specialLaneInfo              SpecialLaneInfo,
      ...
  }

  IceConditions                    ::= SEQUENCE {
      iceDescription                   ITIS.ITIScodes(5906..5930) OPTIONAL, -- J2540
DE_PavementConditions
      winterIndex                 ITIS.ITIScodes(6401..6406)   OPTIONAL,   --   J2540
DE_WinterDrivingIndex
      winterRestrictions          ITIS.ITIScodes(6145..6156)   OPTIONAL,   --   J2540
DE_WinterDrivingRestrictions
      ...
  }

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

  NFPAFireDiamond                  ::= SEQUENCE {
      red-flammability            INTEGER (0..4),
      blue-health                 INTEGER (0..4),
      yellow-chemical             INTEGER (0..4),
      white-specialcode           IA5String(SIZE(0..4))
  }

  Obstructions                     ::= SEQUENCE {
      detection                        DSRC.ObstacleDetection,
      roadSegmentID               DSRC.RoadSegmentReferenceID,
      description                 ITIS.ITIScodes(1282..1319)   OPTIONAL,   --   J2540
DE_Obstructions
      location                         ITIS.ITIScodes(7937..8030) OPTIONAL, -- J2540
DE_GenericLocations
      affectedLanes               DSRC.RoadSegmentList      OPTIONAL,           --
SegmentAttributeLLList?
      reducedspeed                DSRC.AdvisorySpeed OPTIONAL,
      affectedvehicles            DSRC.DisabledVehicle OPTIONAL,
      --How to proceed,          ITIS   J2540   AdviceInstructionsMandatory    and
AdviceInstructionsRecommendations OPTIONAL
      ...
  }

  OverheightVehicle         ::= SEQUENCE {
      roadSegmentID               DSRC.RoadSegmentReferenceID,
    point                              DSRC.Position3D,
      intersection                DSRC.IntersectionReferenceID OPTIONAL,
      vehicleHeight               DSRC.VehicleHeight,   --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)},
      ...
  }

  ParkingInfo                      ::= SEQUENCE {
      parkingOperatingHours       RepeatingFrequency,
      parkingInformation          SEQUENCE (SIZE(1..10)) OF ITIS.ITIScodes(4097..4223),
-- J2540 DE_ParkingInformation
      availableSpaces             INTEGER (0..9999) OPTIONAL, --use parkingInformation
if exact number unknown
      prohibitedVehicles          ProhibitedVehicles OPTIONAL,
```

```
        hourlyParking                                SEQUENCE (SIZE(1..100)) OF HourlyParking OPTIONAL,
        flatRateParking                              SEQUENCE (SIZE(1..100)) OF FlatRateParking OPTIONAL,
        lostTicketRate                               REAL (0.00 .. 9999.00) OPTIONAL, --price in
dollars or other standard monetary unit
        onStreetParkingLaneInfo        DSRC.RoadSegmentList OPTIONAL,
      ...
  }

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

  Placard                                  ::= SEQUENCE {
        phrases                                      IA5String(SIZE(1..100)) OPTIONAL,
        hazmatPlacards                               HAZMATPlacards OPTIONAL,
        nfpaFireDiamond                    NFPAFireDiamond OPTIONAL,
        disabledParking                    BOOLEAN OPTIONAL,
        wideload                                     BOOLEAN OPTIONAL,
        ...
  }

  ProhibitedVehicles         ::= SEQUENCE {
        prohibitedVehicleTypes               SEQUENCE (SIZE(1..50)) OF ITIS.ITIScodes(9217..9261)
OPTIONAL, -- J2540 DE_VehicleGroupsAffected
        prohibitedVehicleMass        DSRC.VehicleMass OPTIONAL,
        vehicleMassLimitNotApply     SEQUENCE  (SIZE(1..50))  OF  ITIS.ITIScodes(9217..9261)
OPTIONAL, -- J2540 DE_VehicleGroupsAffected; vehicles not subject to weight limit, e.g. recreational
vehicles
        ...
  }

  Polygon                            ::= SEQUENCE (SIZE(3..50)) OF DSRC.Position3D

  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
        ...
  }

  RegionInfoContainer        ::= SEQUENCE {
     point                                 DSRC.Position3D, --Lat/Lon in 1/10th integer
microdegrees; Elevation in units of 10cm;
        polygon                                      Polygon OPTIONAL,
        roadwayName                        VisibleString OPTIONAL,
     path                                  Path OPTIONAL,
        heading                                      DSRC.Heading  OPTIONAL,  --Where  the  LSB  is
units of 0.0125 degrees
        -- +Circle?
        -- +RegionID/DestinationID/MapID?
        -- +RoadSegmentID?
        -- +Moving - Variable region?
        ...
  }

  RepeatingEventActiveSlot           ::= SEQUENCE {
        startTime                                    DSRC.DTime OPTIONAL,
        endTime                                      DSRC.DTime OPTIONAL,
        dayOfWeek                                    ManyDayOfWeek OPTIONAL,
        yearmonthday                       DSRC.DDate OPTIONAL,
        monthday                                     DSRC.DYearMonth OPTIONAL,
        day                                          DSRC.DDay OPTIONAL,
        ...
  }

  RepeatingFrequency    ::= SEQUENCE (SIZE(1..500)) OF RepeatingEventActiveSlot

  RestrictedAccess                   ::= SEQUENCE {
```

```
        laneInformation                     DSRC.RoadSegmentList OPTIONAL,
        prohibitedVehicles                  ProhibitedVehicles,
        --permit required?
        ...
    }

    RoadClosure                   ::= SEQUENCE {
        description                         ITIS.ITIScodes(769..895), -- J2540 DE_Closures
        affectedLanes                       DSRC.RoadSegmentList,
        temporaryClosureDuration      DSRC.MinutesDuration OPTIONAL,
        indefiniteClosure                   BOOLEAN OPTIONAL,
      ...
    }

    RoadConditions                ::= SEQUENCE {
        weatherAlerts                       WeatherAlerts OPTIONAL,
        iceConditions                       IceConditions OPTIONAL,
        precipitationConditions       NTCIP.EssPrecipSituation OPTIONAL,
        standingWater                       StandingWater OPTIONAL,
        visibilityConditions          VisibilityConditions OPTIONAL,
        advisorySpeed                       DSRC.AdvisorySpeed OPTIONAL,
        ...
    }

    SchoolZone                    ::= SEQUENCE {
        reducedSpeed                        DSRC.RegulatorySpeedLimit,
        crossingGuards                          DSRC.PublicSafetyDirectingTrafficSubType
OPTIONAL,
        crossingInProgress                  DSRC.PersonalCrossingInProgress OPTIONAL,
        flashingBeacons                     BOOLEAN OPTIONAL,
        childrenPresent                     BOOLEAN OPTIONAL,
        ...
    }

    SpecialEvents                         ::= SEQUENCE {
        description                         ITIS.ITIScodes(3841..3862 | 3585..3608), -- J2540
DE_SpecialEvents and DE_SportingEvents
        reducedSpeed                        DSRC.RegulatorySpeedLimit OPTIONAL,
        trafficDisruptions                  ENUMERATED {normal (0), minor-street-closures (1),
major-street-closures (2), closed-to-all-traffic(3)} OPTIONAL,
        ...
    }

    SpecialLaneInfo               ::= SEQUENCE {
        laneInformation                     DSRC.RoadSegmentList OPTIONAL,
        laneOperatingHours                  RepeatingFrequency,
        prohibitedVehicles                  ProhibitedVehicles OPTIONAL,
        vehiclePricing                          SEQUENCE (SIZE(1..50)) OF VehiclePricing
OPTIONAL,
        ...
    }

    StandingWater                 ::= SEQUENCE {
        description                         ITIS.ITIScodes(3073..3078), -- J2540 DE_Disasters
        affectedLanes                       DSRC.RoadSegmentList OPTIONAL,
        ...
    }

    TimeInfoContainer         ::= SEQUENCE {
        dateTime                            DSRC.DDateTime,  --DHour 0 to 23;  DSecond  in
millisecond; DOffset in minutes from UTC
        durationTime                        DSRC.MinutesDuration,
        repeatingEvent                          DSRC.EventDescription OPTIONAL,
        repeatingFrequency                  RepeatingFrequency OPTIONAL,
        ...
    }

    TimeOfDayPricing              ::= SEQUENCE {
        -- congestion pricing e.g. entering city center. Same as toll?
        ...
    }
```

```
  TollLanes                               ::= SEQUENCE {
        specialLaneInfo                 SpecialLaneInfo,
        ...
  }

  TravelTime                    ::= SEQUENCE {
        travelOrigin                    RegionInfoContainer,
        travelDestination               RegionInfoContainer,
        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)
  }

  VehiclePricing                ::= SEQUENCE {
        vehicleType                     ITIS.ITIScodes(9217..9261),        --        J2540
DE_VehicleGroupsAffected
      minimumOccupancy              INTEGER (1..10), --minimum number of people in vehicle
        costOfEntry                     REAL (0.00 .. 9999.00), --price in dollars or other
standard monetary unit, charged to non-exempt
        activeSlot                          RepeatingFrequency, --Time of day or days of
weeks when this rate is in effect
        ...
  }

  VisibilityConditions          ::= SEQUENCE {
        description                     ITIS.ITIScodes(5377..5393),        --        J2540
DE_VisibilityAndAirQuality
        visibilityDistance            DSRC.GrossDistance OPTIONAL,
        ...
  }

  WeatherAlerts                 ::= SEQUENCE {
        weatherReport                   DSRC.WeatherReport OPTIONAL,
        ambientTemperature              DSRC.AmbientAirTemperature OPTIONAL,
        pressure                        DSRC.AmbientAirPressure OPTIONAL,
        rain                            DSRC.RainSensor OPTIONAL,
        sun                             DSRC.SunSensor OPTIONAL,
        wind                            ITIS.ITIScodes(5121..5133) OPTIONAL, -- J2540
DE_Winds
        windForecast                    ITIS.ITIScodes(5121..5133)   OPTIONAL,   --   J2540
DE_Winds
        --otherforecast
        --include cancellations for adverse driving conditions?
        ...
  }

  WorkZone                      ::= SEQUENCE {
        roadWorkDescription         ITIS.ITIScodes(1025..1061), -- J2540 DE_Roadwork
        roadClosure                     RoadClosure OPTIONAL,
        workersPresent                      DSRC.PublicSafetyAndRoadWorkerActivity
OPTIONAL,
        flagman                             DSRC.PublicSafetyDirectingTrafficSubType
OPTIONAL,
        reducedSpeed                    DSRC.RegulatorySpeedLimit,
        flashingBeacons                 BOOLEAN OPTIONAL,
```

```
        trucksEnteringLeaving        BOOLEAN OPTIONAL,
        ...
  }

  WWD                       ::= SEQUENCE (SIZE(1..500)) OF WWDSequence
  --alternative implementation use DSCR.PathHistory

  WWDSequence                      ::= SEQUENCE {
        timeInfo                              TimeInfoContainer,
        regionInfo                            RegionInfoContainer,
        speed                                 DSRC.Velocity OPTIONAL, --Units of 0.02 m/s
        wwdID                   DSCR.TemporaryID OPTIONAL,
        ...
  }

END
```

B Worked Examples

The applications which are developed in this document are expressed in ASN.1 encoded using the UPER method. This section of the document provides an informative example of a well-formed message which meets this specification.

Dynamic Traveler Information:
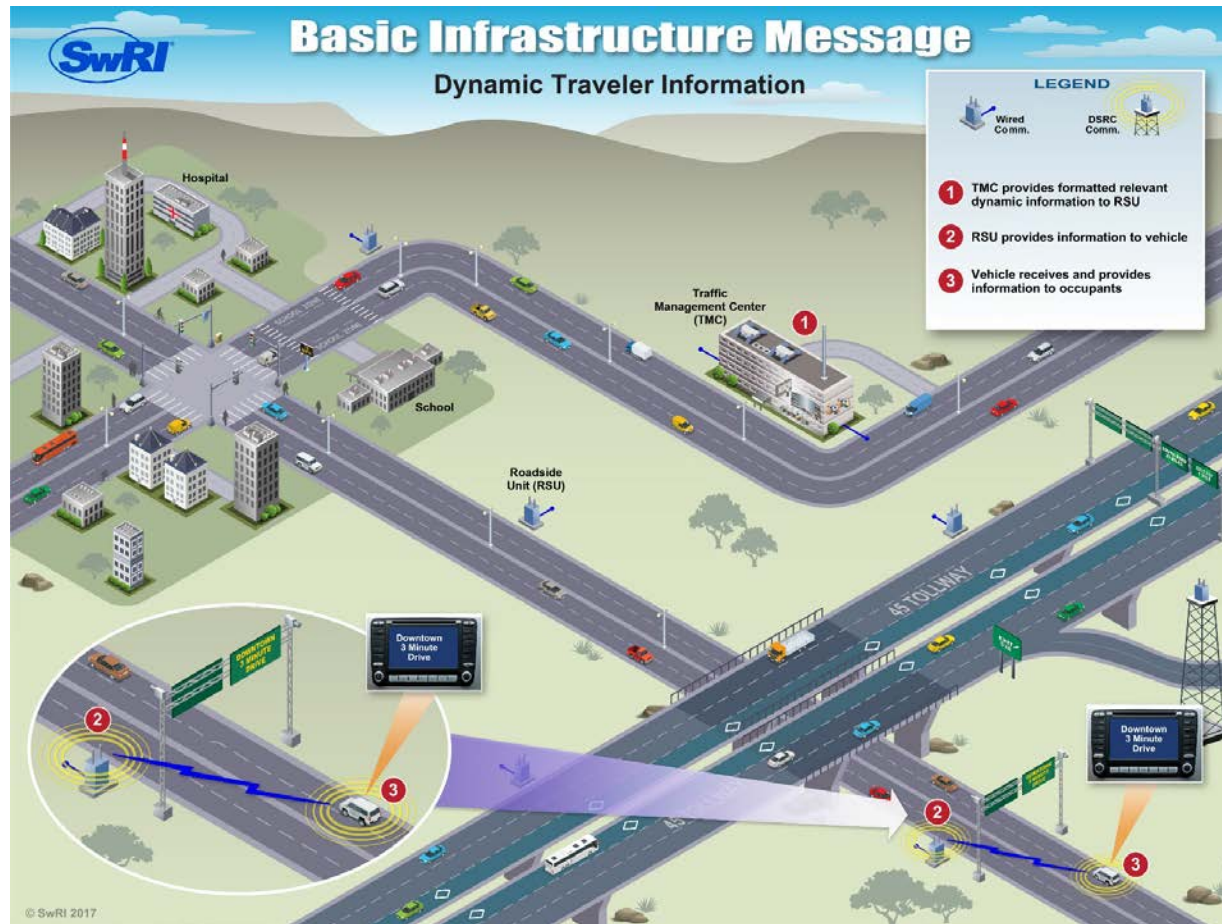
Figure 1 — Dynamic Traveler Information Graphic

The BIM data message in an XML format is:

```
<?xml version="1.0" encoding="UTF-8"?>
<BasicInformationMessage>
  <commonContainer>
    <timeInfo>
      <dateTime>
        <year>2017</year>
        <month>10</month>
        <day>30</day>
        <hour>15</hour>
        <minute>3</minute>
        <second>29992</second>
        <offset>-300</offset>
      </dateTime>
      <durationTime>30</durationTime>
    </timeInfo>
    <regionInfo>
      <point>
        <lat>294534879</lat>
        <long>-986300315</long>
        <elevation>2323</elevation>
      </point>
      <polygon>
        <Position3D>
          <lat>294534879</lat>
          <long>-986300315</long>
        </Position3D>
        <Position3D>
          <lat>294532114</lat>
          <long>-986295929</long>
        </Position3D>
        <Position3D>
          <lat>294600968</lat>
          <long>-986238840</long>
        </Position3D>
        <Position3D>
          <lat>294603558</lat>
          <long>-986243322</long>
        </Position3D>
      </polygon>
      <roadwayName>I-410</roadwayName>
      <heading>17200</heading>
    </regionInfo>
  </commonContainer>
  <dynamicInfoContainer>
    <priority><medium-priority/></priority>
    <typeOfInfo><congestion/></typeOfInfo>
```
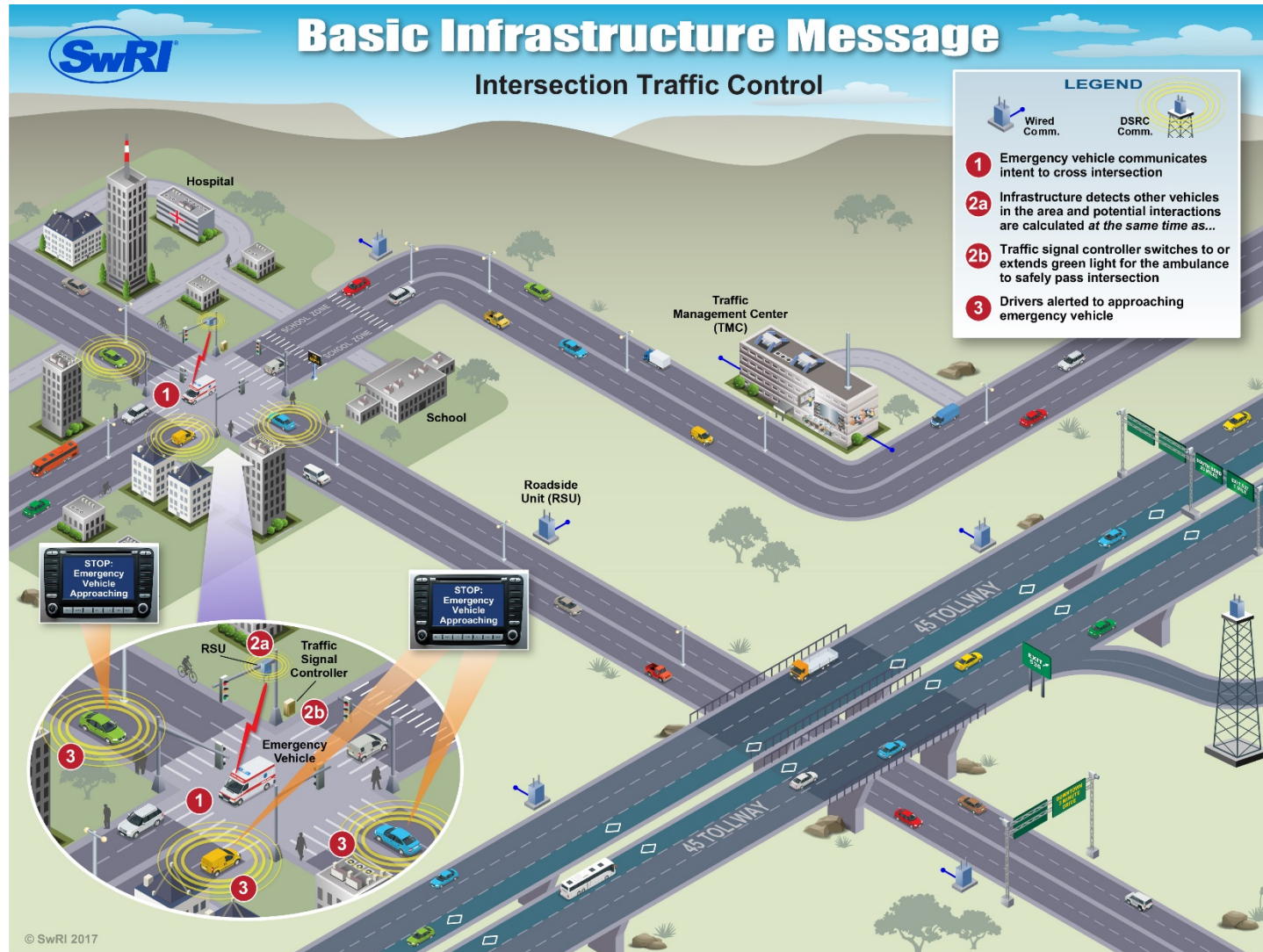
```
    <congestionInfo>
      <CongestionInfo>
        <queueAheadWarning><true/></queueAheadWarning>
        <startOfQueue>
          <point>
            <lat>294534879</lat>
            <long>-986300315</long>
            <elevation>2323</elevation>
          </point>
          <heading>2800</heading>
        </startOfQueue>
        <lengthOfQueue>500</lengthOfQueue>
        <speedLimit>
          <type><vehicleMaxSpeed/></type>
          <speed>1453</speed>
        </speedLimit>
        <averageVehicleSpeed>671</averageVehicleSpeed>
        <normalConditions><true/></normalConditions>
      </CongestionInfo>
    </congestionInfo>
  </dynamicInfoContainer>
</BasicInformationMessage>
```

Emergency Vehicles and Intersection Traffic Control:

Figure 2 — Emergency Vehicles and Intersection Traffic Control

The BIM data message in an XML format (for the Emergency Vehicle Example) is:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<BasicInformationMessage>
  <commonContainer>
    <timeInfo>
      <dateTime>
        <year>2017</year>
        <month>9</month>
        <day>27</day>
        <hour>8</hour>
        <minute>3</minute>
        <second>59999</second>
        <offset>-300</offset>
      </dateTime>
      <durationTime>300</durationTime>
    </timeInfo>
    <regionInfo>
      <point>
        <lat>294661820</lat>
        <long>-986173679</long>
        <elevation>2685</elevation>
      </point>
      <polygon>
        <Position3D>
          <lat>294663635</lat>
          <long>-986174002</long>
        </Position3D>
        <Position3D>
          <lat>294661820</lat>
          <long>-986173679</long>
        </Position3D>
        <Position3D>
          <lat>294662847</lat>
          <long>-986166582</long>
        </Position3D>
        <Position3D>
          <lat>294663072</lat>
          <long>-986148937</long>
        </Position3D>
        <Position3D>
          <lat>294664745</lat>
          <long>-986149007</long>
        </Position3D>
        <Position3D>
          <lat>294664661</lat>
          <long>-986166761</long>
        </Position3D>
```

```
            </polygon>
            <roadwayName>Ingram Rd</roadwayName>
            <heading>6520</heading>
          </regionInfo>
      </commonContainer>
      <emergencyVehicleContainer>
        <notification>
            <INTEGER>7425</INTEGER>
            <INTEGER>7438</INTEGER>
        </notification>
        <description>
            <typeEvent>513</typeEvent>
            <priority>E0</priority>
        </description>
        <emergencyDetails>
            <sspRights>1</sspRights>
            <sirenUse><inUse/></sirenUse>
            <lightsUse><inUse/></lightsUse>
            <multi><multiVehicle/></multi>
        </emergencyDetails>
      </emergencyVehicleContainer>
</BasicInformationMessage>
```
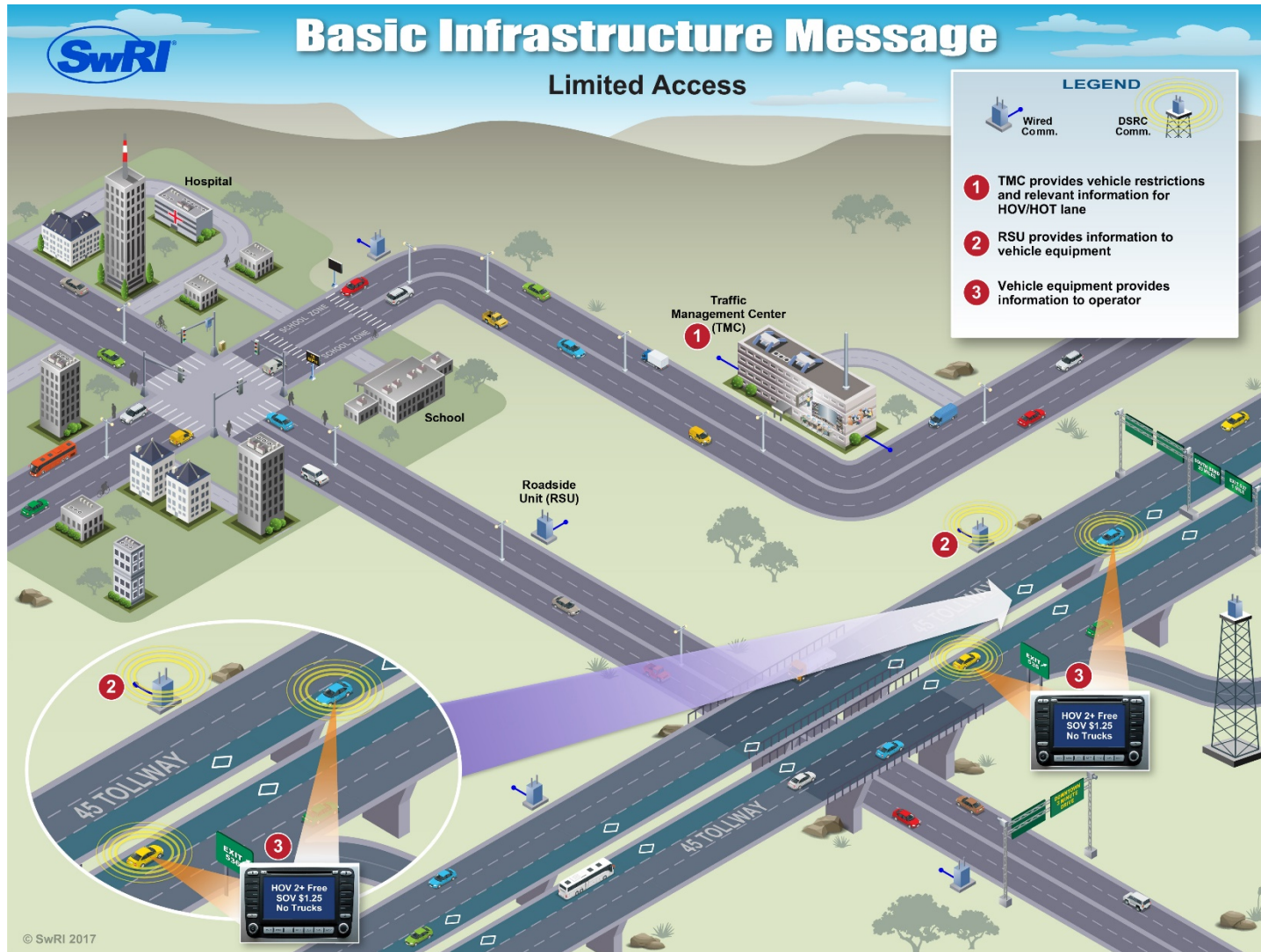
Limited Access:

Figure 3 — Limited Access

The BIM data message in an XML format is:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<BasicInformationMessage>
  <commonContainer>
    <timeInfo>
      <dateTime>
        <year>2017</year>
        <month>10</month>
        <day>4</day>
        <hour>11</hour>
        <minute>4</minute>
        <second>10500</second>
        <offset>-300</offset>
      </dateTime>
      <durationTime>32000</durationTime>
    </timeInfo>
    <regionInfo>
      <point>
        <lat>297847891</lat>
        <long>-956500980</long>
        <elevation>296</elevation>
      </point>
      <polygon>
        <Position3D>
          <lat>297847449</lat>
          <long>-956458107</long>
        </Position3D>
        <Position3D>
          <lat>297848046</lat>
          <long>-956458164</long>
        </Position3D>
        <Position3D>
          <lat>297847891</lat>
          <long>-956500980</long>
        </Position3D>
        <Position3D>
          <lat>297847244</lat>
          <long>-956500922</long>
        </Position3D>
      </polygon>
      <roadwayName>Katy FWY</roadwayName>
      <heading>7200</heading>
    </regionInfo>
  </commonContainer>
  <limitedAccessContainer>
    <hotLanes>
      <specialLaneInfo>
        <laneOperatingHours>
          <RepeatingEventActiveSlot>
```

```xml
          <startTime>
            <hour>7</hour>
            <minute>0</minute>
            <second>0</second>
          </startTime>
          <endTime>
            <hour>13</hour>
            <minute>0</minute>
            <second>0</second>
          </endTime>
        </RepeatingEventActiveSlot>
        <RepeatingEventActiveSlot>
          <startTime>
            <hour>15</hour>
            <minute>0</minute>
            <second>0</second>
          </startTime>
          <endTime>
            <hour>19</hour>
            <minute>0</minute>
            <second>0</second>
          </endTime>
        </RepeatingEventActiveSlot>
      </laneOperatingHours>
      <prohibitedVehicles>
        <prohibitedVehicleTypes>
          <INTEGER>9218</INTEGER>
          <INTEGER>9223</INTEGER>
          <INTEGER>9225</INTEGER>
          <INTEGER>9229</INTEGER>
          <INTEGER>9231</INTEGER>
          <INTEGER>9232</INTEGER>
        </prohibitedVehicleTypes>
        <prohibitedVehicleMass>19</prohibitedVehicleMass>
        <vehicleMassLimitNotApply>
          <INTEGER>9224</INTEGER>
        </vehicleMassLimitNotApply>
      </prohibitedVehicles>
      <vehiclePricing>
        <VehiclePricing>
          <vehicleType>9220</vehicleType>
          <minimumOccupancy>1</minimumOccupancy>
          <costOfEntry>1.00</costOfEntry>
          <activeSlot>
            <RepeatingEventActiveSlot>
              <startTime>
                <hour>7</hour>
                <minute>0</minute>
                <second>0</second>
              </startTime>
              <endTime>
```

```
              <hour>19</hour>
              <minute>0</minute>
              <second>0</second>
            </endTime>
          </RepeatingEventActiveSlot>
        </activeSlot>
      </VehiclePricing>
      <VehiclePricing>
        <vehicleType>9220</vehicleType>
        <minimumOccupancy>1</minimumOccupancy>
        <costOfEntry>0.50</costOfEntry>
        <activeSlot>
          <RepeatingEventActiveSlot>
            <startTime>
              <hour>19</hour>
              <minute>0</minute>
              <second>0</second>
            </startTime>
            <endTime>
              <hour>7</hour>
              <minute>0</minute>
              <second>0</second>
            </endTime>
          </RepeatingEventActiveSlot>
        </activeSlot>
      </VehiclePricing>
      <VehiclePricing>
        <vehicleType>9220</vehicleType>
        <minimumOccupancy>2</minimumOccupancy>
        <costOfEntry>0.00</costOfEntry>
        <activeSlot>
          <RepeatingEventActiveSlot>
            <startTime>
              <hour>7</hour>
              <minute>0</minute>
              <second>0</second>
            </startTime>
            <endTime>
              <hour>13</hour>
              <minute>0</minute>
              <second>0</second>
            </endTime>
          </RepeatingEventActiveSlot>
          <RepeatingEventActiveSlot>
            <startTime>
              <hour>15</hour>
              <minute>0</minute>
              <second>0</second>
            </startTime>
            <endTime>
              <hour>19</hour>
```
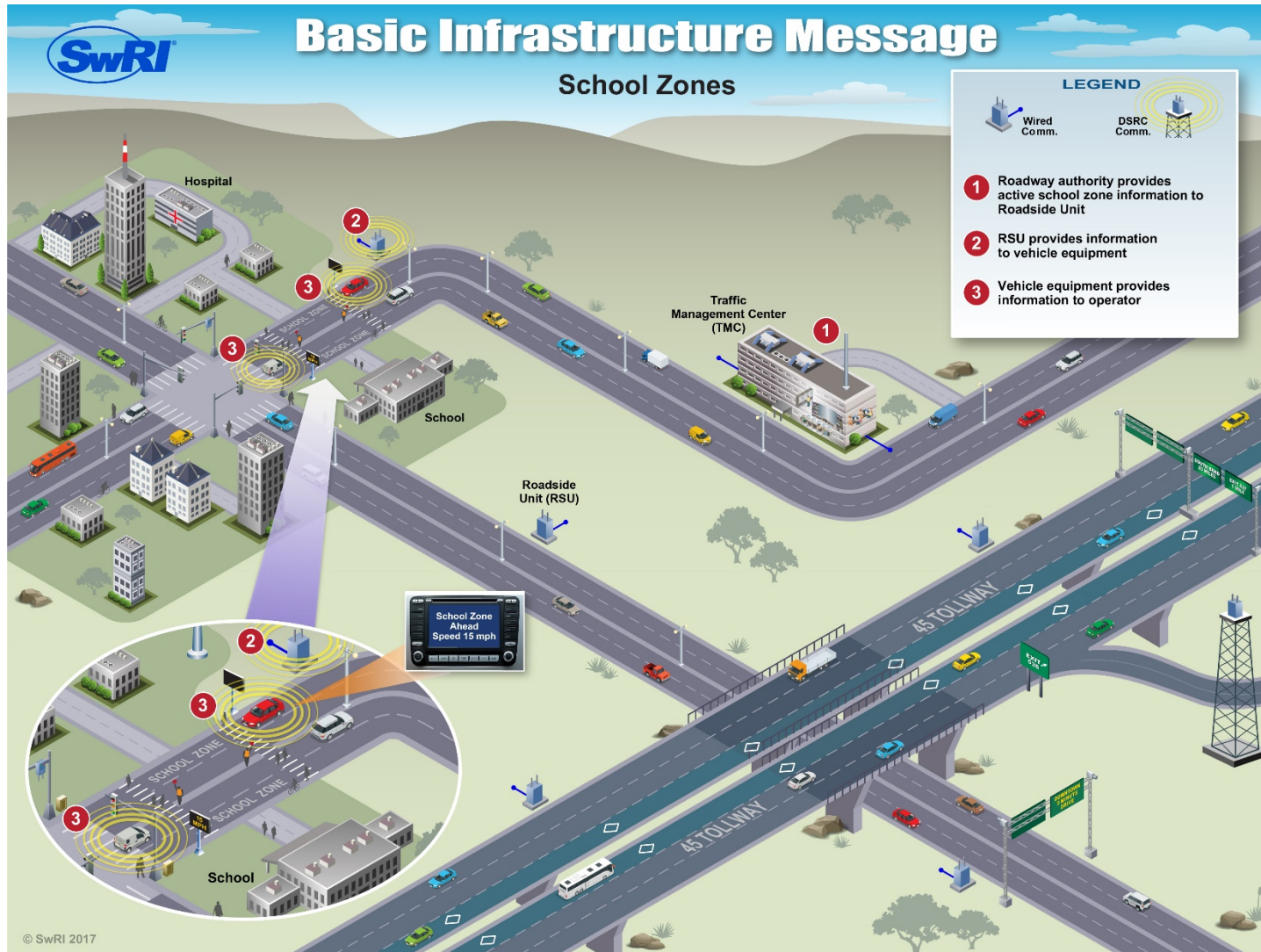
```
                    <minute>0</minute>
                    <second>0</second>
                </endTime>
            </RepeatingEventActiveSlot>
        </activeSlot>
    </VehiclePricing>
    <VehiclePricing>
        <vehicleType>9219</vehicleType>
        <minimumOccupancy>1</minimumOccupancy>
        <costOfEntry>0.00</costOfEntry>
        <activeSlot>
            <RepeatingEventActiveSlot>
                <dayOfWeek>
                    <monday/><tuesday/><wednesday/><thursday/><friday/><saturday/>
                    <sunday/>
                </dayOfWeek>
            </RepeatingEventActiveSlot>
        </activeSlot>
    </VehiclePricing>
    </vehiclePricing>
    </specialLaneInfo>
    </hotLanes>
  </limitedAccessContainer>
</BasicInformationMessage>
```

Situational Awareness: School Zone

Figure 4 — Situational Awareness: School Zone

The BIM data message in an XML format is:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<BasicInformationMessage>
  <commonContainer>
    <timeInfo>
      <dateTime>
        <year>2017</year>
        <month>9</month>
        <day>27</day>
        <hour>8</hour>
        <minute>3</minute>
        <second>59999</second>
        <offset>-300</offset>
      </dateTime>
      <durationTime>30</durationTime>
      <repeatingEvent>
        <typeEvent>4124</typeEvent>
      </repeatingEvent>
      <repeatingFrequency>
        <RepeatingEventActiveSlot>
          <startTime>
            <hour>7</hour>
            <minute>0</minute>
            <second>0</second>
            <offset>-300</offset>
          </startTime>
          <endTime>
            <hour>9</hour>
            <minute>0</minute>
            <second>0</second>
            <offset>-300</offset>
          </endTime>
          <dayOfWeek>
            <monday/><tuesday/><wednesday/><thursday/><friday/>
          </dayOfWeek>
        </RepeatingEventActiveSlot>
        <RepeatingEventActiveSlot>
          <startTime>
            <hour>15</hour>
            <minute>0</minute>
            <second>0</second>
            <offset>-300</offset>
          </startTime>
          <endTime>
            <hour>17</hour>
            <minute>0</minute>
            <second>0</second>
            <offset>-300</offset>
          </endTime>
```

```
        <dayOfWeek>
          <monday/><tuesday/><wednesday/><thursday/><friday/>
        </dayOfWeek>
      </RepeatingEventActiveSlot>
    </repeatingFrequency>
  </timeInfo>
  <regionInfo>
    <point>
      <lat>294663650</lat>
      <long>-986163730</long>
      <elevation>2685</elevation>
    </point>
    <polygon>
      <Position3D>
        <lat>294663635</lat>
        <long>-986174002</long>
      </Position3D>
      <Position3D>
        <lat>294661820</lat>
        <long>-986173679</long>
      </Position3D>
      <Position3D>
        <lat>294662847</lat>
        <long>-986166582</long>
      </Position3D>
      <Position3D>
        <lat>294663072</lat>
        <long>-986148937</long>
      </Position3D>
      <Position3D>
        <lat>294664745</lat>
        <long>-986149007</long>
      </Position3D>
      <Position3D>
        <lat>294664661</lat>
        <long>-986166761</long>
      </Position3D>
    </polygon>
    <roadwayName>Ingram Rd</roadwayName>
    <heading>6520</heading>
  </regionInfo>
</commonContainer>
<situationalContainer>
  <schoolZone>
    <reducedSpeed>
      <type><maxSpeedInSchoolZone/></type>
      <speed>447</speed>
    </reducedSpeed>
    <crossingGuards>1</crossingGuards>
    <crossingInProgress><true/></crossingInProgress>
    <flashingBeacons><true/></flashingBeacons>
```
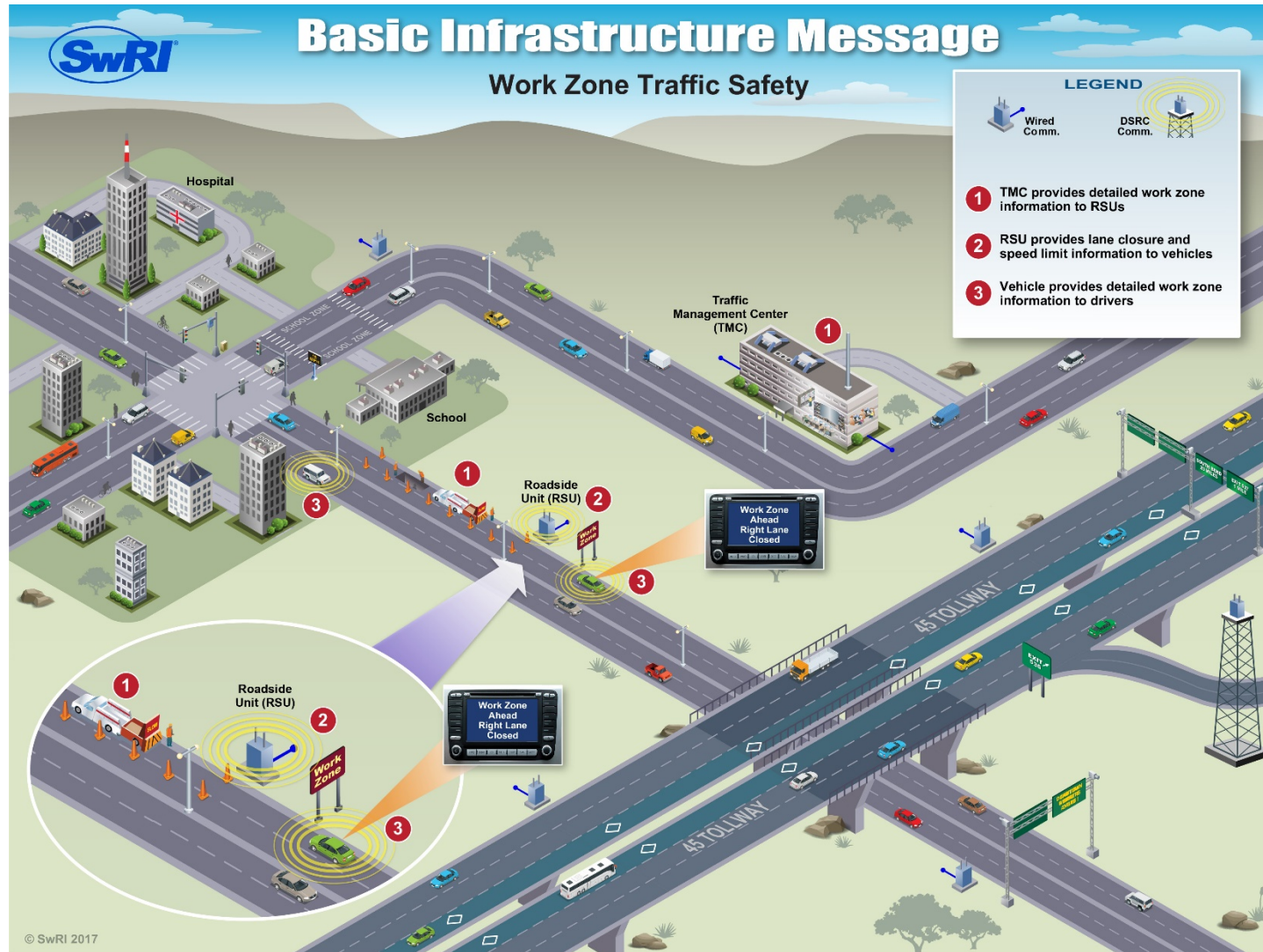
```
        <childrenPresent><true/></childrenPresent>
      </schoolZone>
    </situationalContainer>
</BasicInformationMessage>
```

Situational Awareness: Work Zone

Figure 5 — Situational Awareness: Work Zone

The BIM data message in an XML format is:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<BasicInformationMessage>
  <commonContainer>
    <timeInfo>
      <dateTime>
        <year>2017</year>
        <month>9</month>
        <day>27</day>
        <hour>8</hour>
        <minute>3</minute>
        <second>59999</second>
        <offset>-300</offset>
      </dateTime>
      <durationTime>300</durationTime>
    </timeInfo>
    <regionInfo>
      <point>
        <lat>294663650</lat>
        <long>-986163730</long>
        <elevation>2685</elevation>
      </point>
      <polygon>
        <Position3D>
          <lat>294663635</lat>
          <long>-986174002</long>
        </Position3D>
        <Position3D>
          <lat>294661820</lat>
          <long>-986173679</long>
        </Position3D>
        <Position3D>
          <lat>294662847</lat>
          <long>-986166582</long>
        </Position3D>
        <Position3D>
          <lat>294663072</lat>
          <long>-986148937</long>
        </Position3D>
        <Position3D>
          <lat>294664745</lat>
          <long>-986149007</long>
        </Position3D>
        <Position3D>
          <lat>294664661</lat>
          <long>-986166761</long>
        </Position3D>
      </polygon>
      <roadwayName>Ingram Rd</roadwayName>
```

```
        <heading>6520</heading>
      </regionInfo>
  </commonContainer>
  <situationalContainer>
    <workZone>
      <roadWorkDescription>1025</roadWorkDescription>
      <workersPresent>1</workersPresent>
      <flagman>1</flagman>
      <reducedSpeed>
        <type><maxSpeedInConstructionZone/></type>
        <speed>671</speed>
      </reducedSpeed>
    </workZone>
  </situationalContainer>
</BasicInformationMessage>
```
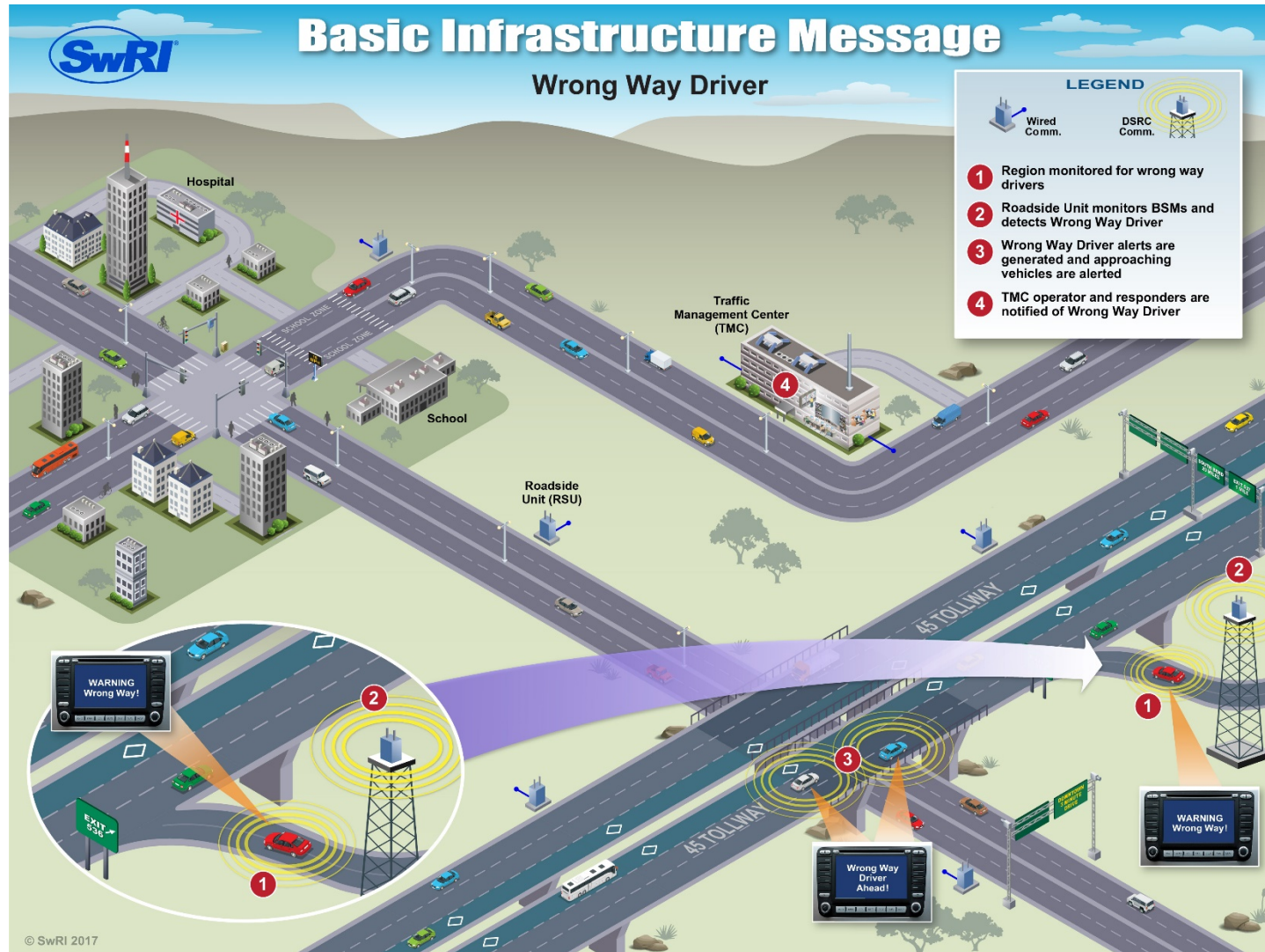
Situational Awareness: Wrong Way Driver

Figure 6 — Situational Awareness: Wrong Way Driver

The BIM data message in an XML format is:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<BasicInformationMessage>
  <commonContainer>
    <timeInfo>
      <dateTime>
        <year>2017</year>
        <month>9</month>
        <day>13</day>
        <hour>11</hour>
        <minute>0</minute>
        <second>0</second>
      </dateTime>
      <durationTime>10</durationTime>
    </timeInfo>
    <regionInfo>
      <point>
        <lat>294539310</lat>
        <long>-98629073</long>
        <elevation>2319</elevation>
      </point>
      <roadwayName>I-410</roadwayName>
      <heading>17720</heading>
    </regionInfo>
  </commonContainer>
  <situationalContainer>
    <wwd>
      <WWDSequence>
        <timeInfo>
          <dateTime>
            <year>2017</year>
            <month>9</month>
            <day>13</day>
            <hour>11</hour>
            <minute>0</minute>
            <second>0</second>
          </dateTime>
          <durationTime>10</durationTime>
        </timeInfo>
        <regionInfo>
          <point>
            <lat>294539310</lat>
            <long>-98629073</long>
            <elevation>2319</elevation>
          </point>
          <roadwayName>I-410</roadwayName>
          <heading>17720</heading>
        </regionInfo>
        <speed>1565</speed>
```

```
        </WWDSequence>
        <WWDSequence>
          <timeInfo>
            <dateTime>
              <year>2017</year>
              <month>9</month>
              <day>13</day>
              <hour>10</hour>
              <minute>59</minute>
              <second>56</second>
            </dateTime>
            <durationTime>10</durationTime>
          </timeInfo>
          <regionInfo>
            <point>
              <lat>294547010</lat>
              <long>-986283310</long>
              <elevation>2318</elevation>
            </point>
            <roadwayName>I-410</roadwayName>
            <heading>17720</heading>
          </regionInfo>
          <speed>1520</speed>
        </WWDSequence>
      </wwd>
    </situationalContainer>
</BasicInformationMessage>
```
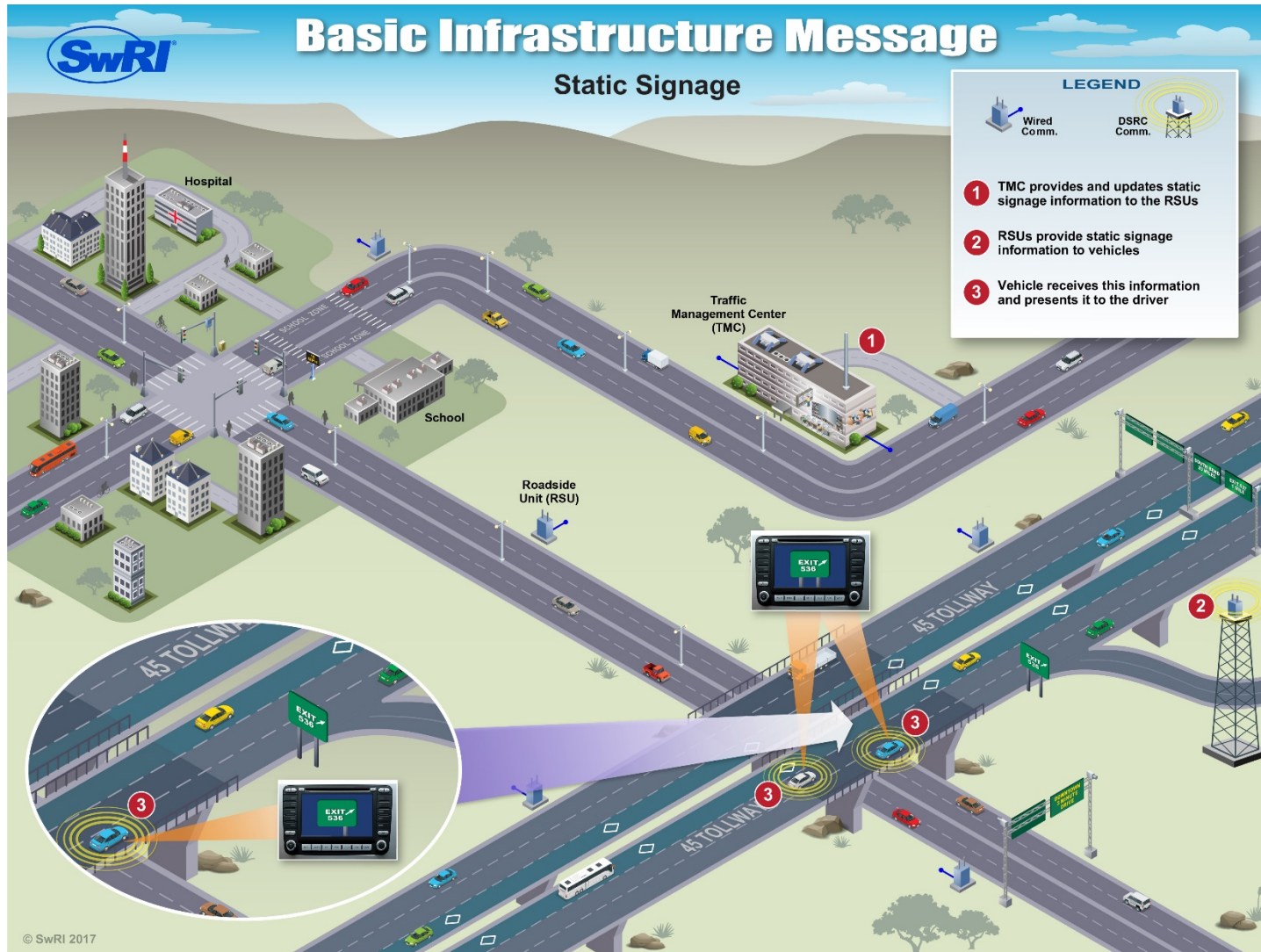
Static Signage:

Figure 7 — Static Signage

The BIM data message in an XML format is:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<BasicInformationMessage>
  <commonContainer>
    <timeInfo>
      <dateTime>
        <year>2017</year>
        <month>10</month>
        <day>18</day>
        <hour>15</hour>
        <minute>3</minute>
        <second>30000</second>
        <offset>-300</offset>
      </dateTime>
      <durationTime>0</durationTime>
    </timeInfo>
    <regionInfo>
      <point>
        <lat>294893475</lat>
        <long>-985737445</long>
        <elevation>2384</elevation>
      </point>
      <roadwayName>I-410</roadwayName>
      <heading>7200</heading>
    </regionInfo>
  </commonContainer>
  <staticSignageContainer>
    <mutcdCode><guide/></mutcdCode>
    <mutcdSignDesignation>E5-1a 536</mutcdSignDesignation>
  </staticSignageContainer>
</BasicInformationMessage>
```

Incidents:

Figure 8 — Incidents

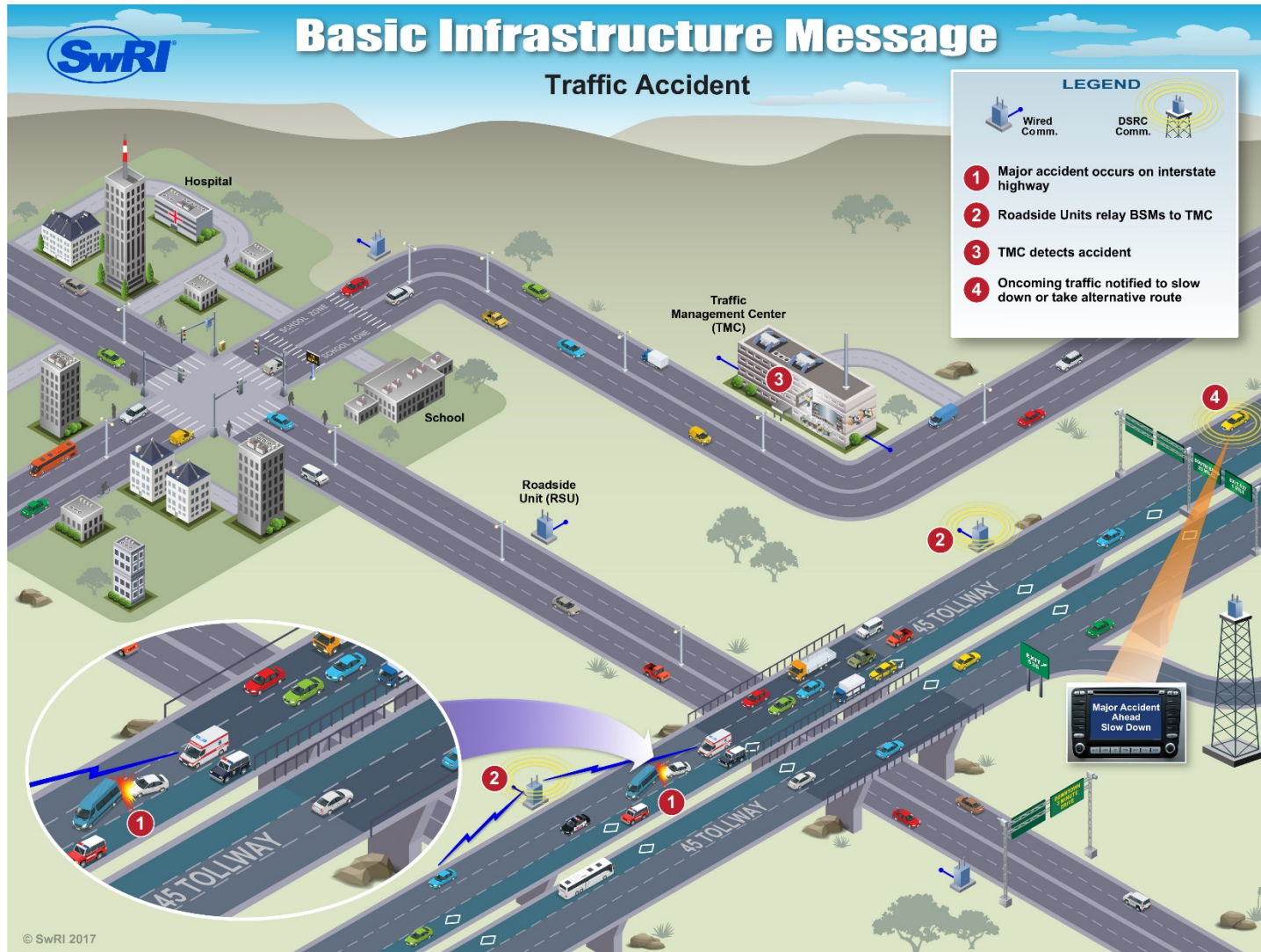The BIM data message in an XML format is:

```
<?xml version="1.0" encoding="UTF-8"?>
<BasicInformationMessage>
  <commonContainer>
    <timeInfo>
      <dateTime>
        <year>2017</year>
        <month>9</month>
        <day>27</day>
        <hour>8</hour>
        <minute>3</minute>
        <second>59999</second>
        <offset>-300</offset>
      </dateTime>
      <durationTime>300</durationTime>
    </timeInfo>
    <regionInfo>
      <point>
        <lat>294663650</lat>
        <long>-986163730</long>
        <elevation>2685</elevation>
      </point>
      <polygon>
        <Position3D>
          <lat>294663635</lat>
          <long>-986174002</long>
        </Position3D>
        <Position3D>
          <lat>294661820</lat>
          <long>-986173679</long>
        </Position3D>
        <Position3D>
          <lat>294662847</lat>
          <long>-986166582</long>
        </Position3D>
        <Position3D>
          <lat>294663072</lat>
          <long>-986148937</long>
        </Position3D>
        <Position3D>
          <lat>294664745</lat>
          <long>-986149007</long>
        </Position3D>
        <Position3D>
          <lat>294664661</lat>
          <long>-986166761</long>
        </Position3D>
      </polygon>
      <roadwayName>Ingram Rd</roadwayName>
```

```
      <heading>6520</heading>
    </regionInfo>
  </commonContainer>
  <incidentsContainer>
    <description>514</description>
    <responderType>
      <ambulance-units/><local-police-units/>
    </responderType>
    <advisorySpeed>
      <type><none/></type>
      <speed>179</speed>
    </advisorySpeed>
    <congestionInfo>
      <queueAheadWarning><true/></queueAheadWarning>
      <startOfQueue>
        <point>
          <lat>294663650</lat>
          <long>-986163730</long>
          <elevation>2685</elevation>
        </point>
        <heading>6560</heading>
      </startOfQueue>
    </congestionInfo>
  </incidentsContainer>
</BasicInformationMessage>
```