



C-ITS MESSAGE PROFILES 2.3.0

C-ROADS Platform

Working Group 2 Technical Aspects

Taskforce 3 Infrastructure Communication

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		302 890-2 added; eventZone made mandatory for single linear relevance or awareness areas (MP_Req_0026 (1)); removal of list of use case specific cC/sCC combinations in the message profiles document; information on detectionZonesToEventPosition added in case of circular awareness areas; references moved to C-Roads_WG2_References document	
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Acronyms

Acronym	Explanation
API	Application Programming Interface
AVG	Automated Vehicle Guidance
CA	Cooperative Awareness
CAM	Cooperative Awareness Message
CCTV	Closed Circuit Television
C-ITS	Cooperative ITS
C-ITS-S	Central ITS Station
C2R	Centre to roadside
CRW	Collision Risk Warning
DE	Data Element
DEN	Decentralized Environmental Notification
DENM	Decentralized Environmental Notification Message
DF	Data Frame
DSRC	Dedicated Short Range Communication
DTI	Digital Transport Infrastructure
F	Facilities Layer
FT	Free Text
FLS	Facilities Layer Service
GBC	Geobroadcast
GLC	Geographic Location Container
GN	GeoNetworking
GNSS	Global Navigation Satellite System
HDT	HD Topology
HF	Header Field
HLN	Hazardous Location Notifications
IP	Internet Protocol
ISMS	Information Security Management Systems
ITS	Intelligent Transport Systems
ITS-G5	ITS-G5 is a European standard for ad-hoc short-range communication of vehicles among each other (V2V) and with Road ITS Stations (V2I). The ITS-G5 Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band is given in [ETSI EN 302 663]. ITS-G5 is a profile of the amendment IEEE 802.11p, which has been incorporated into the main IEEE 802.11 standard, and an IEEE 802.2 LLC. It uses the 5.9 GHz frequency band to support safety- and non-safety ITS applications.

ITS-S	ITS Station
IVI	In-Vehicle Information
IVI service	In-Vehicle Information (IVI) service
IVIM	In-Vehicle Information Message
IVS	In-Vehicle Signage
I2V	Infrastructure to vehicle
km	kilometre
m	metre
MAPEM	MAP (topology) Extended Message
ms	millisecond
MS	Member State
MSP	Mobile ITS G5 System Profile
OBUE	On Board Unit
OSI	Open Systems Interconnection model
PDU	Protocol Data Unit
PKI	Public Key Infrastructure
R-ITS-S	Roadside ITS Station (the so-called RSU)
RCC	Road Configuration Container
RLT	Road and Lane Topology
R2C	Roadside to centre
R2W	Roadside to web services
RSP	ITS-G5 Roadside System Profile (abbreviated as Roadside System Profile or Infrastructure Profile)
RSU	Roadside Unit
RWW	Roadworks Warning
s	seconds
SAP	Service Access Point
SDU	Service Data Unit
SO PV	Source Position Vector
SP	Service Primitive
SPATEM	Signal Phase And Timing Extended Message
SREM	Signal Request Extended Message
SSEM	Signal request Status Extended Message
TCC	Traffic Control Centre
TLC	Traffic Light Control

TLM	Traffic Light Manoeuvre
UTC	Coordinated Universal Time
VMS	Variable Message Sign
V2I	Vehicle to infrastructure
V2V	Vehicle to vehicle
W2R	Web service to roadside

N/A	Not Applicable
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Glossary

ITS-S application	Uses one or more FLSs with different parameters, depending on the situation, to provide an C-ITS service to the user, e.g. RWW, IVS [ETSI TR 102 638].
Use Case Scenario	Denotes a more specific way to execute an ITS-S application, e.g. Scenario 2 of the HLN-RLX use case which defines automatic and continuous distribution of C-ITS messages in case an approaching train is detected by a signalling system or Scenario 3 of the HLN-RLX use case which defines a warning about a malfunctioning or out of order railway crossing signalling system.
Facilities Layer Service (FLS)	In this document, the term Facilities Layer Service (FLS) is derived from the term ITS-S service as defined in [ETSI EN 302 665]. It describes a communication functionality offered by an ITS-S to an ITS-S application.
Aftermarket solutions	stations installed after factory production of the equipped vehicle
Mobile units	the station is actively sending messages while moving or being moved or being stationary
Stationary units	only being active while being stationary

1. Introduction

1.1 C-Roads platform for harmonisation of C-ITS deployment

The C-Roads Platform is a joint initiative of European Member States and road operators for testing and implementing C-ITS services in light of cross-border harmonisation and interoperability. Through the C-Roads Platform, authorities and road operators join together to harmonise the deployment activities of cooperative intelligent transport systems (C-ITS) across Europe. The goal is to achieve the deployment of interoperable cross-border C-ITS services for road users.

C-ITS enables vehicles to interact directly with each other and the surrounding road infrastructure. In road transport, C-ITS typically involves vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication. In order to enable an efficient and undisturbed exchange of information within these services as well as a cross-border implementation, harmonised C-ITS specifications are indispensable. The approach starts from a functional perspective, then requirements applicable to all implementations and then towards technology specifications of currently validated implementations (ITS-G5 for short range communication, IP based for long range cellular). In order to meet these challenges, the C-ROADS platform is divided into five Working Groups. The first Working Group is concerned with organisational tasks, the second with Technical Aspects and the third with Evaluation and Assessment. The fourth Working Group is about Urban C-ITS Harmonisation and Working Group 5 is about Digital Transport Infrastructure (DTI).

The C-Roads Platform is steered by the C-Roads Steering Committee which is composed by Member State representatives. With the support of the Supporting Secretariat, decisions for achieving the goal of the implementation of interoperable end-user services are taken. In this respect specifications, plans and reports, which are proposed and recommended by specific Working Groups, are approved. Within WG2 these specifications are harmonized in 5 Task Forces and derived from pilot activities and the basis for further pilot and implementation activities. This especially goes with technical decisions, which influence deployment and procurement decisions at pilot sites.

The Working Groups are installed as decision support for the Steering Committee to ensure proper decisions towards interoperable deployments. Individual experts participating in the single pilots work together in these Working Groups to prepare proposals and recommendations. Also, members of the single pilot activities as well as of the C-Roads-Working Groups actively contribute to the work of the EU-C-ITS-Platform.

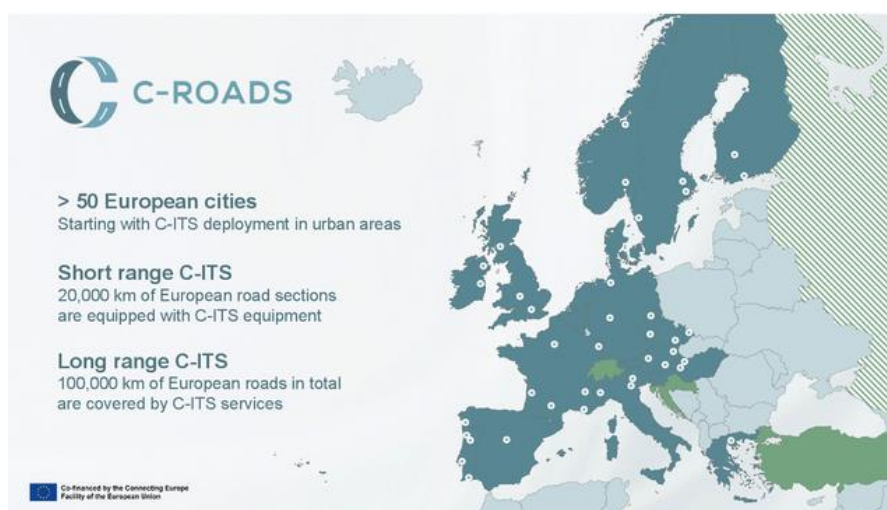


Figure 1 Overview of C-Roads coverage

1.2 Story board C-Roads C-ITS deployment documentation

This document is part of the C-Roads C-ITS Deployment Documentation and Requirements. The complete set of documents is much related to a common project life cycle of a system implementation. As a guide to the C-Roads Documentation, a story board based on such a project life cycle is provided in this section, with emphasis on role of this document *C-ITS Message Profiles*. The story board should be read from left to right and shows the different stages of the project life cycle and how each C-Roads Documentation is related to it, thereby can be supportive to road authorities and other stakeholders.

A complete description of the story board of a C-ITS implementation project, the different stages and the related C-Roads documents is given in *Introduction to the C-Roads WG2 Deployment Documentation and Requirements*.

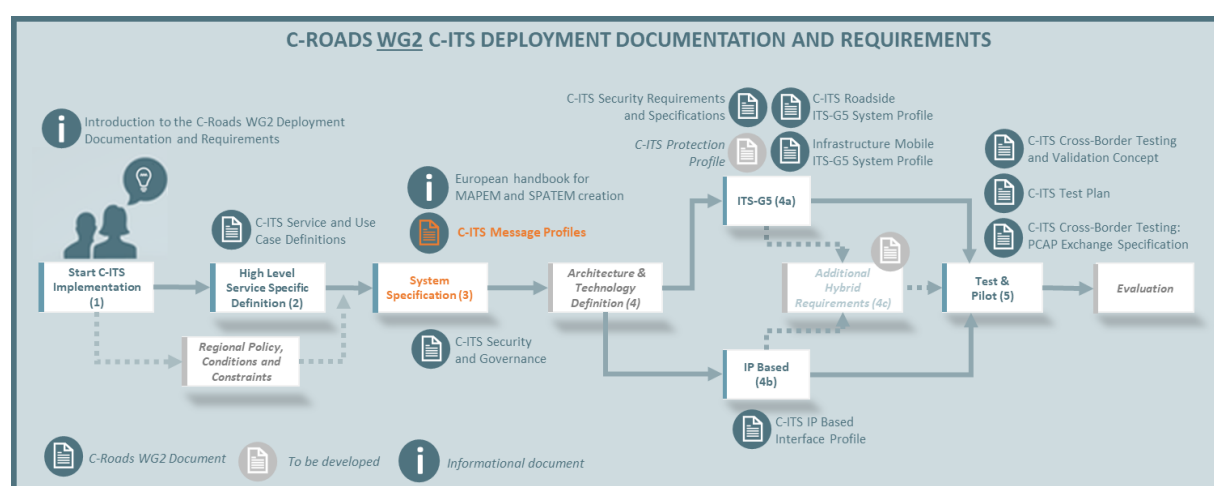


Figure 2: highlight of WG2 document in complete story board

The documents cover a wide range of aspects related to several stages as described in section 1.4 of Introduction to the C-Roads WG2 Deployment Documentation and Requirements. Starting with stage 3, generic requirements and the required governance are specified - those are applicable for all services, use cases and scenarios in a similar way. On stage 4a and 4b, the more detailed specifications are

relevant - including service specific security requirements. Both levels, generic and specific requirements, have impact on the test cases derived on stage 5.

1.3 Scope of this document

This document is one of the documents of stage 3 in the C-Roads workflow, as described in section 1.4 of *Introduction to the C-Roads WG2 Deployment Documentation and Requirements*. This workflow reflects how information flows through the C-ITS station architecture. It starts with an ITS-S application (used by C-ITS Services), which is described in the stage 2 documents. In order to perform its function, the ITS-S application decides to send out messages and in order to do so, it invokes a Service Access Point (SAP) of a Facility Layer Service (FLS). The term SAP is taken from the OSI reference model for the interfaces between layers, many people today would probably rather call it an API. The Facility Layer Service performs its task according to its specification and uses SAPs of underlying layers (transport, network, access) for doing so. The according specifications are not developed in C-Roads, standards are used for this instead, e.g. [ETSI TS 103 831] and [ETSI TS 103 301] for the Facility Layer services.

What the stage 3 documents specify are the profiles used for these standards, depending on how the FLS is invoked. Hence, the behaviour is ITS-S application and use case specific, since different ITS-S applications – as well as the same ITS-S application in different Use Cases – invoke the FLS differently. Stage 3 describes the profiles on FLS level in the document named “C-ITS Message Profiles”, and the underlying layer aspects – where needed – in the “Roadside ITS G5 System Profile” [C-Roads RSP] and “Infrastructure Mobile ITS G5 System Profile” [C-Roads MSP] documents.

The present document *C-ITS Message Profiles* describes the Facility Layer Service (FLS) that are used in the current release of the C-Roads specification. In the current version this includes the following FLS:

- Decentralise Environmental Notification
- Infrastructure to Vehicle Information
- Traffic Light Manoeuvre
- Road and Lane Topology
- Traffic Light Control
- Cooperative Awareness Basic Service
- Collective Perception Service
- Parking Availability Service

This document provides the message profiles used by different ITS-S applications and in different use cases, and it also provides the parameters used to control the FLS behaviour when invoking the underlying layers for transport, network and access.

This document defines the common base for the C-ITS message specifications. The specification targets predominantly the communication between **roadside units and vehicles**. The communication directions derived from this are also known as **I2V** (Infrastructure-to-Vehicle) and **V2I** (Vehicle-to-Infrastructure) communication. It also covers communication from vehicles assuming special roles, such as road operator vehicles, emergency vehicles, public transport vehicles, to other conventional vehicles. The latter falls into the category of **V2V** (vehicle-to-vehicle) communication. This selection has been taken based on maturity consideration, i.e. only specifications that have been implemented and tested in the field can be considered for this document.

Thus, note that the interfaces between the following units are not included in the current release of this specification:

- Roadside and centres (R2C and C2R)
- Roadside and web services (R2W and W2R)

This document is structured into the following three sections:

- Section 2 defines verbal forms and provisions
- Section 3 lists the functional description of supported system FLS and ITS-S applications
- Section 4 provides the technical specifications of the supported FLSs. It includes also the security and management entity related specifications. Nevertheless, these will not be handled fully in this document.

2. Provisions

2.1 Verbal forms for the expression of provisions

In this document, the following verbal forms are used to indicate requirements:

Shall / Shall not

Recommendations shall be indicated by the verbal forms:

Should / Should not

Options shall be indicated by the verbal forms:

May / May not

Possibility and capability as part of information shall be indicated by the verbal forms:

Can / Cannot

Inevitability as part of information used to describe behaviour of systems beyond of the scope of this deliverable shall be indicated by:

Will / Will not

Facts as part of information shall be indicated by the verbal forms:

Is / Is not

2.2 Requirements structure

The requirements defined in this document follow the following structure:

DE/DF	<i>Path_To_DE_or_DF</i>
O/M/C/F	<i>One of Optional/Mandatory/Conditional/Forbidden</i>
ID	<i>Unique Requirement ID</i>
<i>Requirement/ Recommendation/ Option/ Information</i>	Text of requirement here. Note: Optional note.

The unique requirement ID is defined in the following structure:

- MP_Req_xxxx (y): for requirements
- MP_Rec_xxxx (y): for recommendations
- MP_Opt_xxxx (y): for options

- MP_Inf_xxxx (y): for information

Where “xxxx” is replaced by a unique number and (y) is replaced by the version of the requirement.

In the upper right corner it is indicated whether a DE/DF is mandatory (M), optional (O), conditional (C) or forbidden (F). Conditional means that specific conditions apply for the usage of the respective component. The condition itself is defined within the requirement itself. Forbidden means that the component shall not be used.

2.3 Provisions from referenced documents

Normative requirements included in the referenced documents supporting the required functionality of the ITS system shall apply. The verbal forms for the definition of provisions of referenced documents are defined either inside the particular document or generally by the respective SDO (= standards developing organization) or the organization providing them.

2.4 Usage of data elements/data frames

The usage contains information on the use of the Data Elements/Data Frames (DE/DF) in the scope of the C-ITS Roadside ITS G5 System Profile or C-ITS Infrastructure Mobile ITS G5 System Profile. This may contain restrictions regarding value / lexical space in case of DEs (e.g. if only a subset of possible values is used). The usage may contain definitions of DE/DF in accordance with corresponding standards. For all messages, profiles for general usage are provided, which apply to all ITS-S applications. Additionally for some messages, ITS-S application specific's message profile extensions are provided. The necessity of elements is denoted with mandatory or optional.

2.5 Principles of location referencing of infrastructure-based messages

The following principles apply to location referencing.

- Infrastructure is working with map projections.
- Map projections provide equidistant points at the middle of the carriageway.
- There is no rule for the exact number and distance of points, this will be specific to the situation on the road and deviate from message to message.
- Maximum deviation between reality and map projection is determined by the number of lanes.

3. System Facilities Layer Services (System FLSs)

3.1 5.8 GHz DSRC / 5.9 GHz C-ITS Coexistence System FLS

3.1.1 Introduction

The Coexistence FLS supports the announcement of Protected Zones, in which other ITS stations operate without interfering with CEN DSRC based tolling equipment by using mitigation methods in accordance with [ETSI EN 302 571]. In order to avoid harmful interference to CEN DSRC tolling systems operating at 5.8 GHz, ITS stations need to implement mitigation techniques as defined in [ETSI TS 102 792]. These mitigation techniques need to be applied in a Protected Zone, which is a circular area around tolling equipment.

According to [ETSI TS 102 792], there are three ways that mobile and personal ITS stations become aware of a protected zone:

1. Announcement of Protected Zones via Protected Zone Database.
2. Announcement of Protected Zones via CAMs broadcasted from ITS-G5 stations.
3. Direct detection of the tolling signal by a detector in a vehicle (see [ETSI TS 102 792] Clause 5.2.5 for details).

Fixed ITS stations (i.e. roadside installations in a fixed location) may be configured at installation time to meet the coexistence requirements of its local environment ([ETSI TS 102 792], Clause 5.5.2).

Road operators can announce Protected Zones according to (1.) and (2.) above. Road operators shall ensure that their ITS stations (fixed roadside installations as well as VMS/roadworks trailers) operate according to requirements for interference mitigation for CEN DSRC and HDR DSRC in [ETSI EN 302 571].

Protected zone specification based on [ETSI TS 102 792]

As a basis for the coexistence ITS-S application, Protected Zones identify the area in which an ITS station has to ensure not to interfere with CEN DSRC equipment.

3.1.2 Announcement of Protected Zones via Protected Zone Database

To ensure that CEN-DSRC tolling stations are protected against harmful interference by ITS stations, toll chargers and road operators can provide their protected zone data to a European Protected Zone Database. Only permanent tolling installations shall be entered into the database, but not temporary toll stations and tolling enforcement vehicles.

3.1.3 Announcement of Protected Zones via CAMs broadcasted from ITS-G5 roadside stations

As the manufacturers of mobile ITS stations are not required to update the equipment-internal list of Protected Zones after the equipment was built, toll chargers and road operators may announce Protected Zones also by means of the transmission of a Cooperative Awareness Message (CAM) in which the locations of CEN-DSRC tolling stations are given.

3.1.3.1 Message format

A CAM for the Coexistence ITS-S application identifies at least one single Protected Zone but may identify a list of Protected Communication Zones within the data frame *ProtectedCommunicationZonesRSU*. This list may contain up to 16 single data elements of type *ProtectedCommunicationZone*. A protected communication zone is defined at least by the type (permanent or temporary tolling) as well as latitude and longitude of the centre position. An optional radius can be specified, if the radius deviates from the default radius, as specified in [ETSI EN 103 900]. The expiry time shall be specified if the end of tolling operation is known. Chapter 0 provides detailing of the elements used.

3.1.3.2 Operational specifications

The Coexistence FLS can be used by road operators and toll chargers that intend to protect their tolling equipment. It is a prerequisite to the Coexistence FLS that Protected Zone data is made available to the roadside ITS stations (R-ITS-S) that are intended to disseminate these data via CAMs. Protected Zone data may be placed directly in the R-ITS-S or sent to the R-ITS-S from any other infrastructure component.

EXAMPLE: In AT the Protected Zone data is provided by the TCC to the C-ITS-S; then the C-ITS-S distributes it to selected R-ITS-S which broadcast it via CAMs.

Furthermore, it needs to be ensured that the Protected Zone CAMs can be received and processed by mobile ITS stations in time by appropriate selection of the dissemination area and considering the CAM transmission rate.

3.2 Other system FLSs

There are currently no other system FLSs.

4. Functional FLSs

4.1 Introduction

This chapter defines technical and operational specifications of the infrastructure FLSs, in line with their functional description in [C-Roads SUD]. For the current release, those definitions and rules have been considered that have been specified and tested in the context of national implementations.

This chapter is structured into four subsections:

- Subsection 4.2 is based on following facilities layer service definitions based on the ETSI ITS station reference architecture / ITS-S host ([ETSI EN 302 665]) and the facilities layer protocols and communication requirements for infrastructure FLS [ETSI TS 103 301]:
 - Decentralized Environmental Notification (DEN) basic service ([ETSI TS 103 831]),
 - Infrastructure to Vehicle Information (IVI) service ([ETSI TS 103 301]),
 - Road and Lane Topology (RLT) / Traffic Light Maneuver (TLM) service ([ETSI TS 103 301]),
 - Traffic Light Control (TLC) service ([ETSI TS 103 301]),
 - Cooperative Awareness (CA) basic service ([ETSI EN 103 900]),
 - Collective Perception Service (CPS) ([ETSI TS 103 324]),
 - Parking Availability Service (PAS) ([ETSI TS 103 916]).

This section provides the content profiles of the corresponding message sets (DENM, SPATEM, MAPEM, IVIM, SREM, SSEM, CAM, CPM and POIM-PA). Besides the profiles of data elements and data frames used from the respective message sets, the tables in this section also include relevant service parameters from the respective facilities layer services. Note that the tables include only the data elements / data frames from the message payload, not the content of the surrounding data structures of the lower layers including the ItsPduHeader. These data elements / data frames are described in the Roadside ITS-G5 System Profile [C-Roads RSP].

- Subsection Operational Specifications / Triggering Conditions provides operational specifications of the supported FLSs, including their triggering conditions. Service parameters of the respective facilities layer services not mentioned in this document have default values regardless of ITS-S application, use case scenario or national implementation (such general parameters are defined in the C-ITS Roadside ITS-G5 System Profile [C-Roads RSP]). This section also contains choices and parameters of lower layer services (in particular the transport and network layer services and parameters), as far as they are relevant for the ITS-S applications addressed. Wherever the profile indicates ‘not used’ this means: not used for current use cases, kept optional for future use cases, therefore use is not forbidden.
- Subsection Management Entity and subsection Security Principles are reserved for specifications regarding the security and management entities in later revisions.

In the context of a layered communication stack, the message sets handled in this document are Facilities layer PDUs that are exchanged between ITS-Ss. The payload is generated by ITS-S applications in the transmitting ITS-S or other connected ITS-S (e.g. a C-ITS-S) and passed to the Facilities layer via service access points. Beyond the payload, these service access points may include further parameters to control the handling and transmission of the payload (service parameters). At the receiving ITS-S, the messages are forwarded to ITS-S applications or connected ITS-S by forwarding mechanisms.

Once message transmission is triggered, the FLSs may be configured to repeat the transmission, until the ITS-S applications request its termination or trigger another request to generate an updated message.

4.2 Service definition and message content

4.2.1 DEN Basic Service (DEN Basic FLS)

“The DEN service uses the services provided by the protocol entities of the ITS networking & transport layer to disseminate DENM” ([ETSI TS 103 831]).

“A DENM contains information related to an event that has a potential impact on road safety or traffic condition. An event is characterised by an event type, an event reference position, a detection time and a duration. These attributes may change over space and over time” ([ETSI TS 103 831]). The DENM transmission may be independent from the originating ITS-S in some situations.

Four types of DENMs are generated by the DEN basic FLS:

- **new** DENM,
- **update** DENM,
- **cancellation** DENM and
- **negation** DENM.

New and update DENM are being used by all national specifications; the cancellation DENM is not always used. Negation DENM is never used. A common mechanism of terminating an event is sending a **cancellation** DENM by the originating ITS-S. The type of the DENM to be generated depends on the type of the ITS-S application request.

The header of DENM shall be as specified in the data dictionary [ETSI TS 102 894-2]. Detailed data presentation rules of the ITS PDU header in the context of DENM shall be as specified in Annex B of [ETSI TS 103 831].

Sections 4.2.1.1 and 4.2.1.3 provide the message profile for new and update DENMs while section 4.2.1.5 profiles DENM cancellation.

Note: Starting with Release 2.0.6, the DENM based profiles of this document support DENM ([ETSI TS 103 831]) and CDD ([ETSI TS 102 894-2] Release 2 versions). Some of the DENM data elements have thus changed their name - these elements are clearly marked in the profile using "DENM Release 1 notes". Despite the name change, the usage of these data elements is backwards-compatible and will not break earlier implementations based on the old name or interpretation of the data elements. With the move to Release 2, the DENM standard now clearly distinguishes between an awareness area (where information is potentially applicable, like a weather warning, animal or person on the road, ...) and a relevance zone (where the information is applicable for sure, like a roadworks warning, stationary road). The C-ROADS profile supports the following geographical situations for its use cases: Point-based relevance zone, Single circular awareness area, Single linear relevance zone or awareness area (see Figure 3).

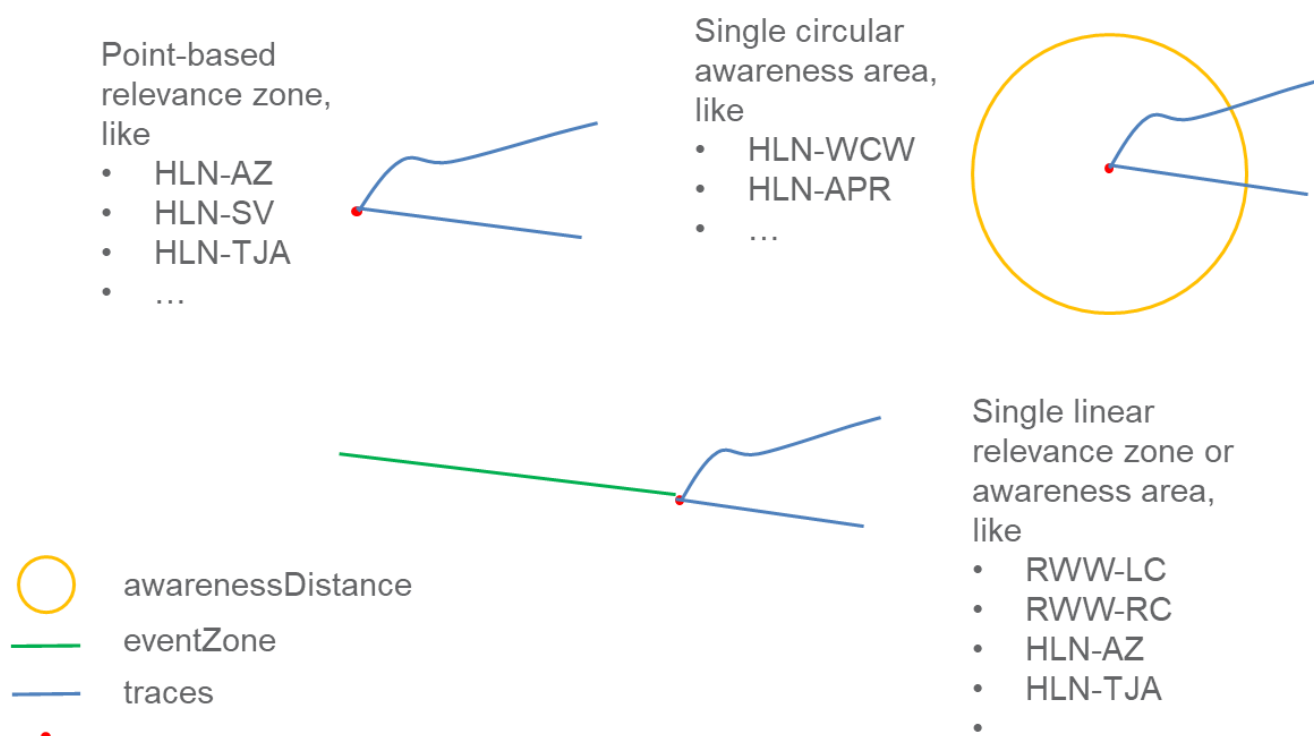


Figure 3 different event zones/areas in DENM

4.2.1.1 DENM general elements

For new and update DENMs, the DENM data elements, DENM data frames and service parameters shall be used according to the definitions in this section. For cancellation DENMs the DENM data elements, DENM data frames and service parameters shall be used according to the definitions in section 4.2.1.5.

DE/DF	DENM.denm.management.actionId
O/M/C/F	Mandatory
ID	MP_Req_0001 (1)
Requirement	In case of centrally detected events, a unique actionId shall be assigned to all DENMs relating to the same event. The resulting DENMs and their actionIds will be used by all ITS-S sending out the same event.
ID	MP_Opt_0002 (1)
Option	In case of locally detected events that are not being sent out by more than one R-ITS-S, individual actionIds may be used, i.e. the generating station may use its own originatingStationId ¹ .
ID	MP_Req_0003 (1)
Requirement	Once the actionId is set, it shall be used for messages relating to the same event, even if they are frequently updated.

¹ DENM.denm.management.actionId.originatingStationId

<i>DE/DF</i>	<i>DENM.denm.management.detectionTime</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0004 (1)</i>
<i>Requirement</i>	In case of locally detected events, the detectionTime shall come from a local time source in the ITS-S (this also includes ITS stations mounted on stationary trailers).
<i>ID</i>	<i>MP_Req_0005 (1)</i>
<i>Requirement</i>	In case of centrally detected events, the detectionTime shall initially be set to the time that the ITS-S application, that creates the DENM, receives the relevant information, i.e. the moment a roadwork or a hazardous location starts / is detected at a functional level.

<i>DE/DF</i>	<i>DENM.denm.management.eventPosition</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0006 (1)</i>
<i>Requirement</i>	The eventPosition shall be located laterally on the affected driving lanes.
<i>ID</i>	<i>MP_Rec_0592 (1)</i>
<i>Recommendation</i>	In case of centrally determined event position, the lateral accuracy shall be within 3m around the centre of the middle of the carriageway.
<i>ID</i>	<i>MP_Rec_0593 (1)</i>
<i>Recommendation</i>	In case of locally determined event position, the lateral accuracy shall be set to the locally detected location.
<i>ID</i>	<i>MP_Inf_0008 (1)</i>
<i>Information</i>	In the I2V use case scenario, the DF eventPosition is used to locate lane or carriageway blockings or hazardous locations. It represents the position where the physical blockage or hazardous location starts on a lane (including hard shoulder) or a carriageway. In case of blockages by trailers, it depends on the national regulation in individual member states whether the blockage is the trailer itself or the first cone in front of the trailer.
<i>ID</i>	<i>MP_Inf_0009 (1)</i>
<i>Information</i>	Legacy Note: Current vehicle implementations don't accept value 800001 (unavailable) for altitudeValue ² . An accurate value needs to be provided. The maximum possible deviation from the value determined by the receiving vehicle is unknown at the moment.

² DENM.denm.management.eventPosition.altitude.altitudeValue

DE/DF	<i>DENM.denm.management.eventPosition.positionConfidenceEllipse</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0010 (1)</i>
Requirement	If no precise value can be given, the DEs semiMajorConfidence ³ and semiMinorConfidence ⁴ shall be set to 4095 (unavailable).
ID	<i>MP_Inf_0011 (1)</i>
Information	Legacy Note: Current vehicle implementations require <ul style="list-style-type: none"> ○ semiMajorConfidence³: Max 10m (unavailable is not acceptable) ○ semiMinorConfidence⁴: Max 10m (unavailable is not acceptable) ○ semiMajorOrientation⁵: anything EXCEPT unavailable

DE/DF	<i>DENM.denm.management.awarenessDistance</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0012 (1)</i>
Requirement	This DE shall be used when describing a single circular awareness area as described in the DENM standard. Note: awarenessDistance describes a circle around the eventPosition ⁶ where the event indicated in the DENM is potentially applicable.
ID	<i>MP_Req_0313 (1)</i>
Requirement	The value shall be set as the minimum value for which the information is valid.
ID	<i>MP_Inf_0013 (1)</i>
Information	DENM Release 1 Note: This DE was previously called “relevanceDistance” in older releases of the DENM standard. Despite the name change, the usage of this DE is backwards-compatible and will not break earlier implementations based on “relevanceDistance”.
ID	<i>MP_Req_0014 (1)</i>
Requirement	When eventZone ⁷ is present, awarenessDistance shall not be used.

³ DENM.denm.management.eventPosition.positionConfidenceEllipse.semiMajorConfidence

⁴ DENM.denm.management.eventPosition.positionConfidenceEllipse.semiMinorConfidence

⁵ DENM.denm.management.eventPosition.positionConfidenceEllipse.semiMajorOrientation

⁶ DENM.denm.management.eventPosition

⁷ DENM.denm.situation.eventZone

DE/DF	<i>DENM.denm.management.trafficDirection</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Opt_0015 (1)</i>
Option	This DF may be used for single circular or single linear awareness areas as well as point based, or single linear relevance zones as defined in the DENM standard. Note: This DF indicates for which traffic direction the message is relevant (from the perspective of the eventPosition ⁶).
ID	<i>MP_Inf_0016 (1)</i>
Information	DENM Release 1 note: This DE was previously called “relevanceTrafficDirection” in older Releases of the DENM standard. Despite the name change, the usage of this DE is backwards-compatible and will not break earlier implementations based on “relevanceTrafficDirection”.
ID	<i>MP_Req_0017 (1)</i>
Requirement	If this DF is used, it shall be set to one of the following values: <ul style="list-style-type: none"> ○ allTrafficDirections (0) ○ sameAsReferenceDirection-upstreamOfReferencePosition (1) ○ sameAsReferenceDirection-downstreamOfReferencePosition (2)

DE/DF	<i>DENM.denm.management.validityDuration</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0018 (1)</i>
Information	Events are represented by DEN messages. The duration of a singular DENM is based on the (configurable) value of validityDuration. As long as an event is valid for the road operator, it will be continuously sent out (using DENM repetition) and updated (using DENM update, renewing validityDuration, detectionTime ⁸ and referenceTime ⁹ in the process). Message update will be triggered by validityDuration falling below a certain (also configurable) threshold. If the event is no longer valid, it is either timing out or being actively cancelled (DENM cancellation).
ID	<i>MP_Inf_0019 (1)</i>
Information	Legacy Note: Vehicles produced before the end of 2023 will drop the messages after 60s and thus ignore longer validityDurations given in the messages. Some vehicles produced from 2024 onwards will keep the messages for 300s and thus ignore longer validityDurations given in the messages. In conclusion, the validityDuration does not need to be changed. But to reach all vehicles continuously, a DENM update (incl. suitable update of detectionTime ⁸ and referenceTime ⁹) needs to be triggered before the 60s run out.

DE/DF	<i>DENM.denm.management.stationType</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0020 (1)</i>

⁸ DENM.denm.management.detectionTime

⁹ DENM.denm.management.referenceTime

<i>Requirement</i>	<p>The stationType shall be set according to the type of C-ITS station and according to [ETSI TS 102 894-2] to one of the following values (depending on the vehicle type):</p> <ul style="list-style-type: none"> ○ 15 (roadSideUnit): for road side unit (fixed and portable) and C-ITS-S ○ 9 (trailer): for static and towed trailers ○ 10 (specialVehicle): for vehicles of category M, N or O for conveying passengers or goods and for performing a special function for which special body arrangements and/or equipment are necessary ○ 6 (bus): for bus ○ 11 (tram): for tram <p>Note: The stationType does not reflect the role of the vehicle, e.g., a police car can have stationType passengerCar (5) but the vehicle role in the CAM is emergency (6) when being in service.</p>
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DF	<i>DENM.denm.situation.informationQuality</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0021 (1)</i>
Information	<p>Guidance on the source of information:</p> <ul style="list-style-type: none"> ○ certain (6): Recent human verification of a detected event by a qualified person who belongs to the same organisation as the source or originator of the ITS message (e.g. road operator or operator of ITS stations). Human verification can be provided by a qualified person who is on-site or observes the event via CCTV. ○ probable (4): Automatic detection under conditions or within an environment, where detections are predictable. ○ risk of (2): Automatic detection under conditions where the results are not very reliable. Or reports from experienced or trustworthy third-party organisations. <p>Note: informationQuality expresses the likelihood of occurrence of an event and not the quality of the location information of the event, which is expressed by eventPosition⁶ and positionConfidenceEllipse¹⁰</p>
DE	<i>MP_Inf_0022 (1)</i>
Information	<p>General definition in relation to EN 16157-3 (DATEX II):</p> <ul style="list-style-type: none"> ○ certain: The source is completely certain of the occurrence of the situation or event. ○ probable: The source has a reasonably high level of confidence of the occurrence of the situation or event. ○ risk of: The source has a moderate level of confidence of the occurrence of the situation or event. <p>Note: DATEX II definitions in EN 16157-3 on ProbabilityOfOccurrence relate “situation record version content”, not to events in the C-ROADS terminology.</p>
DE	<i>MP_Req_0023 (1)</i>
Requirement	For new DENMs, informationQuality shall be set according to the definitions in <i>MP_Inf_0021 (1)</i> .
DE	<i>MP_Req_0024 (1)</i>
Requirement	<p>For update DENMs, informationQuality shall be set as follows:</p> <ul style="list-style-type: none"> ○ reduced from 6 to 4 during the validity duration of the event after an update, if this update is generated automatically without reliable re-confirmation of the event ○ if a re-confirmation by a qualified person is given, the informationQuality stays at or returns to 6 ○ upgraded from 2 or 4 to 6 in case of human verification of the event
DE	<i>MP_Inf_0025 (1)</i>
Information	<p>For cancellation DENMs, the informationQuality is absent since the situation container is absent.</p> <p>If an automated detection system reports the end of the event, then the DENM should be terminated.</p> <p>Note: there may be a latency between the actual end time of the event and the time of the message.</p>

¹⁰ DENM.denm.management.eventPosition.positionConfidenceEllipse

<i>DE/DF</i>	<i>DENM.denm.situation.eventType</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0224 (1)</i>
<i>Requirement</i>	The eventType shall be set according to the use case specific specifications in the interoperability requirements of each DENM based use case specified in [C-Roads SUD].

DE/DF	DENM.denm.situation.eventZone
O/M/C/F	Conditional
ID	MP_Req_0026 (1)
Requirement	This DE shall be used when describing single linear relevance zones or awareness areas as described in the DENM standard, when the endpoint of the physical blockage can be determined.
ID	MP_Req_0027 (1)
Requirement	When awarenessDistance ¹¹ is present, eventZone shall not be used.
ID	MP_Req_0028 (1)
Requirement	If this DE is used, it shall describe the start of a blockage to the end of the blockage, or to the start of a new blockage (another DENM). Note: In the context of single linear relevance or awareness zones, the eventPoint values are provided without corresponding eventDeltaTime ¹² , since the points describe a geospatial extent and not a trajectory.
ID	MP_Opt_0029 (1)
Option	If this DE is used, up to 23 eventPoints may be used.
ID	MP_Inf_0030 (1)
Information	This profile optionally uses this DE when describing single linear relevance or awareness zones as described in the DENM standard. In a relevance zone, the event extends with high certainty over the entire area, in an awareness zone, the event is located somewhere within the area. In the context of single linear relevance or awareness zones, the eventPoint values are provided without corresponding eventDeltaTime ¹² , since the points describe a geospatial extent and not a trajectory.
ID	MP_Req_0031 (1)
Requirement	The DE informationQuality ¹³ shall be set to the same value as informationQuality ¹⁴ in the SituationContainer of the whole DENM.
ID	MP_Rec_0032 (1)
Recommendation	If the eventZone covers an intersection or an entry (in case of a road with physically separated driving directions), one path point of the eventZone should be on the intersection or the location where the traffic enters the eventZone.
ID	MP_Inf_0033 (1)
Information	DENM Release 1 Note: This DE was previously called "eventHistory" in older releases of the DENM standard. Despite the name change, the usage of this DE is backwards-compatible and will not break earlier implementations based on "eventHistory".
ID	MP_Req_0034 (1)
Requirement	The principles of location referencing, defined in section 2.5 of this document shall be fulfilled.

¹¹ DENM.denm.management.awarenessDistance

¹² DENM.denm.situation.eventZone.eventDeltaTime

¹³ DENM.denm.situation.eventZone.informationQuality

¹⁴ DENM.denm.situation.informationQuality

<i>DE/DF</i>	<i>DENM.denm.situation.linkedDenms</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Opt_0035 (1)</i>
<i>Option</i>	This DE may be used to list the actionId(s) ¹⁵ of related DENMs.
<i>ID</i>	<i>MP_Inf_0036 (1)</i>
<i>Information</i>	DENM Release 1 Note: Before DENM Release 2, the DE referenceDenms ¹⁶ was the only way to link DENMs, and only in RWW scenarios. DENM Release 2 allows for linkage of every kind of DENM using this DE.

<i>DE/DF</i>	<i>DENM.denm.location.eventSpeed</i>
<i>O/M/C/F</i>	<i>Conditional</i>
<i>ID</i>	<i>MP_Req_0037 (1)</i>
<i>Requirement</i>	The DF eventSpeed provides the speed of a moving event and shall therefore only be used for non-stationary events.
<i>ID</i>	<i>MP_Inf_0038 (1)</i>
<i>Information</i>	Legacy Note: Current vehicle implementations require the DF eventSpeed.

¹⁵ DENM.denm.management.actionId

¹⁶ DENM.denm.alacarte.roadWorks.referenceDenms

<i>DE/DF</i>	<i>DENM.denm.location.eventPositionHeading</i>
<i>O/M/C/F</i>	<i>Conditional</i>
<i>ID</i>	<i>MP_Req_0039 (1)</i>
<i>Requirement</i>	Heading information via the DF eventPositionHeading shall be provided for moving events.
<i>ID</i>	<i>MP_Opt_0222 (1)</i>
<i>Option</i>	For stationary events, this DF may be used. Note: [ETSI TS 103 831] v2.2.1 contains a non-backwards compatible change which forbids the usage of this DF for stationary events. A change request to correct this is filed at ETSI and a change is expected in the next release.
<i>ID</i>	<i>MP_Req_0040 (1)</i>
<i>Requirement</i>	In particular cases like a reversal movement (e.g., an emergency vehicle in intervention), the heading referenced in the DENM shall be latched to the value before going backward. Note: This way, the event will be considered by vehicles driving towards the mobile ITS station. Note: This implies that heading in CAM is for the example of straight backwards movement +180° compared to the one of DENM.
<i>ID</i>	<i>MP_Rec_0041 (1)</i>
<i>Recommendation</i>	If the speed is below 1 m/s, then the heading value should be latched to the last value before this event.
<i>ID</i>	<i>MP_Req_0042 (1)</i>
<i>Requirement</i>	If <i>MP_Rec_0041 (1)</i> is true, then confidence ¹⁷ shall be set to 'out of range'.
<i>ID</i>	<i>MP_Req_0043 (1)</i>
<i>Requirement</i>	Once the speed rises above 1 m/s, then value ¹⁸ shall be unlatched.
<i>ID</i>	<i>MP_Inf_0223 (1)</i>
<i>Information</i>	Legacy Note: Current vehicle implementations require an eventPositionHeading for RWW use cases, but the confidence ¹⁹ is optional.

¹⁷ DENM.denm.location.eventPositionHeading.confidence

¹⁸ DENM.denm.location.eventPositionHeading.value

¹⁹ DENM.denm.location.eventPositionHeading.confidence

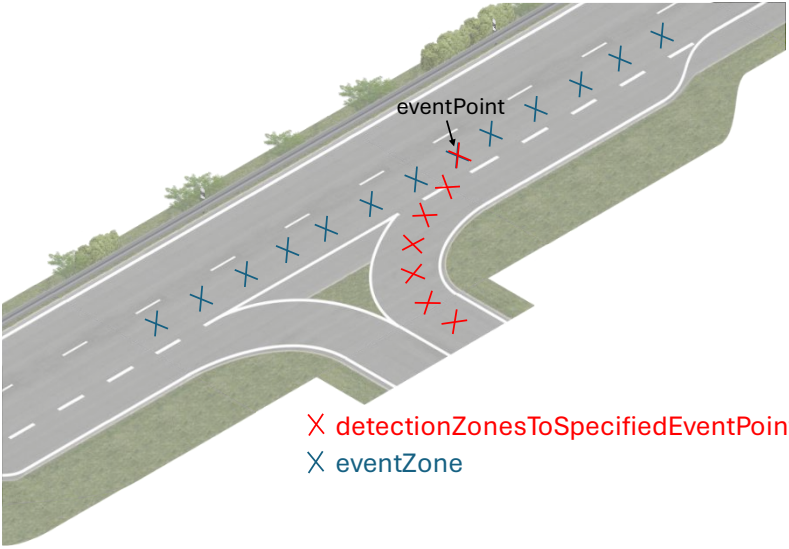
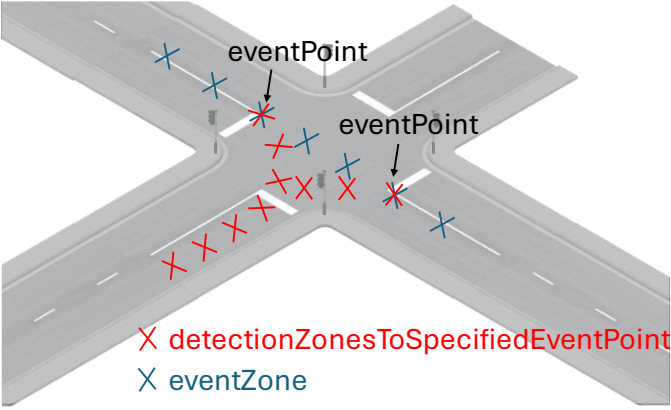
DE/DF	<i>DENM.denm.location.detectionZonesToEventPosition</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0044 (1)</i>
Requirement	At least one instance of detectionZonesToEventPosition shall be provided.
ID	<i>MP_Rec_0045 (1)</i>
Recommendation	Where needed and possible, multiple (up to seven) instances should be provided for different approaches to the event position. Nevertheless, the number of instances possible is limited by the size of the DENM.
ID	<i>MP_Rec_0046 (1)</i>
Recommendation	Road operators should use design method one of [SAE J2945/1] for instances generated in mobile units / vehicles.
ID	<i>MP_Inf_0047 (1)</i>
Information	No matter what design method is used, it is important that mobile units / vehicles take appropriate measures that their detectionZonesToEventPosition always is a usable, linear trajectory leading up to current position of the vehicle.
ID	<i>MP_Rec_0048 (1)</i>
Recommendation	For instances generated centrally (in the TCC or C-ITS-S) for RSU-based dissemination, a method that ensures that the density of points in the instance of detectionZonesToEventPosition is dependent on the curvature of the road should be used (exact method to be defined in a later revision). For existing systems and if that is not possible for the road operator, equidistant points can be used instead.
ID	<i>MP_Rec_0049 (1)</i>
Recommendation	The most relevant instance should have up to 40 equidistant points and a maximum of 3 additional instances with each up to 40 equidistant points should be used in order not to overload the resulting DENM with trace points. Note: a suitable method that ensures the placement of points based on curvature of the road has been published in the [C2C CC Automotive Requirements for the Infrastructure to Vehicle Information (IVI) Service] (RS_ARI_47 & 48). C-Roads is in the process of harmonisation of that method with C2C-CC.
ID	<i>MP_Rec_0050 (1)</i>
Recommendation	In all cases, the most relevant instance of detectionZonesToEventPosition should have a minimum length of 600m.
ID	<i>MP_Req_0051 (1)</i>
Requirement	The possible instances leading to the event position shall be prioritized by relevance (which is the type of road).
ID	<i>MP_Inf_0314 (1)</i>
Information	In case of circular awareness areas, detectionZonesToEventPosition must be provided (as it is mandatory), however they do not lead to the beginning of the event but to the middle of the event (eventPosition). In conclusion, the event does not start at the eventPosition and the detectionZone is already within the event area, so it does not make sense to interpret the detectionZonesToEventPosition.

<i>DE/DF</i>	<i>DENM.denm.location.lanePositions</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Rec_0052 (1)</i>
<i>Recommendation</i>	<p>This DE should be used to indicate the affected lanes. It replaces the DE lanePosition²⁰.</p> <p>Note: Before DENM Release 2, the DE lanePosition²⁰ was the only way to indicate one single affected lane, and only in RWW scenarios. DENM Release 2 now contains the DE lanePositions that allows to indicate more precisely which lanes are affected and to what extent.</p> <p>Note: If more than 4 lanes are affected, do not provide lanePositions so every driver will be careful.</p>

<i>DE/DF</i>	<i>DENM.denm.location.linkedIvims</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Rec_0053 (1)</i>
<i>Recommendation</i>	This DE should be used to reference related IVIMs.

<i>DE/DF</i>	<i>DENM.denm.location.linkedMapems</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Opt_0054 (1)</i>
<i>Option</i>	This DE may be used to reference a related MAPEM.

²⁰ DENM.denm.alacarte.lanePosition

DE/DF	<i>DENM.denm.location.detectionZonesToSpecifiedEventPoint</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Inf_0055 (1)</i>
Information	The DF detectionZonesToSpecifiedEventPoint represent the detection zone information defined by the DENM standard being a list of well-ordered waypoints that forms an itinerary approaching towards the specified event point. The specified event point is an existing path point within the eventZone ⁷ and referenced by its position within the list of path points which form the event zone.
ID	<i>MP_Rec_0056 (1)</i>
Recommendation	<p>The specified event point should be located where the traffic enters the event zone.</p>  <p>zone.</p>
ID	<i>MP_Rec_0057 (1)</i>
Recommendation	<p>If eventPosition⁶ is not located where the traffic enters the event zone, one instance of detectionZonesToSpecifiedEventPoint should lead to one event point for each possible traffic direction closest to the entry point.</p> 

<i>DE/DF</i>	<i>DENM.denm.alacarte.lanePosition</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Rec_0058 (1)</i>
<i>Recommendation</i>	<p>This DE should not be used anymore. The DE lanePositions²¹ should be used instead.</p> <p>Note : Before DENM Release 2, this was the only way to indicate one single affected lane, and only in RWW scenarios. DENM Release 2 now contains the DE lanePositions²¹ that allows to indicate more precisely which lanes are affected and to what extent. This DE should no longer be used and is considered deprecated.</p>

<i>DE/DF</i>	<i>DENM.denm.alacarte.roadWorks</i>
<i>O/M/C/F</i>	<i>Conditional</i>
<i>ID</i>	<i>MP_Req_0059 (1)</i>
<i>Requirement</i>	This container shall only be used in case of RWW use cases.

<i>DE/DF</i>	<i>DENM.denm.alacarte.positioningSolution</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Rec_0060 (1)</i>
<i>Recommendation</i>	This DE should be set to manuallyByOperator (6) for I2V use cases.

4.2.1.2 Information Quality and Triggering Conditions

Example for changing information quality during the validity duration of an event:

²¹ DENM.denm.location.lanePositions

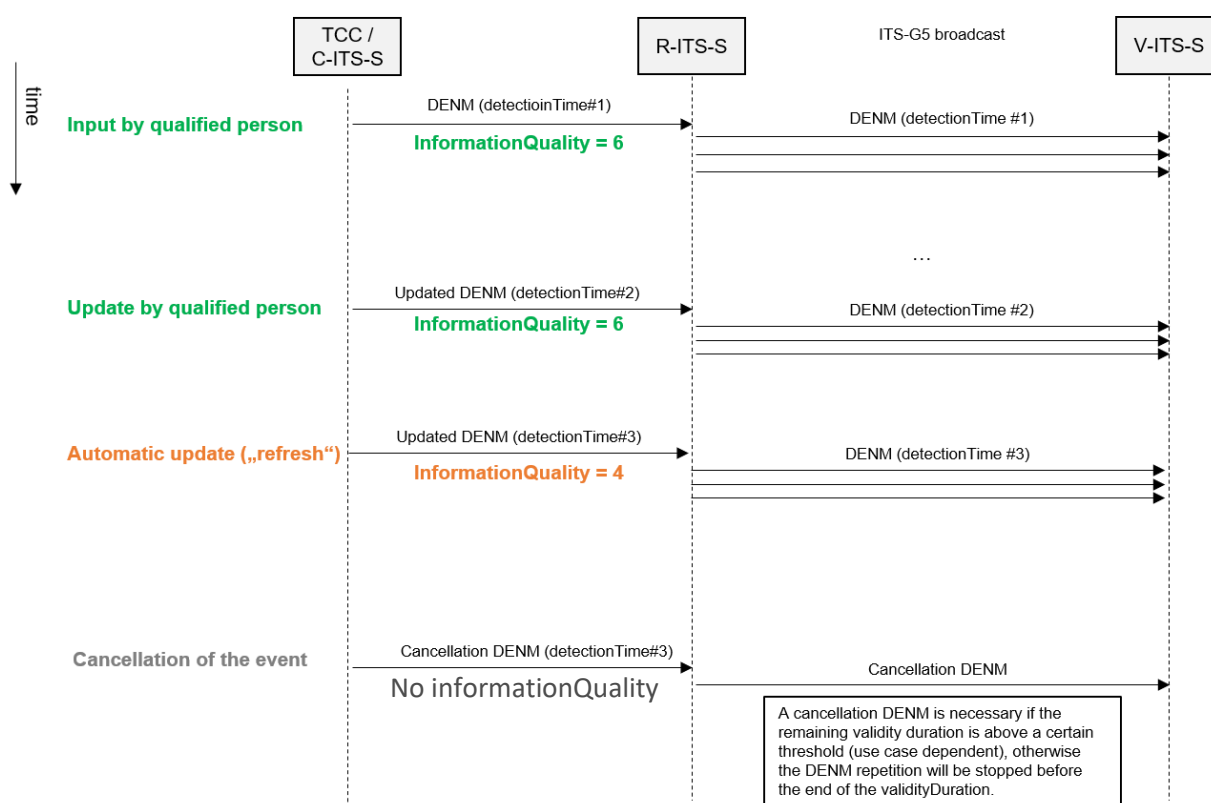


Figure 4 Example sequence diagram of informationQuality in the lifecycle of an event

4.2.1.3 Roadworks Warning (RWW)

DE/DF	<i>DENM.denm.alacarte.roadWorks.closedLanes</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0062 (1)</i>
Recommendation	This DF should be used to indicate for each lane if it is usable for driving or closed. Note: The lanes are counted from inside border of the road excluding the hard shoulder.

DE/DF	<i>DENM.denm.alacarte.roadWorks.speedLimit</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Opt_0063 (1)</i>
Option	This DE may be used to indicate a speed limit.

DE/DF	<i>DENM.denm.alacarte.roadWorks.recommendedPath</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0064 (1)</i>
Recommendation	This DF should be used to indicate a recommended path to be followed.

<i>DE/DF</i>	<i>DENM.denm.alacarte.roadWorks.trafficFlowRule</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Rec_0065 (1)</i>
<i>Recommendation</i>	This DE should be used to indicate the side of the road to which the traffic should flow around a roadwork.

<i>DE/DF</i>	<i>DENM.denm.alacarte.roadWorks.referenceDenms</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Rec_0066 (1)</i>
<i>Recommendation</i>	<p>This DE should not be used anymore. The DE linkedDenms²² should be used instead.</p> <p>Note: Before DENM Release 2, this was the only way to link DENMs, and only in RWW scenarios. DENM Release 2 now contains the DE linkedDenms²³ that allows for linkage of every kind of DENM, this DE should no longer be used and is considered deprecated.</p>

4.2.1.4 Hazardous Location Notifications (HLN)

The following section defines the specific usage of DENM data elements and DENM data frames for HLN.

<i>DE/DF</i>	<i>DENM.denm.management.trafficDirection</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0068 (1)</i>
<i>Requirement</i>	<p>One of the following values shall be used:</p> <ul style="list-style-type: none"> ○ allTrafficDirections (0), ○ sameAsReferenceDirection-upstreamOfReferencePosition (1) ○ sameAsReferenceDirection-downstreamOfReferencePosition (2)

²² DENM.denm.situation.linkedDenms

²³ DENM.denm.situation.linkedDenms

4.2.1.5 DENM profile for cancellation

ID	MP_Req_0070 (1)
Requirement	<p>The following requirements hold for DENM cancellation:</p> <ul style="list-style-type: none"> ○ MP_Req_0006 (1) ○ MP_Req_0010 (1) ○ MP_Req_0012 (1) ○ MP_Req_0017 (1) ○ MP_Req_0020 (1) <p>The following options hold for DENM cancellation:</p> <ul style="list-style-type: none"> ○ MP_Opt_0015 (1) <p>The following information holds for DENM cancellation:</p> <ul style="list-style-type: none"> ○ MP_Inf_0013 (1) ○ MP_Inf_0016 (1) ○ MP_Inf_0019 (1)

DE/DF	DENM.denm.management
O/M/C/F	Mandatory
ID	MP_Req_0315 (1)
Requirement	For cancellation DENMs, only the ManagementContainer shall be used. All other containers should not be used or can be ignored.

DE/DF	DENM.denm.management.actionId
O/M/C/F	Mandatory
ID	MP_Req_0071 (1)
Requirement	It shall be the same as the event that is being cancelled.

DE/DF	DENM.denm.management.detectionTime
O/M/C/F	Mandatory
ID	MP_Req_0072 (1)
Requirement	For DENM termination, this DE shall be the time at which the termination of the event is detected.

DE/DF	DENM.denm.management.termination
O/M/C/F	Mandatory
ID	MP_Req_0073 (1)
Requirement	<p>This DE shall be set to 0 (isCancellation).</p> <p>Note: A DENM where this DE is used will render all other messages with the same actionId¹⁵ invalid.</p>

<i>DE/DF</i>	<i>DENM.denm.management.validityDuration</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0074 (1)</i>
<i>Requirement</i>	The validity of the event termination information. This DE shall be set so that the validityDuration is at least as long as the remaining validityDuration of the last sent DENM with the same actionId ¹⁵ , thereby making sure, that all messages related to the specific event are cancelled.

4.2.2 Infrastructure to Vehicle Information (IVI) Service (IVI FLS)

“IVI service is one instantiation of the infrastructure services to manage the generation, transmission and reception of the IVIM messages. An IVIM supports mandatory and advisory road signage such as contextual speeds and roadworks warnings. IVIM either provides information of physical road signs such as static or variable road signs, virtual signs or roadworks” ([ETSI TS 103 301]).

The IVI FLS instantiated in an ITS-Station shall provide either the transmission or the reception service.

Four types of IVIMs are generated by the IVI FLS:

- **new** IVIM
- **update** IVIM
- **cancellation** IVIM and
- **negation** IVIM.

“The type of the IVI to be generated upon an ITS-S application request” ([ETSI TS 103 301]).

The header of IVIM shall be as specified in the data dictionary [ETSI TS 102 894-2].

The data elements of the IVIM message payload are defined in [ISO/TS 19321].

Data elements, data frames and service parameters for new and update IVIM are defined in sections IVIM general elements, In-Vehicle Signage (IVS), Free Text (FT), Automated Vehicle Guidance (AVG), HD Topology (HDT) and Destination Travel Time (DTT). Section IVIM profile for cancellation defined IVIM cancellation.

4.2.2.1 IVIM general elements

<i>DE/DF</i>	<i>IviStructure.mandatory.serviceProviderId</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Inf_0075 (1)</i>
<i>Information</i>	Together with <i>ivIdentificationNumber</i> ²⁴ , this is the unique identifier for messages for the receiving V-ITS-S.
<i>ID</i>	<i>MP_Req_0076 (1)</i>
<i>Requirement</i>	The tuple of <i>serviceProviderId</i> and <i>ivIdentificationNumber</i> ²⁴ shall be unique at every given point in time within a radius of at least 25km around the <i>referencePosition</i> ²⁵ .

<i>DE/DF</i>	<i>IviStructure.mandatory.ivIdentificationNumber</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Inf_0077 (1)</i>
<i>Information</i>	This component serves as the ID of the message per service provider and can be used by other related messages as a reference.

²⁴ *IviStructure.mandatory.ivIdentificationNumber*

²⁵ *IviStructure.optional.glc.referencePosition*

DE/DF	<i>IviStructure.mandatory.timestamp</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0078 (1)</i>
Requirement	The DE timestamp shall be provided.
ID	<i>MP_Inf_0221 (1)</i>
Information	This DE is the timestamp representing the time at which the IVI message is generated or when the last content change of the messages had occurred.

DE/DF	<i>IviStructure.mandatory.validFrom</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0079 (1)</i>
Requirement	This DE shall be present if the contained information is not yet applicable at the point in time when the message is transmitted.
ID	<i>MP_Req_0080 (1)</i>
Requirement	This DE shall not be used if the contained information is applicable at the point in time when the message is transmitted.
ID	<i>MP_Req_0081 (1)</i>
Requirement	Temporal restrictions of individual signs (when a sign is either valid or invalid only for a certain time period) shall be encoded with suitable ISO14823Attributes (DTM, EDT) in the DF roadSignCodes ²⁶ and not by using validFrom of the overall IVIM.

DE/DF	<i>IviStructure.mandatory.validTo</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0082 (1)</i>
Requirement	If validTo is used for an IVIM with status "new" or "update", it shall be set to a time at least 1 hour ahead of the time indicated by the DE timestamp. Note: The minimum duration of 1 hour at the time of first transmission ensures that the entire area affected by the IVIM can be traversed even at slow speed and/or with pauses without the message timing out.
ID	<i>MP_Inf_0083 (1)</i>
Information	Providing this end time can serve the purpose of avoiding an issue of perpetually valid IVIM in case cancellation is missed repeatedly. Hence, this component is not used for either message management or indication of the validity of the signage information. It just provides a fallback measure.
ID	<i>MP_Req_0084 (1)</i>
Requirement	Temporal restrictions of individual signs (when a sign is either valid or invalid only for a certain time period) shall be encoded with suitable ISO14823Attributes (DTM, EDT) in the DF roadSignCodes ²⁶ and not by using validTo of the overall IVIM.

²⁶ IviStructure.optional.giv.roadSignCodes

<i>DE/DF</i>	<i>IviStructure.mandatory.connectedIviStructures</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Opt_0085 (1)</i>
<i>Option</i>	connectedIviStructures may be used to connect individual, self-contained IVIMs belonging to the same event or scenario, only if the event or scenario cannot be fit into one IVIM.

<i>DE/DF</i>	<i>IviStructure.mandatory.ivStatus</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0086 (1)</i>
<i>Requirement</i>	<p>Message management of the IVIM is done via update and cancellation of messages. For that, iviStatus shall be set as follows:</p> <ul style="list-style-type: none"> ○ “new” for new information in the IVIM, e.g. when a new sign is activated on a previously inactive VMS or when changes in the geographic location (GLC, RCC) occur. ○ “update” when the information in the IVIM changes, e.g. when signs change from one state to another on a VMS without changes in the overall geographic location (GLC, RCC). ○ “cancellation” when the information in the IVIM is no longer valid, e.g. when signs are switched off on a VMS or the geographical location (GLC, RCC) changes.

<i>DE/DF</i>	<i>IviStructure.optional.glc</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Rec_0087 (1)</i>
<i>Recommendation</i>	An IVIM can contain more than one Geographical Location Container (GLC). An additional GLC should only be included in an IVIM if required zones cannot be defined within the value range constraints of the DF deltaPositions ²⁷ towards the referencePosition ²⁸ .

²⁷ IviStructure.optional.glc.parts.zone.segment-setOfLanes.line.deltaPositions

²⁸ IviStructure.optional.glc.referencePosition

DE/DF	<i>IviStructure.optional.glc.referencePosition</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0088 (1)</i>
Requirement	The referencePosition shall be centred laterally among the regular driving lanes in one direction, with accuracy allowing for a maximum lateral offset of 3m to the true centre of the regular driving lanes.
ID	<i>MP_Req_0089 (1)</i>
Requirement	Longitudinally, it shall be located somewhere along the longitudinal extension of the zones (detection zones, relevance zones) defined in the same GLC.
ID	<i>MP_Opt_0090 (1)</i>
Option	Road operators may decide to put the referencePosition always at the beginning of the first relevanceZone defined in the same GLC.
ID	<i>MP_Opt_0091 (1)</i>
Option	The altitude ²⁹ may be set to unavailable if unknown. If the altitude ²⁹ is provided, it is the altitude of the road.

DE/DF	<i>IviStructure.optional.glc.parts</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0092 (1)</i>
Requirement	An IVIM shall be self-contained, so the definition of all geographical zones referred to within the IVIM shall be included in the same IVIM.
ID	<i>MP_Rec_0093 (1)</i>
Recommendation	The definition of all geographical zones should be included in as few parts as possible.

DE/DF	<i>IviStructure.optional.glc.parts.zoneld</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0094 (1)</i>
Requirement	zoneld value “32” indicates “no zone” and therefore shall not be used in the GLC as an active zoneld. This is necessary because zone assignment in the RCC can happen either in the RccPart ³⁰ or in the individual laneConfiguration ³¹ , but due to an error in the IVI standard, zoneld is mandatory in both.

DE/DF	<i>IviStructure.optional.glc.parts.laneNumber</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0095 (1)</i>
Requirement	This DE shall be used, if single lanes are described in this location container. The default is absent (no lane information).

²⁹ IviStructure.optional.glc.referencePosition.altitude

³⁰ IviStructure.optional.rcc

³¹ IviStructure.optional.rcc.laneConfiguration

DE/DF	<i>IviStructure.optional.glc.parts.zoneHeading</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Inf_0096 (1)</i>
Information	zoneHeading can be used for relevance zones only to convey the effective direction of applicability of the sign at the first point (=deltaPosition ²⁷) of the zone, indicating the traffic direction.

DE/DF	<i>IviStructure.optional.glc.parts.zone</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0097 (1)</i>
Requirement	The standard defines different representation options, of which the “area” (for NG-TSA) and “segment-setOfLanes” (for all other IVIM based use cases) options shall be used.

DE/DF	<i>IviStructure.optional.glc.parts.zone.segment-segment-setOfLanes</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Rec_0098 (1)</i>
Recommendation	Neither the referencePosition ²⁸ nor the segmentReferencePosition ³² should be part of the zone definition itself.
ID	<i>MP_Req_0099 (1)</i>
Requirement	The first deltaPosition ²⁷ in a zone shall describe the first point of the respective zone. If a zone begins at the referencePosition ²⁸ or the segmentReferencePosition ³² , the first deltaPosition shall be set to (0,0).

³² IviStructure.optional.glc.parts.zone.segment-segment-setOfLanes.segmentReferencePosition

<i>DE/DF</i>	<i>IviStructure.optional.glc.parts.zone.segment-setOfLanes.line</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0100 (1)</i>
<i>Requirement</i>	<p>The “segment-setofLanes” option uses the segmentExtended sequence, in which the polygonalLine shall be centred laterally among the set of all regular driving lanes in one direction that are part of that zone.</p> <p>NOTE: Previous versions of this profile used the segment option instead of the segmentExtended option added in the 2024 version of the IVI standard. The segment option is still available for backwards compatibility to implementations based on earlier profiles. Note however that in the segment option, the first deltaPosition²⁷ of any zone refers back to the original referencePosition²⁸ of the GLC / GlcPart. Due to the restriction of possible values for deltaPosition, the maximum distance between the first point of a zone and its referencePosition is between 1-1.5km. If a zone exceeded these values, another GlcPart with a new referencePosition was necessary. This is why segmentExtended is the preferred solution.</p>
<i>ID</i>	<i>MP_Req_0101 (1)</i>
<i>Requirement</i>	The maximum lateral offset to the true centre of the set of regular driving lanes in one direction described by the zone shall be less than 3m.

DE/DF	<i>IviStructure.optional.glc.parts.zone.segment-segment-setOfLanes.line.deltaPositions</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0102 (1)</i>
<i>Requirement</i>	<p>In the (detection and relevance) zones which starts geographically closest to the referencePosition²⁸, the optional segmentReferencePosition³² within the segmentExtended sequence shall not be used, which results in the first entry of deltaPositions²⁷ contained in polygonalLine referring to the reference position given in the corresponding GLC / GlcPart. All subsequent zones shall instead refer to the zone that ends closest to them by providing the unique identifier (zoneld) of that zone as segmentReferencePosition. Thus, the last point of the referred zone is the new reference position instead of using the original referencePosition in the GLC / GlcPart.</p> <p>Note: Previous versions of this profile used the segment option instead of the segmentExtended option added in the 2024 version of the IVI standard. The segment option is still available for backward compatibility to implementations based on earlier profiles. Note however that in the segment option, the first deltaPosition of any zone refers back to the original referencePosition of the GLC / GlcPart. Due to the restriction of possible values for deltaPosition, the maximum distance between the first point of a zone and its referencePosition is between 1-1.5km. If a zone exceeded these values, another GlcPart with a new referencePosition was necessary. This is why segmentExtended is the preferred solution.</p>
ID	<i>MP_Req_0103 (1)</i>
<i>Requirement</i>	<p>The delta positions in polygonalLine shall be sorted starting from the zone's point (=deltaPosition²⁷) that is closest to the reference position (either referencePosition²⁸ or segmentReferencePosition³²) to the one that is farthest from the reference position, along the course of the road.</p> <p>Note: In case of identical distance of both extremities to the reference position, the designer can choose the most suitable extremity to start with.</p>
ID	<i>MP_Rec_0104 (1)</i>
<i>Recommendation</i>	<p>The density of deltaPositions²⁷ in the polygonalLine should be dependent on the curvature of the road (exact method to be defined in a later revision). NOTE: For existing systems and if that is not possible for the road operator, equidistant points (=deltaPositions) can be used instead.</p> <p>Note: a suitable method that ensures density of points based on curvature of the road has been published in the "Automotive requirements for the infrastructure to vehicle information (IVI) service" (RS_ARI_47 & 48) published by C2C-CC. C-ROADS is in the process of harmonisation of that method with C2C-CC</p>

DE/DF	<i>IviStructure.optional.rcc</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0105 (1)</i>
Requirement	The RCC shall be provided, except if the road operator does not have the information.
ID	<i>MP_Inf_0106 (1)</i>
Information	One RccPart is used for all zones in an IVIM that have the same overall characteristics, i.e. same number of driving lanes at the beginning and end.

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0107 (1)</i>
Information	A list of (1..16) instances of LaneInformation. The number of elements in the list represents the total number of lanes (including hard shoulders) of the directional carriageway.
ID	<i>MP_Req_0108 (1)</i>
Requirement	Each lane shall be represented only once.

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.direction</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0109 (1)</i>
Requirement	Direction of Relevance in relation to the direction (implicitly) defined by the zone using the DE direction. Shall always be set to sameDirection(0).

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.validity</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Opt_0110 (1)</i>
Option	Per default absent. May be set if known in case of lane management if laneType = emergency and laneStatus = provisionallyOpen.

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.laneType</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0111 (1)</i>
Requirement	laneType shall be set to 'traffic' for all lanes available for regular driving. On motorways, the selection shall be restricted to the values „traffic (0)“, „acceleration (3)“, „deceleration (4)“ or „emergency (18)“.

<i>DE/DF</i>	<i>lviStructure.optional.rcc.laneConfiguration.laneWidth</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0112 (1)</i>
<i>Requirement</i>	<p>Shall be provided with an accuracy of 0,3m, if available for the road operator.</p> <p>Note: laneWidth defined the width of the lane in centimetres measured at the first position of the polygonal line indicated by Zonelds</p>

4.2.2.2 In-Vehicle Signage (IVS)

The In-Vehicle Signage (IVS) ITS-S application is implemented using In-Vehicle Information (IVI) messages according to [ISO/TS 19321].

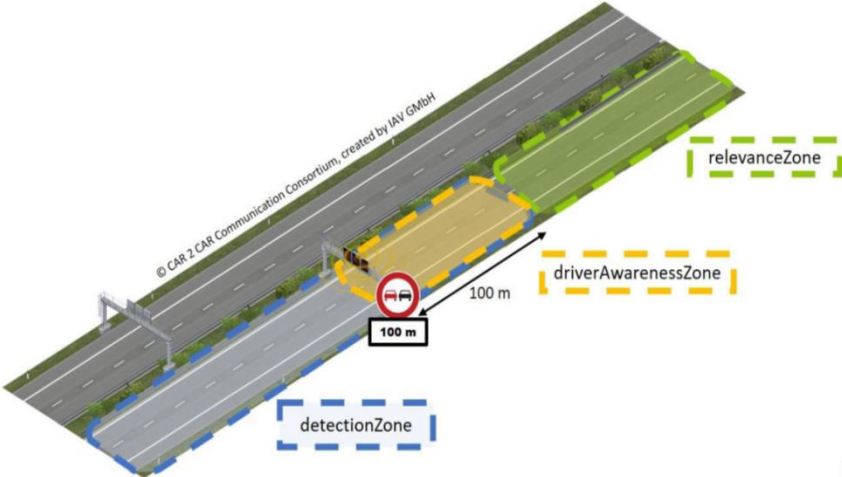
Since all implementations are making use of the IVI standard [ISO/TS 19321], the following section describes how respective data elements and data frames are applied. The IviManagementContainer, GeographicLocationContainer and RoadConfigurationContainer are used as profiled in section 4.2.2.1.

DE/DF	<i>IviStructure.optional.giv</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0113 (1)</i>
Requirement	The giv shall be used for In-Vehicle Signage (IVI-IVS).
ID	<i>MP_Req_0114 (1)</i>
Requirement	One GicPart shall be provided for each traffic sign. Note: While one GicPart could in theory support up to 4 traffic signs via RSCode, these are reserved for additional signs (subsigns) that can be attached to the main sign.

DE/DF	<i>IviStructure.optional.giv.detectionZonelds</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0115 (1)</i>
Information	Refers to one or more zones described in the GLC that act as detection zone for the current GicPart / traffic sign.
ID	<i>MP_Req_0116 (1)</i>
Requirement	Detection zones shall be defined in such a way that the first point (=deltaPosition ²⁷) of any detection zone geographically corresponds (with a maximum deviation of 1m) to either <ul style="list-style-type: none"> ○ any point (=deltaPosition) in a relevance zone or ○ any point (=deltaPosition) in a detection zone leading up to a relevance zone defined in the same IVIM.
ID	<i>MP_Req_0117 (1)</i>
Requirement	The complete detection zone (consisting of one or more consecutive detection zones) shall have a minimum length of 800m and, except if the physical infrastructure of the road operator (e.g. a ramp leading up to the motorway being shorter, the distance between two consecutive traffic signs being less than 800m, physical restrictions in urban and rural scenarios ...) does not make this possible.
ID	<i>MP_Rec_0118 (1)</i>
Recommendation	The complete detection zone (consisting of one or more consecutive detection zones) should have a maximum length of 2000m.
ID	<i>MP_Req_0119 (1)</i>
Requirement	If a driver awareness zone is defined, the associated detection zone shall be longer than or equal to the driver awareness zone, but never shorter.

<i>DE/DF</i>	<i>lviStructure.optional.giv.relevanceZoneIds</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Inf_0120 (1)</i>
<i>Information</i>	Refers to one or more zones described in the GLC that act as relevance zone for the current GicPart / traffic sign.
<i>ID</i>	<i>MP_Req_0121 (1)</i>
<i>Requirement</i>	The relevance zone shall represent the complete road segment where the traffic rules indicated by the sign in the GicPart are applicable.

<i>DE/DF</i>	<i>lviStructure.optional.giv.direction</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Inf_0122 (1)</i>
<i>Information</i>	Direction of Relevance in relation to the direction (implicitly) defined by the zone using the DE direction.
<i>ID</i>	<i>MP_Req_0123 (1)</i>
<i>Requirement</i>	direction shall always be set to sameDirection(0).

DE/DF	<i>IVIStructure.optional.giv.driverAwarenessZonelds</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0124 (1)</i>
Requirement	<p>driverAwarenessZonelds shall be provided if the applicability of a sign does not start at the position of the sign but in a certain distance, with the physical sign located before the start of the relevance zone (see figure below). In this case, the driver</p>  <p>awareness zone shall represent the complete area between the location of the physical sign and the start of the relevance zone.</p>
ID	<i>MP_Req_0125 (1)</i>
Requirement	<p>A driver awareness zone shall always be shorter than or equal to the associated detection zone, but never longer.</p> <p>Note: That means that a detection zone might need to be extended to have the same length as the associated driver awareness zone in scenarios where the driver awareness zone is longer than 800m (which is the minimum requirement for a detection zone).</p>
ID	<i>MP_Rec_0589 (1)</i>
Recommendation	<p>In case of a sequence of identical signs with progressively decreasing distance to validity, only one sign in the series should be encoded.</p>

DE/DF	<i>IviStructure.optional.giv.applicableLanes</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Opt_0126 (1)</i>
Option	If applicable to all lanes on a carriageway this DF may be absent.
ID	<i>MP_Req_0127 (1)</i>
Requirement	If not applicable to all lanes on a carriageway, this DF shall be provided.
ID	<i>MP_Rec_0128 (1)</i>
Recommendation	This DF should not be used if the RCC is not provided.
ID	<i>MP_Rec_0129 (1)</i>
Recommendation	In case the RCC cannot be provided (see MP_Req_0105), applicable lanes should not be used and only signs valid for all legally drivable lanes on the entire carriageway should be transmitted.

DE/DF	<i>IviStructure.optional.giv.ivimeType</i>												
O/M/C/F	<i>Mandatory</i>												
ID	<i>MP_Inf_0130 (1)</i>												
Information	Provides the type of IVI to allow for classification and prioritization of IVI at the receiving ITS-S.												
ID	<i>MP_Req_0131 (1)</i>												
Requirement	<p>Shall be used according to the following mapping from ISO/TS 14823 service categories to iviType:</p> <table border="1"> <thead> <tr> <th>iviType in ISO 19321</th><th>Service category in ISO 14823</th></tr> </thead> <tbody> <tr> <td>0 (immediateDangerWarningMessages)</td><td>11 (Warning), 31 (ambient road condition), 32 (road condition)</td></tr> <tr> <td>1 (regulatoryMessages)</td><td>12 (regulatory)</td></tr> <tr> <td>2 (trafficRelatedInformationMessages)</td><td>13 (guide)</td></tr> <tr> <td>3 (pollutionMessages)</td><td>n/a</td></tr> <tr> <td>4 (noTrafficRelatedInformationMessages)</td><td>21 (public facilities)</td></tr> </tbody> </table>	iviType in ISO 19321	Service category in ISO 14823	0 (immediateDangerWarningMessages)	11 (Warning), 31 (ambient road condition), 32 (road condition)	1 (regulatoryMessages)	12 (regulatory)	2 (trafficRelatedInformationMessages)	13 (guide)	3 (pollutionMessages)	n/a	4 (noTrafficRelatedInformationMessages)	21 (public facilities)
iviType in ISO 19321	Service category in ISO 14823												
0 (immediateDangerWarningMessages)	11 (Warning), 31 (ambient road condition), 32 (road condition)												
1 (regulatoryMessages)	12 (regulatory)												
2 (trafficRelatedInformationMessages)	13 (guide)												
3 (pollutionMessages)	n/a												
4 (noTrafficRelatedInformationMessages)	21 (public facilities)												

DE/DF	<i>IviStructure.optional.giv.vehicleCharacteristics</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0132 (1)</i>
Requirement	If present, it shall contain the definition of the characteristics of the vehicles to which the GeneralIviContainer is applicable.

DE/DF	<i>IviStructure.optional.giv.vehicleCharacteristics.train</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0133 (1)</i>
Requirement	If present, it shall contain the characteristics applicable to the entire vehicle train.

DE/DF	<i>IviStructure.optional.giv.roadSignCodes</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0134 (1)</i>
Information	roadSignCodes specifies one road sign (including additional (sub)signs attached to it) applicable to a relevance zone. Additional attributes to the [ISO 14823-1] road sign code can be added as provided by the ISO14823Attributes.
ID	<i>MP_Req_0135 (1)</i>
Requirement	When a road sign (represented by a RSCode) applies to multiple lanes, it shall occur only once in an IVIM (using one GicPart), with applicableLanes ³³ indicating the concerned lanes.
ID	<i>MP_Inf_0136 (1)</i>
Information	UK RSCode - MPH not KPH for particular signs including speed

DE/DF	<i>IviStructure.optional.giv.RSCode.layoutComponentId</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Inf_0137 (1)</i>
Information	This data frame can be used to associate RSCode to the layout component of referenced layout.

DE/DF	<i>IviStructure.optional.giv.RSCode.code</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0138 (1)</i>
Requirement	For sign-coding the choice iso14823 of type ISO 14823Code (according to [ISO 14823-1]) shall be used.

DE/DF	<i>IviStructure.optional.giv.RSCode.code.iso14823Code.attributes</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0139 (1)</i>
Requirement	Restrictions for individual signs in regard to <ul style="list-style-type: none"> ○ Validity in time (DMT, EDT) ○ Lane Flow (DFL) ○ Vehicle dimensions (VED) ○ Speed (SPE) ○ Rate if Incline (ROI) ○ Distance between vehicles (DBT) ○ Destination (DDD) shall be encoded using the appropriate attributes.

³³ IviStructure.optional.giv.applicableLanes

DE/DF	<i>IviStructure.optional.giv.extraText</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Inf_0140 (1)</i>
Information	Can be used to present additional text associated to a sign (subpanel text) if there is no machine-readable encoding possible.
ID	<i>MP_Req_0590 (1)</i>
Requirement	Shall not be used to if there is a corresponding subpanel code in [ISO 14823-1] representing the required subpanel information
ID	<i>MP_Inf_0141 (1)</i>
Information	One line of Text with a maximum of 32 letters per RSCode (sign or subsign) used in the GicPart. Ordered, so the first line of text corresponds to the first RSCode, the second line to the second RSCode, with a maximum of 4 lines.
ID	<i>MP_Req_0142 (1)</i>
Requirement	If a road sign does not have extra text, a string with a single NULL character (ASCII 0x00) shall be added.
ID	<i>MP_Inf_0143 (1)</i>
Information	The DE language uses a bitstring representing the language according to [ISO 639-1], e.g. German text is encoded as DE (D (10010) and E (10000) 1001010000 according to [ISO 14816]). The actual text can be found in the DE textContent, which is restricted to 32 letters. NOTE: May be ignored by receiving vehicles (i.e. neither evaluated nor shown to the driver) and should only be used for informative and not regulatory data

DE/DF	<i>IviStructure.optional.giv.extraText.layoutComponentId</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0144 (1)</i>
Requirement	In order to be backwards compatible to version 1 of the [ISO/TS 19321] standard, layoutComponentId is mandatory here and shall statically be set to “1”

4.2.2.3 Free Text (FT)

The Free Text (FT) ITS-S application is implemented using In-Vehicle Information (IVI) messages according to [ISO/TS 19321].

Since all implementations are making use of the IVI standard [ISO/TS 19321], the following section describes how respective data elements and data frames from the TextContainer are applied. The IviManagementContainer, GeographicLocationContainer, GeneralIviContainer and RoadConfigurationContainer are used as profiled in section 4.2.2.1, with the only difference that the GeneralIviContainer is optional in a Free Text scenario.

DE/DF	<i>IviStructure.optional.giv</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0145 (1)</i>
Requirement	Shall be used if the Free Text Information also contains a traffic sign. Used as profiled in chapter 4.2.2.1.

DE/DF	<i>lviStructure.optional.tc.detectionZoneIds</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0146 (1)</i>
Information	Refers to one or more zones described in the GLC that act as detection zone for the current TcPart.
ID	<i>MP_Req_0147 (1)</i>
Requirement	Detection zones shall be defined in such a way that the first point (=deltaPosition ²⁷) of any detection zone geographically corresponds (with a maximum deviation of 1m) to either <ul style="list-style-type: none"> ○ any point (=deltaPosition) in a relevance zone or ○ any point (=deltaPosition) in a detection zone leading up to a relevance zone defined in the same IVIM.
ID	<i>MP_Req_0148 (1)</i>
Requirement	The complete detection zone (consisting of one more consecutive detection zones) shall have a minimum length of 800m, except if the physical infrastructure of the road operator (e.g. a ramp leading up to the motorway being shorter, the distance between two consecutive traffic signs being less than 800m, physical restrictions in urban and rural scenarios ...) does not make this possible.
ID	<i>MP_Rec_0149 (1)</i>
Recommendation	The complete detection zone (consisting of one more consecutive detection zones) should have a maximum length of 2000m, except if the physical infrastructure of the road operator (e.g. a ramp leading up to the motorway being shorter, the distance between two consecutive traffic signs being less than 800m, physical restrictions in urban and rural scenarios ...) does not make this possible.

DE/DF	<i>lviStructure.optional.tc.relevanceZoneIds</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0150 (1)</i>
Information	Refers to one or more zones described in the GLC that act as relevance zone for the current TcPart.
ID	<i>MP_Req_0151 (1)</i>
Requirement	The relevance zone shall represent the complete road segment where the traffic information indicated by the text in the TcPart are applicable.

DE/DF	<i>lviStructure.optional.tc.direction</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0152 (1)</i>
Information	Direction of Relevance in relation to the direction (implicitly) defined by the zone using the DE direction.
ID	<i>MP_Req_0153 (1)</i>
Requirement	Shall always be set to sameDirection(0).

<i>DE/DF</i>	<i>IviStructure.optional.tc.driverAwarenessZonelds</i>
<i>O/M/C/F</i>	<i>Conditional</i>
<i>ID</i>	<i>MP_Req_0154 (1)</i>
<i>Requirement</i>	Mandatory only if the applicability of a sign does not start at the position of the sign but in a certain distance, with the physical sign located before the start of the relevance zone. In this case, the driver awareness zone shall represent the complete area between the location of the physical sign and the start of the relevance zone.
<i>ID</i>	<i>MP_Req_0155 (1)</i>
<i>Requirement</i>	<p>A driver awareness zone shall always be shorter than or equal to the associated detection zone, but never longer.</p> <p>Note: That means that a detection zone might need to be extended to have the same length as the associated driver awareness zone in scenarios where the driver awareness zone is longer than 800m (which is the minimum requirement for a detection zone)</p> <p>Note: Please also note the maximum length recommendation of 2000m for a detection zone, which thus also extends to the driver awareness zone.</p>
<i>ID</i>	<i>MP_Rec_0594 (1)</i>
<i>Recommendation</i>	In case of a sequence of identical signs with progressively decreasing distance to validity, only one sign in the series should be encoded.

<i>DE/DF</i>	<i>IviStructure.optional.tc.applicableLanes</i>
<i>O/M/C/F</i>	<i>Conditional</i>
<i>ID</i>	<i>MP_Req_0156 (1)</i>
<i>Requirement</i>	Shall be used if lane specific.
<i>ID</i>	<i>MP_Opt_0157 (1)</i>
<i>Option</i>	If applicable to all lanes on a carriageway this DF may be absent.

<i>DE/DF</i>	<i>IviStructure.optional.tc.iviType</i>												
<i>O/M/C/F</i>	<i>Mandatory</i>												
<i>ID</i>	<i>MP_Inf_0158 (1)</i>												
<i>Information</i>	Provides the type of IVI to allow for classification and prioritization of IVI at the receiving ITS-S.												
<i>ID</i>	<i>MP_Req_0159 (1)</i>												
<i>Requirement</i>	<p>prioritization of IVI at the receiving ITS-S. The following mapping from ISO/TS 14823 service categories to iviType shall be used if a traffic sign is part of the message:</p> <table border="1"> <thead> <tr> <th>iviType in ISO 19321</th><th>Service category in ISO 14823</th></tr> </thead> <tbody> <tr> <td>0 (immediateDangerWarningMessages)</td><td>11 (Warning), 31 (ambient road condition), 32 (road condition)</td></tr> <tr> <td>1 (regulatoryMessages)</td><td>12 (regulatory)</td></tr> <tr> <td>2 (trafficRelatedInformationMessages)</td><td>13 (guide)</td></tr> <tr> <td>3 (pollutionMessages)</td><td>n/a</td></tr> <tr> <td>4 (noTrafficRelatedInformationMessages)</td><td>21 (public facilities)</td></tr> </tbody> </table>	iviType in ISO 19321	Service category in ISO 14823	0 (immediateDangerWarningMessages)	11 (Warning), 31 (ambient road condition), 32 (road condition)	1 (regulatoryMessages)	12 (regulatory)	2 (trafficRelatedInformationMessages)	13 (guide)	3 (pollutionMessages)	n/a	4 (noTrafficRelatedInformationMessages)	21 (public facilities)
iviType in ISO 19321	Service category in ISO 14823												
0 (immediateDangerWarningMessages)	11 (Warning), 31 (ambient road condition), 32 (road condition)												
1 (regulatoryMessages)	12 (regulatory)												
2 (trafficRelatedInformationMessages)	13 (guide)												
3 (pollutionMessages)	n/a												
4 (noTrafficRelatedInformationMessages)	21 (public facilities)												
<i>ID</i>	<i>MP_Req_0160 (1)</i>												
<i>Requirement</i>	If only free text is part of the message, only 2 (trafficRelatedInformationMessages) or 4 (noTrafficRelatedInformationMessages) shall be used.												

<i>DE/DF</i>	<i>IviStructure.optional.tc.vehicleCharacteristics</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Req_0161 (1)</i>
<i>Requirement</i>	If present, it shall contain the definition of the characteristics of the vehicles to which the GeneralIviContainer is applicable.

<i>DE/DF</i>	<i>IviStructure.optional.tc.vehicleCharacteristics.train</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Req_0162 (1)</i>
<i>Requirement</i>	The component "train", if present, shall contain the characteristics applicable to the entire vehicle train.

DE/DF	<i>IviStructure.optional.tc.text</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0163 (1)</i>
Information	<p>The complete Free Text information can be represented in one instance of the DF Text, which has no size restriction. Other instances of DF Text can be used to express the same text in different languages.</p> <p>The DE language data uses a bitstring representing the language according to [ISO 639-1], e.g. German text is encoded as DE (D (10010) and E (10000) 1001010000 according to [ISO 14816]).</p> <p>The actual Free Text can be found in the DE textContent³⁴, which is an UTF8String without a size restriction.</p>
ID	<i>MP_Rec_0164 (1)</i>
Recommendation	Should only be used for informative and not regulatory data since it may be ignored by receiving vehicles (i.e. neither evaluated nor shown to the driver).

DE/DF	<i>IviStructure.optional.tc.data</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0165 (1)</i>
Requirement	Meant for a binary representation of text in a picture. Due to an error in the standard, this DE is mandatory and therefore shall be set to an empty string.

4.2.2.4 Automated Vehicle Guidance (AVG)

The Automated Vehicle Guidance (AVG) ITS-S application is implemented using In-Vehicle Information (IVI) messages according to [ISO/TS 19321].

Since all implementations are making use of the IVI standard [ISO/TS 19321], the following section describes how respective data elements and data frames from the AutomatedVehicleContainer are applied. The IviManagementContainer, GeographicLocationContainer and RoadConfigurationContainer are used as profiled in chapter 4.2.2.1.

DE/DF	<i>IVIStructure.optional.avc</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0166 (1)</i>
Requirement	The AutomatedVehicleContainer shall be used for the AVG service.

³⁴ IviStructure.optional.tc.text.textContent

DE/DF	IVIStructure.optional.avc.detectionZonelds
O/M/C/F	Mandatory
ID	MP_Req_0167 (1)
Requirement	<p>Detection zones shall be defined in such a way that the first point (=deltaPosition²⁷) of any detection zone geographically corresponds (with a maximum deviation of 1m) to either:</p> <ul style="list-style-type: none"> ○ any point (=deltaPosition) in a relevance zone or ○ any point (=deltaPosition) in a detection zone leading up to a relevance zone defined in the same IVIM.
ID	MP_Req_0168 (1)
Requirement	<p>The complete detection zone (consisting of one more consecutive detection zones) shall have a minimum length of 800m, except if the physical infrastructure of the road operator (e.g. a ramp leading up to the motorway being shorter, the distance between two consecutive traffic signs being less than 800m, physical restrictions in urban and rural scenarios ...) does not make this possible.</p>
ID	MP_Rec_0169 (1)
Recommendation	<p>The complete detection zone (consisting of one more consecutive detection zones) should have a maximum length of 2000m, except if the physical infrastructure of the road operator (e.g. a ramp leading up to the motorway being shorter, the distance between two consecutive traffic signs being less than 800m, physical restrictions in urban and rural scenarios ...) does not make this possible.</p>

DE/DF	IVIStructure.optional.avc.relevanceZonelds
O/M/C/F	Mandatory
ID	MP_Inf_0170 (1)
Information	Refers to one or more zones described in the GLC that act as relevance zone for the current AvCPart.
ID	MP_Req_0171 (1)
Requirement	The relevance zone shall represent the complete road segment where the traffic information indicated by the text in the AvCPart are applicable.

DE/DF	IVIStructure.optional.avc.direction
O/M/C/F	Mandatory
ID	MP_Inf_0172 (1)
Information	Direction of Relevance in relation to the direction (implicitly) defined by the zone using the DE direction.
ID	MP_Req_0173 (1)
Requirement	Shall always be set to sameDirection(0).

DE/DF	<i>IVIStructure.optional.avc.applicableLanes</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0174 (1)</i>
Requirement	Shall be used if lane specific.
ID	<i>MP_Opt_0175 (1)</i>
Option	If applicable to all lanes on a carriageway this DF may not be used.

DE/DF	<i>IVIStructure.optional.avc.vehicleCharacteristics</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0176 (1)</i>
Requirement	If present, it shall contain the definition of the characteristics of the vehicles to which the AutomatedVehicleContainer is applicable.

DE/DF	<i>IVIStructure.optional.avc.automatedVehicleRules</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0177 (1)</i>
Requirement	This DF shall be used for the use case SAE Level Guidance, otherwise it shall not be used.

DE/DF	<i>IVIStructure.optional.avc.automatedVehicleRules.priority</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0178 (1)</i>
Requirement	Shall be set to value 0 for use case SAE Level Guidance.

DE/DF	<i>IVIStructure.optional.avc.automatedVehicleRules.allowedSaeAutomationLevels</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0179 (1)</i>
Information	<p>A list of automation levels (0-5). As the use case SAE Level Guidance informs about SAE levels road operators find unsuitable for automated driving on a selected segment, the respective opposite levels are encoded in this DE. If for example SAE levels 4 and 5 are unsuitable from the road operator's point of view, levels 0, 1, 2, and 3 are be put into allowedSaeAutomationLevels.</p> <p>Note: See use case description for any further information about the use case.</p>

DE/DF	<i>IVIStructure.optional.avc.automatedVehicleRules.roadSignCodes</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0180 (1)</i>
Requirement	If used, code ³⁵ shall be set to iso14823.

DE/DF	<i>IVIStructure.optional.avc.automatedVehicleRules.extraText</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Inf_0181 (1)</i>
Information	Can be used to present additional text associated to a sign (subpanel text) only if there is no subpanel code available in [ISO 14823-1].
ID	<i>MP_Inf_0182 (1)</i>
Information	One line of Text with a maximum of 32 letters per RSCode (sign or subsign) used in the AutomatedVehicleRule. Ordered, so the first line of text corresponds to the first RSCode, the second line to the second RSCode, with a maximum of 4 lines.
ID	<i>MP_Req_0183 (1)</i>
Requirement	If a road sign does not have extra text, a string with a single NULL character (ASCII 0x00) shall be added.
ID	<i>MP_Inf_0184 (1)</i>
Information	<p>The DE language uses a bitstring representing the language according to [ISO 639-1], e.g. German text is encoded as DE (D (10010) and E (10000) 1001010000 according to [ISO 14816]).</p> <p>The actual text can be found in the DE textContent, which is restricted to 32 letters.</p> <p>Note: May be ignored by receiving vehicles (i.e. neither evaluated nor shown to the driver) and should only be used for informative and not regulatory data.</p>

DE/DF	<i>IVIStructure.optional.avc.platooningRules</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0185 (1)</i>
Requirement	This DF shall be used for the use case Platoon Support Information, otherwise it shall not be used.

DE/DF	<i>IVIStructure.optional.avc.platooningRules.priority</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0186 (1)</i>
Requirement	Shall be set to value 0 for use case Platoon Support Information.

³⁵ IVIStructure.optional.avc.roadSignCodes.code

DE/DF	<i>IVIStructure.optional.avc.platooningRules.allowedSaeAutomationLevels</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0187 (1)</i>
Information	<p>A list of automation levels (0-5). As the use case Platoon Support Information informs about SAE levels road operators find unsuitable for platooning on a selected segment, the respective opposite levels are encoded in this DE. If for example SAE levels 4 and 5 are unsuitable for platooning from the road operator's point of view, levels 0, 1, 2, and 3 are be put into allowedSaeAutomationLevels.</p> <p>Note: See use case description for any further information about the use case.</p>

DE/DF	<i>IVIStructure.optional.avc.platooningRules.roadSignCodes</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0188 (1)</i>
Requirement	If used, IVIStructure.optional.avc.roadSignCodes.code shall be set to iso14823.

DE/DF	<i>IVIStructure.optional.avc.platooningRules.extraText</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Inf_0189 (1)</i>
Information	Can be used to present additional text associated to a sign (subpanel text) only if there is no subpanel code available in [ISO 14823-1].
ID	<i>MP_Inf_0190 (1)</i>
Information	One line of Text with a maximum of 32 letters per RSCode (sign or subsign) used in the GicPart. Ordered, so the first line of text corresponds to the first RSCode, the second line to the second RSCode, with a maximum of 4 lines.
ID	<i>MP_Req_0191 (1)</i>
Requirement	If a road sign does not have extra text, a string with a single NULL character (ASCII 0x00) shall be added.
ID	<i>MP_Inf_0192 (1)</i>
Information	<p>The DE language uses a bitstring representing the language according to [ISO 639-1], e.g. German text is encoded as DE (D (10010) and E (10000) 1001010000 according to [ISO 14816]).</p> <p>The actual text can be found in the DE textContent³⁴, which is restricted to 32 letters.</p> <p>Note: May be ignored by receiving vehicles (i.e. neither evaluated nor shown to the driver) and should only be used for informative and not regulatory data</p>

4.2.2.5 HD Topology (HDT)

The HD Topology (HDT) ITS-S application is implemented using In-Vehicle Information (IVI) messages according to [ISO/TS 19321].

Since all implementations are making use of the IVI standard [ISO/TS 19321], the following section describes how respective data elements and data frames from the RoadConfigurationContainer are applied. The IviManagementContainer and the GeographicLocationContainer are used as profiled in chapter 4.2.2.1. The GeneralIviContainer is used as profiled in chapter In-Vehicle Signage (IVS).

DE/DF	<i>IviStructure.optional.rcc.relevanceZoneIds</i>
O/M/C/F	Mandatory
ID	MP_Req_0193 (1)
Requirement	Shall be set to 32 ("no Zone") as the specific information about relevance zones is indicated for each lane individually in the laneConfiguration ³¹ / LaneInformation.

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.direction</i>
O/M/C/F	Mandatory
ID	MP_Inf_0194 (1)
Information	Direction of Relevance in relation to the direction (implicitly) defined by the zone using the DE direction.
ID	MP_Req_0195 (1)
Requirement	Shall always be set to sameDirection(0).

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.validity</i>
O/M/C/F	Optional
ID	MP_Opt_0196 (1)
Option	May be set if known in case of lane management if laneType ³⁶ = emergency and laneStatus ³⁷ = provisionallyOpen.

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.laneType</i>
O/M/C/F	Mandatory
ID	MP_Req_0197 (1)
Requirement	laneType shall be set to traffic (0) for all lanes available for regular driving.
ID	MP_Req_0198 (1)
Requirement	On motorways, the selection shall be restricted to the values traffic (0), acceleration (3), deceleration (4) or emergency (18).

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.laneWidth</i>
O/M/C/F	Optional
ID	MP_Req_0199 (1)
Requirement	Shall be provided with an accuracy of 0,3m if available for the road operator.

³⁶ IviStructure.optional.rcc.laneConfiguration.laneType

³⁷ IviStructure.optional.rcc.laneConfiguration.laneStatus

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.detectionZonelds</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0200 (1)</i>
Requirement	The DE detectionZonelds shall be used.
ID	<i>MP_Req_0591 (1)</i>
Requirement	In addition to the requirement above, the following requirements/recommendations shall apply for detectionZonelds: <ul style="list-style-type: none"> ○ MP_Req_0116 (1) ○ MP_Req_0148 (1) ○ MP_Rec_0169 (1)

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.relevanceZonelds</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0201 (1)</i>
Requirement	The DE relevanceZonelds shall be used.

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.laneCharacteristics</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0202 (1)</i>
Requirement	The DF laneCharacteristics shall be used.

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.laneCharacteristics.existinglaneMarkingStatus</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0203 (1)</i>
Information	Indicates the status of the pre-existing, original lane markings. Set to TRUE if the original markings are still in effect, set to FALSE if they are not.

DE/DF	<i>IviStructure.optional.rcc.laneConfiguration.mergingWith</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0204 (1)</i>
Requirement	As this is a mandatory DE, the maximum value of “32” shall be used to indicate “not used” if there is no merging or diverging occurring.

4.2.2.6 Destination Travel Time (DTT)

The Destination Travel Time (DTT) ITS-S application is implemented using In-Vehicle Information (IVI) messages according to [ISO/TS 19321].

Since all implementations are making use of the IVI standard [ISO/TS 19321], the following section describes how respective data elements and data frames from the ISO14823Code [ISO 14823-1] are applied in the GeneralIviContainer. This section also describes the respective data elements and data frames of GDD attribute, InternationalSign-DestinationInformation. The rest of the elements and data frames are used as profiled in chapter 4.2.2.1.

The IviManagementContainer, GeographicLocationContainer and RoadConfigurationContainer are used as profiled in chapter 4.2.2.1.

DE/DF	<i>IviStructure.optional.giv.roadSignCodes.layoutComponentId</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0205 (1)</i>
Recommendation	Should only be used to associate RSCode to the layout component of referenced layout.

DE/DF	<i>IviStructure.optional.giv.roadSignCodes.code</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0206 (1)</i>
Requirement	For destination travel time, the choice iso14823 of type ISO 14823Code (according to [ISO 14823-1]) shall be used.
ID	<i>MP_Inf_0207 (1)</i>
Information	The attributes SET (Section) and NOL (Number of Lane) are not supported because these attributes are providing duplicated information already supported in the Application Container.

DE/DF	<i>IviStructure.optional.giv.roadSignCodes.code.iso14823.pictogramCode.serviceCategoryCode.trafficSignPictogram</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0208 (1)</i>
Requirement	For destination travel time, the choice – informative shall be used.

DE/DF	<i>IviStructure.optional.giv.roadSignCodes.code.iso14823.pictogramCode.pictogramCategoryCode</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0209 (1)</i>
Requirement	For destination travel time, nature – 1, serialNumber – 11 shall be used, if no specific reason (e.g. traffic jam) for the travel time is given.

DE/DF	<i>IviStructure.optional.giv.roadSignCodes.code.iso14823.attributes</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0210 (1)</i>
Requirement	For Destination Travel Time, ddd [InternationalSign-destinationInformation] attribute shall be used.

The following requirements cover GDD attribute elements specific to Destination Information (DDD).

DE/DF	<i>lviStructure.optional.giv roadSignCodes.code.iso14823.attributes.ddd.junctionDirection</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0211 (1)</i>
Requirement	Should only be used, if a digital representation of a VMS/road sign is sent. Shall not be used otherwise

DE/DF	<i>lviStructure.optional.giv roadSignCodes.code.iso14823.attributes.ddd.roundaboutCwDirection</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0212 (1)</i>
Requirement	Should only be used, if a digital representation of a VMS/road sign is sent. Shall not be used otherwise

DE/DF	<i>lviStructure.optional.giv roadSignCodes.code.iso14823.attributes.ddd.roundaboutCcwDirection</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0213 (1)</i>
Requirement	Should only be used, if a digital representation of a VMS/road sign is sent. Shall not be used otherwise

DE/DF	<i>lviStructure.optional.giv roadSignCodes.code.iso14823.attributes.ddd.ioList.destPlace</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0214 (1)</i>
Requirement	Shall be used if the destination is a place.

DE/DF	<i>lviStructure.optional.giv roadSignCodes.code.iso14823.attributes.ddd.ioList.destRoad</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0215 (1)</i>
Requirement	Shall be used if the destination is a road.

DE/DF	<i>lviStructure.optional.giv roadSignCodes.code.iso14823.attributes.ddd.ioList.roadNumberIdentifier</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0216 (1)</i>
Requirement	Shall be unique for each road per service provider.

DE/DF	<i>IviStructure.optional.giv roadSignCodes.code.iso14823.attributes.ddd.ioList.streetName</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0217 (1)</i>
Requirement	Shall be unique for each street per service provider.

DE/DF	<i>IviStructure.optional.giv roadSignCodes.code.iso14823.attributes.ddd.ioList distanceToDestinationPlace.unit</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0312 (1)</i>
Requirement	Value 9 (minutesOfTime) shall be used.

4.2.2.7 IVIM profile for cancellation

ID	<i>MP_Req_0225 (1)</i>
Requirement	In addition to the requirements in this section, the following requirements shall be included in an IVIM cancellation: <ul style="list-style-type: none"> ○ MP_Req_0078 (1) ○ MP_Inf_0221 (1) ○ MP_Req_0086 (1)

ID	<i>MP_Rec_0226 (1)</i>
Recommendation	All other containers should not be used or can be ignored.

DE/DF	<i>IviStructure.mandatory.serviceProviderId</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0218 (1)</i>
Requirement	Shall be set to the serviceProviderId of the originating service provider who issued the IVIM to be cancelled earlier, since a cancellation of the IVI service can only be provided by the organization that originally provided the IVI service.

DE/DF	<i>IviStructure.mandatory.ividentificationNumber</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0219 (1)</i>
Requirement	For the generation of a cancellation IVIM, the ividentificationNumber shall be set to the ividentificationNumber of the message to be cancelled issued by the same service provider earlier.

4.2.3 Traffic Light Maneuver (TLM) and Road and Lane Topology (RLT) Service (TLM FLS and RLT FLS)

Traffic Light Manoeuvre (TLM)

The TLM FLS is one instantiation of the infrastructure services to manage the generation, transmission and reception of SPATEM messages. The TLM FLS includes safety-related information for supporting

traffic participants (vehicles, pedestrians, etc.) to execute safe manoeuvres in an intersection area. The goal is to enter and exit an intersection "conflict area" in a controlled way. The TLM FLS informs in real-time about the operational states of the traffic light controller, the current signal state, the residual time of the state before changing to the next state, the allowed manoeuvres and aids with crossing. Additionally, the TLM FLS foresees the inclusion of detailed green way advisory information and the status for public transport prioritization.

Road and Lane Topology (RLT)

The RLT FLS is one instantiation of the infrastructure services to manage the generation, transmission and reception of a digital topological map, which defines the topology of an infrastructure area. It includes the lane topology for e.g. vehicles, bicycles, parking, public transportation and the paths for pedestrian crossings and the allowed maneuvers within an intersection area or a road segment. Examples for describing topology with the data structures offered by MAPEM are provided in Annex G of [ISO/TS 19091] and the European handbook for MAPEM and SPATEM creation [C-Roads SPATEM/MAPEM handbook].

Operational parameters and relevant standards

The TLM and RLT FLSs including operational parameters are defined in [ETSI TS 103 301]. Data elements, data frames and service parameters shall be used according to the definitions in section 4.2.3.2 and 4.2.3.3. Wherever the profile indicates 'not used' this means: not used for current ITS-S application, kept optional for future ITS-S application, therefore use is not forbidden. The header of MAPEM/SPATEM shall be as specified in the data dictionary [ETSI TS 102 894-2].

4.2.3.1 Parameter settings

The parameters in the table below are cited in the requirement tables.

Table 1 Service parameters associated with TLM and RLT FLS

Parameter	Value	Unit	Description	Min. Value	Max. Value	Source Document
<i>dRangeIdUnique</i>	5	km	Radius around every intersection within which the <i>IntersectionID</i> tuple shall be unique	5	--	--
<i>pLateralNodeOffset</i>	3	m	Maximum lateral offset to the center of the lane for the node points within a MAP	--	--	--
<i>pLaneAngleDeviation</i>	5	°	Maximum angle between the connection of the node points and the corresponding tangent to the lane center	--	--	--
<i>pMaxPerpendDistLaneCenter</i>	3	m	Maximum perpendicular distance between the linear connection of two consecutive lane nodes and the actual center of the lane	--	--	--
<i>pMaxNoOfNodesPerLane</i>	18	--	Maximum allowed number of nodes per lane Note: It is a recommendation to stay below this number to control the message size, however for the sake of functionality exceptions are possible.	--	--	--
<i>pMinLaneWidth</i>	2.6	m	Minimum (normal) width of a merging/diverging lane before enabling/disabling the taper to left / right indication	--	--	--
<i>pMinIngressLaneLength</i>	300	m	Minimum length of an ingress lane representation in MAPEM, unless the lane ends earlier for example at the adjacent intersection	--	--	--
<i>pSpeedLimitHigh</i>	60	kph	Allowed speed limit above which the required minimum ingress lane length is increased	--	--	--
<i>pMinIngressLaneLengthHighSpeed</i>	500	m	Minimum length of an ingress lane representation in MAPEM for an allowed speed limit above <i>pSpeedLimitHigh</i>	--	--	--
<i>pMinEgressLaneLength</i>	5	m	Minimum length of an egress lane representation in MAPEM	--	--	--
<i>pTimeMarkUnknown</i>	36001	1/10 s	Value to indicate an unknown <i>TimeMark</i>	--	--	[SAE J2735 2016-01]
<i>pTimeMarkMin</i>	0	1/10 s	Minimum value of <i>TimeMark</i>	--	--	[SAE J2735 2016-01]

<i>pTimeMarkOutOfRange</i>	36000	1/10 s	Value to indicate an instant which is not in the UTC hour of the referenced instant	--	--	[SAE J2735 2016-01]
<i>tTimeOfChangeAccuracy</i>	500	ms	Accuracy of phase state change time information for signal controllers operating at fixed time	--	--	--
<i>tDelayFailureTransmission</i>	200	ms	Maximum allowed delay between the instant the traffic light controller goes into failure until the information is being transmitted	--	--	--
<i>pMinDifference</i>	0.3	m	Parameter which indicates if the lane width difference is significant.	--	--	--

4.2.3.2 MAPEM general elements

<i>DE/DF</i>	<i>MAPEM.mapData.timestamp</i>					
<i>O/M/C/F</i>	<i>Optional</i>					
<i>ID</i>	<i>MP_Rec_0316 (1)</i>					
<i>Recommendation</i>	timestamp should not be used to set a timestamp of related MAPs.					

<i>DE/DF</i>	<i>MAPEM.mapData.msgIssueRevision</i>					
<i>O/M/C/F</i>	<i>Mandatory</i>					
<i>ID</i>	<i>MP_Req_0317 (1)</i>					
<i>Requirement</i>	msgIssueRevision shall be set to 0 as defined in ISO TS 19091.					

<i>DE/DF</i>	<i>MAPEM.mapData.layerType</i>					
<i>O/M/C/F</i>	<i>Optional</i>					
<i>ID</i>	<i>MP_Rec_0318 (1)</i>					
<i>Recommendation</i>	layerType should not be used.					

<i>DE/DF</i>	<i>MAPEM.mapData.layerID</i>					
<i>O/M/C/F</i>	<i>Conditional</i>					
<i>ID</i>	<i>MP_Req_0319 (1)</i>					
<i>Requirement</i>	If fragmentation has been applied to a MAPEM a layerID shall be used as defined in ISO 19091 section G.8.3.2 on DE_LayerID.					
<i>ID</i>	<i>MP_Inf_0320 (1)</i>					
<i>Information</i>	There do not exist requirements on logical fragmentation, e.g. full lanes, approaches or otherwise. Fragmentation is simply data size-based in bytes (max. 1398 per message). Also there do not exist requirements on the order of reception of fragments. The receiver shall be able to assemble the messages. The revision number of the MAPEM assures which fragments belong together. Validation of MAPEM shall be done on the message level, not the fragment level.					

DE/DF	MAPEM.mapData.intersections
O/M/C/F	Optional
ID	MP_Req_0321 (1)
Requirement	intersections shall be used in any MAPEM that describes one or more intersection areas or other areas that include traffic lights such as urban intersections, roundabouts or toll stations.
ID	MP_Req_0322 (1)
Requirement	intersections shall not be used when MAPEM only provides road segments.
ID	MP_Req_0323 (1)
Requirement	In case of tolling stations, every direction at the tolling station shall be encoded in a dedicated intersection. Therefore, the number of intersections in intersections field of MapData shall reflect all the available traffic direction at the tolling station.

DE/DF	MAPEM.mapData.roadSegments
O/M/C/F	Optional
ID	MP_Req_0324 (1)
Requirement	roadSegments shall be used to describe roadway segments without intersections (e.g. roadworks) and without traffic lights.
ID	MP_Inf_0325 (1)
Information	No SPAT message be linked to a MapData described with roadSegments.

DE/DF	MAPEM.mapData.dataParamters.processMethod
O/M/C/F	Optional
ID	MP_Rec_0326 (1)
Recommendation	processMethod should not be used.

DE/DF	MAPEM.mapData.dataParamters.lastCheckedDate
O/M/C/F	Optional
ID	MP_Opt_0327 (1)
Option	lastCheckedDate may be used as yyyy-mm-dd.

DE/DF	MAPEM.mapData.dataParamters.geoidUsed
O/M/C/F	Optional
ID	MP_Rec_0328 (1)
Recommendation	geoidUsed should not be used.

DE/DF	MAPEM.mapData.regional
O/M/C/F	Optional
ID	MP_Rec_0329 (1)
Recommendation	This DE should not be used.

DE/DF	<i>MAPEM.mapData.regional.signalHeadLocations</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0330 (1)</i>
Recommendation	signalHeadLocations should not be used.

DE/DF	<i>MAPEM.mapData.intersections.intersectionGeometry</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0331 (1)</i>
Requirement	In case 'intersections' is used intersectionGeometry shall be used.

DE/DF	<i>MAPEM.intersections.intersectionGeometry.name</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Opt_0332 (1)</i>
Option	name may be used.
ID	<i>MP_Inf_0333 (1)</i>
Information	Typically, human readable and recognizable by road authority.

DE/DF	<i>MAPEM.mapData.intersections.intersectionGeometry.id</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0334 (1)</i>
Requirement	id shall be identical to the appropriate id tuple of the corresponding SPATEM 'intersectionState'.
ID	<i>MP_Rec_0335 (1)</i>
Recommendation	The combination of region and id should be unique within a country.
ID	<i>MP_Req_0336 (1)</i>
Requirement	The combination of region and id shall be unique within a radius of <i>dRangeIdUnique</i> around each intersection.
ID	<i>MP_Inf_0337 (1)</i>
Information	This applies specifically to cases where multiple intersections are conveyed in one MAPEM/SPATEM combination.

DE/DF	<i>MAPEM.mapData.intersections.intersectionGeometry.id.region</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0338 (1)</i>
Requirement	region shall be present.
ID	<i>MP_Req_0339 (1)</i>
Information	RoadRegulatorIDs are managed and assigned nationally, and each road regulator assigns IDs to intersections.

DE/DF	<i>MAPEM.mapData.intersections.intersectionGeometry.id.id</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0340 (1)</i>
Information	The uniqueness within a radius is to ensure backwards compatibility with short-range communication deployments.

DE/DF	<i>MAPEM.mapData.intersections.intersectionGeometry.revision</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0341 (1)</i>
Requirement	The revision number shall increase by 1 each time the MapData of this intersection changes.
ID	<i>MP_Req_0342 (1)</i>
Requirement	The revision numbers of SPATEM and MAPEM shall be the same as an indication that the right MAPEM revision is used as defined in ISO TS 19091.

DE/DF	<i>MAPEM.mapData.intersections.intersectionGeometry.refPoint</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0343 (1)</i>
Requirement	refPoint shall be roughly at the centre of the conflict area, which is demarcated by the 1st nodes of the ingress and egress lanes.

DE/DF	<i>MAPEM.mapData.intersections.intersectionGeometry.refPoint.elevation</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0595 (1)</i>
Recommendation	elevation should not be used.
ID	<i>MP_Inf_0596 (1)</i>
Information	Replaced by regional Reg-Position3D.

DE/DF	<i>MAPEM.mapData.intersections.intersectionGeometry.refPoint.regional</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Opt_0344 (1)</i>
Option	regional may be used.

DE/DF	<i>MAPEM.mapData.intersections.intersectionGeometry.refPoint.regional.altitude</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0345 (1)</i>
Requirement	altitude shall be used.

DE/DF	MAPEM.mapData.intersections.intersectionGeometry.refPoint.regional.altitude.altitudeConfidence
O/M/C/F	Mandatory
ID	MP_Req_0347 (1)
Requirement	If altitudeConfidence is not available it shall be set to (15) = unavailable.

DE/DF	MAPEM.mapData.intersections.intersectionGeometry.laneWidth
O/M/C/F	Optional
ID	MP_Opt_0348 (1)
Option	laneWidth may provide the default width of the intersection, while deviations from this lane width are provided using dWidth.
ID	MP_Inf_0349 (1)
Information	Also see pMinLaneWidth.

DE/DF	MAPEM.mapData.intersections.intersectionGeometry.laneSet
O/M/C/F	Mandatory
ID	MP_Req_0350 (1)
Requirement	laneSet shall include all vehicle lanes of an intersection and all other lanes of an intersection that have signalized connections (e.g. including lanes for pedestrians (crosswalk), cyclists (bikeLane), tracked vehicles (trackedVehicles) and busses (vehicle)).
ID	MP_Req_0351 (1)
Requirement	In case of tolling stations, laneSet shall contain all ingress and egress lanes at the tolling barrier for the current intersection geometry. Thus, the number of lanes in laneSet shall include at least two times the number of tolling lanes.

DE/DF	MAPEM.mapData.intersections.intersectionGeometry.preemptPriorityData
O/M/C/F	Optional
ID	MP_Rec_0352 (1)
Recommendation	preemptPriorityData should not be used.

DE/DF	MAPEM.mapData.intersections.intersectionGeometry.regional
O/M/C/F	Optional
ID	MP_Rec_0354 (1)
Recommendation	regional should not be used.

DE/DF	MAPEM.mapData.roadSegments.RoadSegment
O/M/C/F	Mandatory
ID	MP_Req_0355 (1)
Requirement	In case 'roadSegments' is used RoadSegment shall be used.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.name</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Opt_0356 (1)</i>
Option	name may be used.
ID	<i>MP_Inf_0357 (1)</i>
Information	Typically, human readable and recognizable by road authority.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.id</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0358 (1)</i>
Requirement	The combination of region and id shall be unique within a country.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.id.region</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0359 (1)</i>
Requirement	region shall be used.
ID	<i>MP_Inf_0360 (1)</i>
Information	RoadRegulatorIDs are managed and assigned nationally, and each road regulator assigns IDs to road segments.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.id.id</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0361 (1)</i>
Information	The uniqueness within a radius is to ensure backwards compatibility with short-range communication deployments.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.revision</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0362 (1)</i>
Requirement	revision number shall increase by 1 each time the MapData of this road segment changes.
ID	<i>MP_Inf_0363 (1)</i>
Information	As defined in ISO TS 19091.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.refPoint</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0364 (1)</i>
Requirement	refPoint shall be used.
ID	<i>MP_Opt_0365 (1)</i>
Option	The reference point may be at the beginning or end of the road section described.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.refPoint.elevation</i>
O/M/C/F	Optional
ID	MP_Rec_0366 (1)
Recommendation	elevation should not be used.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.refPoint.regional</i>
O/M/C/F	Optional
ID	MP_Opt_0367 (1)
Option	regional may be used.
ID	MP_Inf_0368 (1)
Information	When given provides altitude.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.refPoint.regional.altitude</i>
O/M/C/F	Mandatory
ID	MP_Req_0369 (1)
Requirement	altitude shall be used.
ID	MP_Inf_0370 (1)
Information	Consists of altitudeValue and altitudeConfidence. In case it cannot be provided, "unavailable" can be used instead.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.refPoint.regional.altitude.altitudeValue</i>
O/M/C/F	Mandatory
ID	MP_Req_0371 (1)
Requirement	altitudeValue shall be used.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.refPoint.regional.altitude.altitudeConfidence</i>
O/M/C/F	Mandatory
ID	MP_Req_0372 (1)
Requirement	If altitudeConfidence is not available it shall be set to (15) = unavailable.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.laneWidth</i>
O/M/C/F	Optional
ID	MP_Opt_0373 (1)
Option	laneWidth may provide the default width of a lane for the road segment, while deviations from this lane width are provided using dWidth ³⁸ .

³⁸ A value added to the current lane width at this node and from this node onwards, in 1cm steps.

<i>DE/DF</i>	<i>MAPEM.mapData.roadSegments.RoadSegment.laneSet</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0374 (1)</i>
<i>Requirement</i>	LaneSet shall include all vehicle lanes and should include all delimitations or barriers of a road segment (e.g. including road boundaries).
<i>ID</i>	<i>MP_Opt_0375 (1)</i>
<i>Option</i>	Depending on the use case it may also include other types of lanes such as bicycle or pedestrian lanes.
<i>ID</i>	<i>MP_Inf_0376 (1)</i>
<i>Information</i>	For further details see C_ROADS_WG2_TF2_Service and Use Case Definitions [C-Roads SUD]

<i>DE/DF</i>	<i>MAPEM.mapData.roadSegments.RoadSegment.regional</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Rec_0377 (1)</i>
<i>Recommendation</i>	regional should not be used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane</i>
O/M/C/F	Mandatory
ID	<i>MP_Req_0384 (1)</i>
Requirement	For each ingress approach at least one ingress lane of type vehicle shall be present.
ID	<i>MP_Req_0385 (1)</i>
Requirement	Vehicle ingress and egress lanes shall follow the main road with priority and have a minimum length of pMinIngressLaneLength and pMinEgressLaneLength (see section 4.2.3.1) respectively.
ID	<i>MP_Rec_0386 (1)</i>
Recommendation	Minor side-roads along the ingress lanes should not be described or interrupt the lane.
ID	<i>MP_Req_0387 (1)</i>
Requirement	Non-right-of-way merging lanes shall start at the diverge/merge point.
ID	<i>MP_Req_0388 (1)</i>
Requirement	At intersections with higher speed limits allowed (> pSpeedLimitHigh) the vehicle ingress lanes shall be minimum pMinIngressLaneLengthHighSpeed long (see section 4.2.3.1).
ID	<i>MP_Req_0389 (1)</i>
Requirement	If an adjacent intersection is closer than pMinIngressLaneLength or in case the lane ends before pMinIngressLaneLength (see section 4.2.3.1), ingress lanes shall be shortened to the first egress point of the adjacent intersection or to where the lane ends.
ID	<i>MP_Req_0390 (1)</i>
Requirement	If no MAPEM is transmitted for the adjacent intersection, the ingress lanes shall be shortened such that they don't intersect the adjacent intersection's conflict area.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.laneID</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.laneID</i>
O/M/C/F	Mandatory
ID	<i>MP_Req_0391 (1)</i>
Requirement	When an IVI message describes the same area, the lane identifiers as provided by the IVI message shall be used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.ingressApproach</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.laneID.ingressApproach</i>
O/M/C/F	Mandatory
ID	MP_Req_0392 (1)
Requirement	In case DF intersections is used ingressApproach shall be used.
ID	MP_Req_0393 (1)
Requirement	Each ingress lane shall have the ApproachID set.
ID	MP_Req_0394 (1)
Requirement	Ingress and egress approaches of the same arm shall have the same ApproachID.
ID	MP_Req_0395 (1)
Requirement	For unidirectional ingress lanes, the data element 'ingressApproach' (of type DE_ApproachID) shall be present and used.
ID	MP_Req_0396 (1)
Requirement	For lanes that cross both the ingress- and egress approach of an intersection arm (crosswalks) both data elements 'ingressApproach' and 'egressApproach (of type DE_ApproachID) shall be present and used to indicate the approaches that are crossed.
ID	MP_Req_0397 (1)
Requirement	All bicycle lanes (separated from vehicle lanes) in one quadrant of an intersection shall have the same ingress ApproachID which is unique within the intersection.
ID	MP_Req_0398 (1)
Requirement	Bicycle lanes at safe islands shall have the ApproachID set in the same manner as pedestrian lanes, i.e. the ingress or egress ApproachID of the approach they cross.
ID	MP_Req_0399 (1)
Requirement	For lanes of type vehicle (LaneAttributes.LaneTypeAttributes = vehicle), ingress lanes of a common drive direction towards the intersection shall have a common ingress approach ID as a mandatory attribute.
ID	MP_Req_0400 (1)
Requirement	If a non-priority road is included into the ingress structure, all lanes of the non-priority roads shall be grouped into one or several separate approaches that only represent these non-priority roads.
ID	MP_Inf_0401 (1)
Information	For further details on how to use these data elements, see ISO /TS 19091:2019 G.8.2.6.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.egressApproach</i>
O/M/C/F	Forbidden
ID	MP_Req_0402 (1)
Requirement	In case DF roadSegments is used egressApproach shall not be used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.egressApproach</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0403 (1)</i>
Requirement	egressApproach shall follow the same requirements as ingressApproach (s. MP_Req_0392 (1) – MP_Inf_0401 (1))

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.laneAttributes.directionalUse</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.laneAttributes.directionalUse</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0405 (1)</i>
Requirement	In case DF roadSegments is used, directionalUse shall be set as egressPath unless it is a bidirectional lane.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.laneAttributes.sharedWith</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.laneAttributes.sharedWith</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0406 (1)</i>
Requirement	sharedWith shall be used with bits as defined: overlappingLaneDescriptionProvided (0) multipleLanesTreatedAsOneLane (1) -- not permitted in profile as all lanes shall be described. otherNonMotorizedTrafficTypes (2) -- e.g. horse drawn individualMotorizedVehicleTraffic (3) -- passenger cars busVehicleTraffic (4) taxiVehicleTraffic (5) pedestriansTraffic (6) cyclistVehicleTraffic (7) trackedVehicleTraffic (8) pedestrianTraffic (9) -- use 6 instead (error)

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. laneAttributes.laneType</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane. laneAttributes.laneType</i>
O/M/C/F	Mandatory
ID	MP_Req_0407 (1)
Requirement	laneType shall be used in this profile: vehicle crosswalk bikeLane sidewalk median trackedVehicle -- see ISO TS19091 for pedestrian crossing examples.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. laneAttributes.laneType.median</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane. laneAttributes.laneType.median</i>
O/M/C/F	Optional
ID	MP_Opt_0408 (1)
Option	median may be used to indicate the kind of physical separation between traffic flows.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. laneAttributes.laneType.striping</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane. laneAttributes.laneType.striping</i>
O/M/C/F	Optional
ID	MP_Rec_0409 (1)
Recommendation	striping should not be used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. laneAttributes.laneType.parking</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane. laneAttributes.laneType.parking</i>
O/M/C/F	Optional
ID	MP_Rec_0410 (1)
Recommendation	parking should not be used.

<i>DE/DF</i>	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. maneuvers MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.maneuvers</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Req_0411 (1)</i>
<i>Requirement</i>	maneuvers (of type DE_AllowedManeuvers) shall not be used in any instance of a 'generic lane' within a MAPEM.

<i>DE/DF</i>	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0412 (1)</i>
<i>Requirement</i>	For tolling stations, nodeList shall start at the tolling barrier and end where the tolling lanes merge to the motorway lanes for both ingress and egress lanes.
<i>ID</i>	<i>MP_Opt_0413 (1)</i>
<i>Option</i>	Since the main highway road section may contain fewer lanes than the total number of channels, multiple lanes may be merged at their last point
<i>ID</i>	<i>MP_Inf_0414 (1)</i>
<i>Information</i>	Definition: For intersections description, a 'conflict area' is the area of the intersection that is limited by the first nodes of ingress / egress vehicle lanes, first nodes of 'ingresspath' crosswalk lanes, and stop lines of bicycle lanes. For a better understanding, see also e.g. Figure G.6 in [ISO/TS 19091 2019-06].

DE/DF	<code>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. nodeList.nodes</code> <code>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList nodes</code>
O/M/C/F	Mandatory
ID	MP_Req_0415 (1)
Requirement	When intersections is used, the first node of any vehicle lane shall be the node of the lane which is closest to the centre of the intersection.
ID	MP_Req_0416 (1)
Requirement	When roadSegments is used, the first node of any vehicle lane shall be the node of the lane the traffic flow reaches first.
ID	MP_Req_0417 (1)
Requirement	The number of node points shall be limited to pMaxNoOfNodesPerLane nodes per lane (for both ingress and egress lanes).
ID	MP_Req_0418 (1)
Requirement	The perpendicular distance between the linear connection of two node points and the center of the lane shall be less than pMaxPerpendDistLaneCenter.
ID	MP_Req_0419 (1)
Requirement	The angle between the linear connection of two node points and the corresponding tangent to the lane center shall not be greater than pLaneAngleDeviation.
ID	MP_Opt_0420 (1)
Option	The number of nodes of a lane may exceed pMaxNoOfNodesPerLane to keep the perpendicular distance between the linear connection of two node points and the centre of the lane lower than pMaxPerpendDistLaneCenter, to fulfil pMinIngressLaneLength.
ID	MP_Rec_0421 (1)
Recommendation	For curved lanes when the centre line of the GenericLane deviates from the actual centre line more than 0.5m, an additional node should be used.

DE/DF	<code>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. nodeList.nodes.computed</code> <code>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList. nodes.computed</code>
O/M/C/F	Optional
ID	MP_Rec_0422 (1)
Recommendation	computed should not be used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.connectsTo</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.connectsTo</i>
O/M/C/F	Conditional
ID	<i>MP_Req_0423 (1)</i>
Requirement	The data element connectsTo shall be present at least for every ingress lane of an intersection that is controlled by a traffic light.
ID	<i>MP_Req_0424 (1)</i>
Requirement	When intersections is used, the data field 'connectsTo' shall include every possible connection between ingress and egress lanes of one intersection.
ID	<i>MP_Req_0425 (1)</i>
Requirement	The contained connections shall however not include those requiring lane changes in the conflict area (if applicable).
ID	<i>MP_Req_0426 (1)</i>
Requirement	U-turns are optional and shall only be included if they are allowed by traffic rules. When u-turns are provided they shall have a separate connection which has a signalGroupID that represents a virtual traffic signal for which SPATEM shall contain movementPhaseState (9): caution-conflicting-traffic in case the maneuver is active.
ID	<i>MP_Req_0427 (1)</i>
Requirement	There shall be no duplicate connections indicated via 'connectsTo' between the same ingress and egress lanes for the same direction. The only exception may be userclass.
ID	<i>MP_Req_0428 (1)</i>
Requirement	When roadSegments is used, the data field 'connectsTo' shall include every possible connection between two lanes of a road segment.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.overlays</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.overlays</i>
O/M/C/F	Optional
ID	<i>MP_Rec_0429 (1)</i>
Recommendation	overlays should not be used.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.regional</i>
O/M/C/F	Conditional
ID	<i>MP_Req_0430 (1)</i>
Requirement	DF regional shall not be used when roadSegments is used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.regional</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0431 (1)</i>
Requirement	DF regional shall be used when intersections is used.
ID	<i>MP_Inf_0432 (1)</i>
Information	Relevant for use case scenario safe intersection manoeuvre

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. nodeList.nodes.nodeXY MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList. nodes.nodeXY</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0433 (1)</i>
Requirement	The absolute lateral offset of node points to the center of the lane shall be less than <i>pLateralNodeOffset</i> (see section 4.2.3.1).
ID	<i>MP_Inf_0434 (1)</i>
Information	<p>The angle between the linear connection of two node points and the corresponding tangent to the lane center shall not be greater than <i>pLaneAngleDeviation</i> (see section 4.2.3.1).</p> <p>In more formal wording: let be the vector representing the linear connection of two node points, and be the vector representing the shortest distance of vector to the center of the lane (that is, it is perpendicular to the tangent of the center line of the lane at the foot of the dropped perpendicular).</p> <p>Then for it shall always hold that <i>pLaneAngleDeviation</i>.</p> <p>For (i.e. crosses the lane center) the angle α between and the tangent to the lane center at the intersection point with the lane center shall be less than <i>pLaneAngleDeviation</i>.</p>

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. nodeList.nodes.nodeXY.delta.node-LatLon</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0435 (1)</i>
Requirement	The data element node-LatLon shall not be used for the Signalized Intersections use cases. Instead, additional nodes shall be added.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList. nodes.nodeXY.delta.regional MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList. nodes.nodeXY.delta.regional</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0436 (1)</i>
Recommendation	regional should not be used.

<i>DE/DF</i>	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.nodeXY.attributes</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList.nodes.nodeXY.attributes</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Opt_0437 (1)</i>
<i>Option</i>	attributes may be used to provide any optional attributes which are needed.
<i>ID</i>	<i>MP_Req_0438 (1)</i>
<i>Requirement</i>	All attributes shall be provided in the order of the nodes (as opposed to the driving direction).
<i>ID</i>	<i>MP_Req_0439 (1)</i>
<i>Requirement</i>	Left/right indications by attributes shall be interpreted based on the order of the nodes.
<i>ID</i>	<i>MP_Inf_0440 (1)</i>
<i>Information</i>	As optional attributes which might be needed are considered changes to the current lane width and elevation. 'Merge point' definition: s. MP_Inf_0447 (1).

<i>DE/DF</i>	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.nodeXY.attributes.localNode</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList.nodes.nodeXY.attributes.localNode</i>
<i>O/M/C/F</i>	<i>Conditional</i>
<i>ID</i>	<i>MP_Req_0441 (1)</i>
<i>Requirement</i>	When applicable, node attributes Stopline, mergePoint and divergePoint shall be used.
<i>ID</i>	<i>MP_Req_0442 (1)</i>
<i>Requirement</i>	The first node of an ingress lane, which is not a diverge or merge point, shall be the node that shall not be passed by a vehicle when movement is not allowed (from regulations, typically this is the stop line on the street).
<i>ID</i>	<i>MP_Req_0443 (1)</i>
<i>Requirement</i>	The node attribute 'stopLine' shall be used to indicate where the do-not-block section starts. Note: this high accuracy can be achieved by calculating the cumulative node offset position relative to the referencePosition of both nodes.
<i>ID</i>	<i>MP_Req_0444 (1)</i>
<i>Requirement</i>	The doNotBlock segment-attribute shall be appropriately enabled/disabled to indicate the do-not-block area.
<i>ID</i>	<i>MP_Req_0445 (1)</i>
<i>Requirement</i>	Each diverge or merge point (of type DF_NodeXY) shall be explicitly marked with corresponding node attribute (DF_NodeAttributeSetXY) "divergePoint" or "mergePoint".
<i>ID</i>	<i>MP_Req_0446 (1)</i>
<i>Requirement</i>	For diverging / merging lanes one node shall be defined as diverge / merge point. This node shall be present with the same absolute position with an accuracy of 0,1 meter in the ongoing lane and as first / last node in the diverging / merging lane.
<i>ID</i>	<i>MP_Inf_0447 (1)</i>
<i>Information</i>	<p>'Merge point' definition: as all attributes are provided in the order of the nodes, a 'merge point' designates a node of a lane where the lane is split into two lanes in driving direction towards an intersection (ingress). On the other hand, a merge point on an egress lane is located, where two lanes end in one lane in driving direction. The opposite applies for 'diverge points'.</p> <p>When ingress and egress approaches are not used, a merge point designates a node where two lanes end in one lane following the order of the nodes list. A diverge point designates a point where the lane is split into two lanes.</p> <p>Note: This adds on to [ISO/TS 19091 2019-06] where it is only stated that the first node "should be the node closest to the geometric centre of the intersection and is typically at the stop line". This is only part of the informative text – see [ISO/TS 19091 2019-06], 6.5.7.</p> <p>Note: For further details see [ISO/TS 19091 2019-06] 'localNode'.</p>

<i>DE/DF</i>	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList. nodes.nodeXY.attributes.localNode. nodeAttributeXY MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList. nodes.nodeXY.attributes.localNode. nodeAttributeXY</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0448 (1)</i>
<i>Requirement</i>	In case localNode is used nodeAttributeXY shall be used.

<i>DE/DF</i>	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. nodeList.nodes.nodeXY.attributes.disabled MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList. nodes.nodeXY.attributes.disabled</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Req_0449 (1)</i>
<i>Requirement</i>	A SegmentAttributeXY of value 'doNotBlock' shall be present in the 'disabled' list at the first node of the lane thereafter, which may again be blocked by a vehicle.
<i>ID</i>	<i>MP_Rec_0450 (1)</i>
<i>Recommendation</i>	Subject to case. It should be used at least the segment attributes from the following categories, for which guidelines are provided in ISO TS 19091: <ul style="list-style-type: none"> - General items - Porous lane states and merging - Bike lane needs - Lane geometry details - doNotBlock - taperToLeft - taperToRight
<i>ID</i>	<i>MP_Req_0451 (1)</i>
<i>Requirement</i>	A SegmentAttributeXY of value 'taperToLeft' or 'taperToRight' shall be present in the 'disabled' list of the last node of the merging lane (i.e. at the merge point).
<i>ID</i>	<i>MP_Req_0452 (1)</i>
<i>Requirement</i>	Tapers shall be described with a minimum of 2 nodes where the segmentAttributeXY of value "taperToLeft" or "taperToRight" is applied according to the following requirements.
<i>ID</i>	<i>MP_Req_0453 (1)</i>
<i>Requirement</i>	A SegmentAttributeXY of value 'taperToLeft' or 'taperToRight' shall be present in the 'enabled' list of the first node of the diverging lane (i.e. at the diverge point).
<i>ID</i>	<i>MP_Req_0454 (1)</i>
<i>Requirement</i>	For a diverging lane with tapering, the same 'taperToLeft' or 'taperToRight' shall be disabled via a SegmentAttributeXY in the 'disabled' list at the following node where the real world lane width exceeds pMinLaneWidth for the first time
<i>ID</i>	<i>MP_Req_0455 (1)</i>
<i>Requirement</i>	For a merging lane with tapering (as described above), the same 'taperToLeft' or 'taperToRight' shall be enabled via a SegmentAttributeXY in the 'enabled' list of the preceding node where the real world lane width falls below pMinLaneWidth for the first time.
<i>ID</i>	<i>MP_Inf_0456 (1)</i>
<i>Information</i>	This note provides a descriptive summary of the above tapers requirements. For ingress lanes: in case of a fanout, the node farthest from the intersection is the merge point where 'taperToLeft' or 'taperToRight' is disabled, the other node is where the two lanes do not overlap anymore and the 'taperToLeft' or 'taperToRight' is enabled. In case of a lane-drop, the node closest to the intersection is the diverge point where 'taperToLeft' or 'taperToRight' is enabled, the other node is where the two lanes do not yet overlap and the 'taperToLeft' or 'taperToRight' is disabled. Left and right should in all cases be seen from the order of the nodes.

<i>ID</i>	<i>MP_Inf_0457 (1)</i>
<i>Information</i>	Note: the lane width in the MAPEM is not affected throughout the taper segment (i.e. the use of dWidth is not required). However, as long as a taper is enabled it shall be assumed that 2 vehicles cannot driver side-by-side. Note: For further details see [ISO/TS 19091 2019-06] 'G.8.2.8 DF_NodeAttributeSetXY'.
<i>ID</i>	<i>MP_Inf_0458 (1)</i>
<i>Information</i>	Note on tapers: the area where two lanes (partially) cover each other can be called taper-zone. The dimension of this zone is important for the path guidance of vehicles. It is expected that this zone covers the area where the real world lane width (i.e. the distance between the lane markings) is below pMinLaneWidth. This requirements cannot be checked based only on MAPEM-information because according to ISO 19091, clause G.8.2.8 DF_NodeAttributeSetXY, the reported laneWidth for a diverging or merging lane does not shrink towards the diverge- or merge-point.
<i>ID</i>	<i>MP_Inf_0459 (1)</i>
<i>Information</i>	whiteLine: The whiteLine attribute is used to indicate when the line on the inside of the node is continuous.

<i>DE/DF</i>	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.nodeXY.attributes.disabled.segmentAttributeXY</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList.nodes.nodeXY.attributes.disabled.segmentAttributeXY</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0460 (1)</i>
<i>Requirement</i>	In case disabled is used SegmentAttributeXY shall be used

<i>DE/DF</i>	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.nodeXY.attributes.enabled</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList.nodes.nodeXY.attributes.enabled</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0461 (1)</i>
<i>Requirement</i>	A SegmentAttributeXY of value 'doNotBlock' shall be present in the 'enabled' list at the first node of the lane that shall not be blocked by a vehicle in case of a queue in front of the traffic light.
<i>ID</i>	<i>MP_Rec_0462 (1)</i>
<i>Recommendation</i>	See MP_Rec_0450 (1) for DE disabled.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.nodeXY.attributes.enabled.segmentAttributeXY</i> <i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList.nodes.nodeXY.attributes.enabled.segmentAttributeXY</i>
O/M/C/F	Mandatory
ID	MP_Req_0463 (1)
Requirement	In case enabled is used SegmentAttributeXY shall be used

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList.nodes.nodeXY.attributes.data</i>
O/M/C/F	Optional
ID	MP_Req_0464 (1)
Requirement	data shall not be used when roadSegments is used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.nodeXY.attributes.data</i>
O/M/C/F	Mandatory
ID	MP_Req_0465 (1)
Requirement	data shall be used when intersections is used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.nodeXY.attributes.data.pathEndPointAngle</i>
O/M/C/F	Optional
ID	MP_Rec_0466 (1)
Recommendation	pathEndPointAngle should not be used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.nodeXY.attributes.data.laneCrownPointCenter</i>
O/M/C/F	Optional
ID	MP_Rec_0467 (1)
Recommendation	laneCrownPointCenter should not be used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.nodeXY.attributes.data.laneCrownPointLeft</i>
O/M/C/F	Optional
ID	MP_Rec_0468 (1)
Recommendation	laneCrownPointLeft should not be used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. nodeList.nodes.nodeXY.attributes.data.laneCrownPointRight</i>
O/M/C/F	Optional
ID	MP_Rec_0469 (1)
Recommendation	laneCrownPointRight should not be used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. nodeList.nodes.nodeXY.attributes.data.laneAngle</i>
O/M/C/F	Optional
ID	MP_Rec_0470 (1)
Recommendation	laneAngle should not be used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. nodeList.nodes.nodeXY.attributes.data.regional</i>
O/M/C/F	Optional
ID	MP_Rec_0471 (1)
Recommendation	regional should not be used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. nodeList.nodes.nodeXY.attributes.dwidth MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList. nodes.nodeXY.attributes.dwidth</i>
O/M/C/F	Conditional
ID	MP_Req_0472 (1)
Requirement	The default lane width of the intersection is provided by laneWidth. Any significant lane width difference of at least <i>pMinDifference</i> (see section 4.2.3.1) meters to this default width, shall be expressed with dWidth.
ID	MP_Req_0473 (1)
Requirement	dWidth shall not be used when no road marking exists (e.g. at toll stations) and lanes are not clearly indicated.
ID	MP_Inf_0474 (1)
Information	The location of road markings is deduced from the location of central line in the lane and the width of the lane.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList. nodes.nodeXY.attributes.regional</i>
O/M/C/F	Conditional
ID	MP_Req_0475 (1)
Requirement	regional shall be used for merging and diverging nodes when roadSegments is used.

DE/DF	<code>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. connectsTo.connection</code> <code>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane. connectsTo.connection</code>
O/M/C/F	Mandatory
ID	MP_Req_0476 (1)
Requirement	In case connectsTo is used connection shall be used.

DE/DF	<code>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane. connectsTo.connectingLane.maneuver</code> <code>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane. connectsTo.connectingLane.maneuver</code>
O/M/C/F	Mandatory
ID	MP_Req_0477 (1)
Requirement	The information in the data element 'maneuver' in 'connectingLane' shall be based on the lane marking arrows on the lane itself (if present).
ID	MP_Req_0478 (1)
Requirement	For data element 'maneuver' in 'connectingLane' exactly one of the first four bits of DE_AllowedManeuvers (i.e. exactly one direction indication per connectingLane) shall be set. The maneuver indication "maneuverleft-/maneuverRightTurnonRedAllowed" and "maneuverLaneChangeAllowed" shall not be used. These permissions must be expressed by MovementPhaseState ³⁹ in SPATEM.
ID	MP_Req_0479 (1)
Requirement	In case there are no lane marking arrows on the street, the responsible human message designer shall decide the content of the data element individually for every lane.
ID	MP_Opt_0480 (1)
Option	All other bits of the DE_AllowedManeuvers may be set but will not be used by current vehicle implementations.
ID	MP_Inf_0481 (1)
Information	The use of 'maneuver' (in connectsTo) over 'maneuvers' (in GenericLane) ⁴⁰ is preferred, which provides the same information only in more detail. Therefore, maneuvers (in GenericLane) is not used.

DE/DF	<code>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane. connectsTo.remoteIntersection</code>
O/M/C/F	Optional
ID	MP_Req_0482 (1)
Requirement	remoteIntersection shall not be used when roadSegments is used.

³⁹ SPATEM.spat.intersections.states.state-time-speed.eventState

⁴⁰ MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.maneuvers/
MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.maneuvers

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.connectsTo.remoteIntersection</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0483 (1)</i>
Requirement	remoteIntersection shall only be used if the referenced intersection is part of the same MAPEM.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.connectsTo.signalGroup</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0484 (1)</i>
Requirement	signalGroup shall not be used when roadSegment is used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.connectsTo.signalGroup</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0485 (1)</i>
Requirement	signalGroup shall be used for every connection that is signalised with an operational traffic light and shall not be used if there is no traffic light.
ID	<i>MP_Req_0486 (1)</i>
Requirement	Every given 'signalGroup' / 'intersectionReferenceID' tuple in the MAPEM shall also be found in the SPATEM.
ID	<i>MP_Req_0487 (1)</i>
Requirement	A single connection may be controlled by multiple signal heads, meaning there is not always a 1:1 relationship between signal heads and connections. When multiple signals control a connection, their combined state shall be reflected in the eventState.
ID	<i>MP_Opt_0488 (1)</i>
Option	An exception to the 1:1 relationship occurs when multiple user classes share the same lane but are controlled by separate signals (e.g., public transport). In such cases, a single lane may have multiple overlapping connections.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.connectsTo.connectionID</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0489 (1)</i>
Requirement	connectionID shall not be used when roadSegments is used.

DE/DF	<i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.connectsTo.connectionID</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0490 (1)</i>
Requirement	connectionID shall be used to provide a connection index when ConnectionManeuverAssist or ConnectionTrajectory-addGrpC is used.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList.nodes.NodeXY.attributes.regional.NodeLink.Node.id</i> <i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.NodeXY.attributes.regional.NodeLink.Node.id</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0491 (1)</i>
Requirement	id of the linked node shall be used.
ID	<i>MP_Inf_0492 (1)</i>
Information	As current use is only for merging and diverging points, it is the id of the node from another lane that is at the same position as this node.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList.nodes.NodeXY.attributes.regional.NodeLink.Node.lane</i> <i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.NodeXY.attributes.regional.NodeLink.Node.lane</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0493 (1)</i>
Requirement	Identifier of lane from which node has been issued shall be given.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment.roadLaneSet.genericLane.nodeList.nodes.NodeXY.attributes.regional.NodeLink.Node.connectionID</i> <i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.NodeXY.attributes.regional.NodeLink.Node.connectionID</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0494 (1)</i>
Recommendation	connectionID should not be used.

DE/DF	<i>MAPEM.mapData.roadSegments.RoadSegment. roadLaneSet.genericLane. nodeList.nodes.NodeXY.attributes.regional.NodeLink.Node.intersectionID</i> <i>MAPEM.mapData.intersections.IntersectionGeometry.laneSet.genericLane.nodeList.nodes.NodeXY.attributes.regional.NodeLink.Node.intersectionID</i>
O/M/C/F	Optional
ID	MP_Rec_0495 (1)
Recommendation	intersectionID should not be used.

4.2.3.3 SPATEM general elements

For new and update SPATEMs, the SPATEM data elements, SPATEM data frames and service parameters shall be used according to the definitions in this section.

DE/DF	<i>SPATEM.spat.timestamp</i>
O/M/C/F	Optional
ID	MP_Rec_0496 (1)
Recommendation	This DE should not be used to set a timestamp of related SPATs.

DE/DF	<i>SPATEM.spat.name</i>
O/M/C/F	Optional
ID	MP_Rec_0497 (1)
Recommendation	This DE should not be used to set a name of related SPATs.

DE/DF	<i>SPATEM.spat.intersections</i>
O/M/C/F	Mandatory
ID	MP_Req_0498 (1)
Requirement	All intersections in the related MAPEM shall be set.

DE/DF	<i>SPATEM.spat.regional</i>
O/M/C/F	Optional
ID	MP_Rec_0499 (1)
Recommendation	This DF should not be used to set regional extensions of related SPATs.

DE/DF	<i>SPATEM.spat.intersections.name</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0500 (1)</i>
Recommendation	This DE should be used to name the intersection related SPATs.
ID	<i>MP_Rec_0501 (1)</i>
Recommendation	The intersection name should be the same as the corresponding intersection in the related MAPEM.
ID	<i>MP_Inf_0502 (1)</i>
Information	Typically, human readable and recognizable by road authority.

DE/DF	<i>SPATEM.spat.intersections.id</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0503 (1)</i>
Requirement	The intersection id shall be the same as the corresponding intersection in the related MAPEM.

DE/DF	<i>SPATEM.spat.intersections.revision</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0507 (1)</i>
Requirement	The revision number shall be increased by 1 each time the MapData of this intersection changes.
ID	<i>MP_Req_0508 (1)</i>
Requirement	The revision numbers of SPATEM and MAPEM shall be the same as an indication that the right MAPEM revision is used.

DE/DF	SPATEM.spat.intersections.status
O/M/C/F	Mandatory
ID	MP_Req_0509 (1)
Requirement	<p>This DE shall be set according to EN 12675 to one or more of the following bits:</p> <ul style="list-style-type: none"> 0 (manualControlsEnabled): typically in case of an incident at the intersection, shall be combined with 13 (noValidSPATisAvailableAtThisTime) 2 (failureFlash): typically in case the traffic light controller is out of order, shall be combined with 13 (noValidSPATisAvailableAtThisTime) 5 (fixedTimeOperation): operation of signals is based on time only 6 (trafficDependentOperation): operation of signals is based on different levels of traffic parameters, 7 (standbyOperation): typically in case some or all signals are off, shall be combined with 13 (noValidSPATisAvailableAtThisTime) 8 (failureMode): typically in case the traffic light controller is not able to operate properly (i.e. worse than failureFlash), shall be combined with 13 (noValidSPATisAvailableAtThisTime) 9 (off): typically in case the traffic light controller is not powered, shall be combined with 13 (noValidSPATisAvailableAtThisTime) 12 (noValidMAPisAvailableAtThisTime): only used in case the absence of a valid MAPEM is intentional 13 (noValidSPATisAvailableAtThisTime): used in combination with one of the bits (0), (2), (7), (8), (9). If one of these states is detected, the bit should be sent within less than <i>tDelayFailureTransmission</i> (see section 4.2.3.1) after the traffic light goes into failure mode. <p>Note: bit 1 (stopTimelsActivated) is not used</p> <p>Note: bits 10 (recentMAPmessageUpdate) and 11 (recentChangeInMAPassignedLanesIDsUsed) are not used as such information is available in the MAPEM</p> <p>Note: bits 3 (preemptIsActive), 4 (signalPriorityIsActive) are not used as the DE <i>stateChangeReason</i> offers more detailed information</p>
ID	MP_Inf_0510 (1)
Information	trafficDependentOperation (or actuated operation) refers to an operation mode of the traffic light controller that dynamically adapts the changes to the current traffic situation (i.e., the cycle of the traffic phases is not static but may change over time).
ID	MP_Inf_0511 (1)
Information	A traffic light is considered 'operational', if the corresponding traffic light controller is neither switched off nor in any kind of failure mode. This means that also traffic lights showing some kind of "standby" (e.g. at night) are considered operational.

DE/DF	SPATEM.spat.intersections.moy
O/M/C/F	Mandatory
ID	MP_Req_0512 (1)
Requirement	This DE shall be set to the time of information generation (i.e., when the timeChangeDetails are determined).
ID	MP_Req_0513 (1)
Requirement	The DE moy (minuteOfTheYear) shall be used to validate the reference time of the TimeMarks

DE/DF	<i>SPATEM.spat.intersections.timestamp</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0514 (1)</i>
Requirement	This DE shall be set to the time of information generation (i.e., when the timeChangeDetails are determined).
ID	<i>MP_Inf_0515 (1)</i>
Information	The DE moy ⁴¹ (minuteOfTheYear) combined with DE timestamp represent the information generation time

DE/DF	<i>SPATEM.spat.intersections.enabledLanes</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0516 (1)</i>
Requirement	This DF shall be used when the revocableLane bit is set in any of the lane descriptions of the related intersection in MAPEM, otherwise not used.
ID	<i>MP_Req_0517 (1)</i>
Requirement	The DF enabledLanes shall consist of a list of all LaneIDs where the revocableLane bit is set and the lanes are enabled (i.e, not revoked) at the time of information generation. This list could be empty.

DE/DF	<i>SPATEM.spat.intersections.states</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0518 (1)</i>
Requirement	Every given signalGroup within the intersection shall be found in one or more connections of the same intersection in MAPEM.
ID	<i>MP_Rec_0519 (1)</i>
Recommendation	The list of movement states consist at least of all connections within the intersection if the intersection status MP_Req_0509 (1) should either be bit 5 (fixedTimeOperation) or bit 6 (trafficDependentOperation).
ID	<i>MP_Req_0520 (1)</i>
Requirement	<p>An IntersectionState instance in SPATEM shall not include duplicate MovementState instances in MovementList which over time only differ in the assigned SignalGroupID.</p> <p>Note 1: Depending on the operation mode it is possible that in certain hours of the day two different MovementState instances (SignalGroups) have identical states.</p> <p>Note 2: This implies that multiple lanes in MAPEM may observe the same SignalGroupID, in case the exact same movement rules apply to them at all times.</p>

DE/DF	<i>SPATEM.spat.intersections.states.movementName</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Opt_0521 (1)</i>
Option	This DE may be used to provide a human readable and recognizable name for the movement state.

⁴¹ SPATEM.spat.intersections.moy

DE/DF	<i>SPATEM.spat.intersections.states.signalGroup</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0522 (1)</i>
Requirement	The SignalGroupID shall be unique within the <i>SPATEM.spat.intersections.states</i> .
ID	<i>MP_Req_0523 (1)</i>
Requirement	The SignalGroupID shall be present in one of the connections of the intersection in MAPEM.

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0524 (1)</i>
Requirement	All events in DF state-time-speed shall be sorted in the order of their appearance in time at the traffic light.
ID	<i>MP_Req_0525 (1)</i>
Requirement	<p>At least the movement events instances shall be included to provide the end time of the current green phase or the beginning of the next green phase. In other words and as a general rule, at least movement event instances for the current phase state, the next phase and all transitions in between shall be included in DF state-time-speed.</p> <p>Note: If the current phase state is a transition, the current transition and the next phase have to be included.</p> <p>Definition: ‘Transition’ is a general term denoting all the movement phase states which are not covered by the term phase (so the “Yellows / Ambers” as summarized in SAE J2735).</p> <p>Definition: Phase state is a general term that covers all movement phase states as defined in SAE J2735, i.e. ‘phase state’ includes both phases and transitions.</p>
ID	<i>MP_Inf_0526 (1)</i>
Information	Additional MovementEvent instances may be included.

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.eventState</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0527 (1)</i>
<i>Requirement</i>	<p>This DE shall be set to represent the actual allowed movement state permissions according to the applicable traffic rules as indicated by the traffic lights, including the distinction between protected and permissive movements and can contain the following values:</p> <ul style="list-style-type: none"> ○ 0 (unavailable): unknown or error ○ 1 (dark): shall not be used ○ 2 (stop-then-Proceed): e.g. red light combined with road sign with green arrow for turn movement ○ 3 (stop-and-remain): when vehicles on corresponding lanes are not allowed to enter the conflict zone (e.g. red light) ○ 4 (pre-Movement): transitions that directly precede the phase “permissive-Movement-Allowed” or “protected-Movement-Allowed” (e.g. red/amber as used in some EU countries before green signal) ○ 5 (permissive-Movement-Allowed): when vehicles on corresponding lanes are allowed to enter the conflict zone but there still might occur conflicting traffic which they have to pay attention for (e.g. green "full ball" light, with potential conflicting traffic, especially while turning left or right) ○ 6 (protected-Movement-Allowed): when vehicles on corresponding lanes are allowed to enter the conflict zone and there shouldn't be any conflicting traffic according to the traffic rules (e.g. green "arrow" light, with no conflicting traffic or pedestrians while crossing the conflict area) ○ 7 (permissive-clearance): when vehicles on corresponding lanes are allowed to enter the conflict zone if they are not able to stop before the stop line shall clear the conflict zone and have to be attentive of potential conflicting traffic (e.g. amber "full ball" light, prepare to stop. Used after a "green" signal state)). ○ 8 (protected-clearance): when vehicles on corresponding lanes are allowed to enter the conflict zone if they are not able to stop before the stop line, shall clear the conflict zone and there shouldn't be any conflicting traffic according to the traffic rules (e.g. amber "arrow" light, Directional prepare to stop. Used after a "green arrow" signal state) ○ 9 (caution-Conflicting-Traffic): shall be used for signalGroups belonging to lanes of minor roads if none of the aforementioned MovementPhaseStates are applicable (e.g. if the traffic light controller is in standby mode). It shall indicate that vehicles are allowed to proceed but have to give way to conflicting traffic when present (e.g. Amber light blinking; Proceed with caution, Conflicting traffic may be present in the intersection conflict area) <p>Note 1: The cars need to know the applicable permissions and not the physical representation / colour of the physical traffic lights, i.e. the applicable traffic rules are of relevance.</p> <p>Note 2: There is no 1:1 relation between signal heads and connections, e.g. if a connection is controlled by 2 signals, their combined state shall be reflected in the eventState.</p> <p>Note 3: If no information can be given, “unavailable” shall be used rather than “dark”.</p>
ID	<i>MP_Req_0528 (1)</i>

<i>Requirement</i>	If a failure of the traffic light controller is detected (i.e. the SPATEM.spat.intersections.status has bit (0), (2), (7), (8) or (9)), eventState 0 (unavailable) shall be provided.
<i>ID</i>	MP_Inf_0529 (1)
<i>Information</i>	In case multiple signal lamps apply to one connection (e.g. a combination of a full signal head with one green arrow signal for the right turn), a singular movement phase state shall reflect what the vehicle is allowed to do for the associate manoeuvre, which reflects the combined movement phase state of all applicable signals.

<i>DE/DF</i>	SPATEM.spat.intersections.states.state-time-speed.timing
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	MP_Req_0530 (1)
<i>Requirement</i>	This DF shall be set for every instance of MovementEvent in SPATEM containing an instance of SPATEM.spat.intersections.states.state-time-speed.eventState representing one of the values 2, 3, 4, 5, 6, 7 or 8 (i.e. reds, greens and yellows other than flashing-yellow). Timing data may not be available when SPATEM.spat.intersections.states.state-time-speed.eventState is 0, 1 or 9.
<i>ID</i>	MP_Inf_0531 (1)
<i>Information</i>	All TimeMarks are defined as an offset to the UTC full hour (see TS19091) and not for functional safety, but informative related to signal timing.
<i>ID</i>	MP_Inf_0532 (1)
<i>Information</i>	likelyTime with confidence or minEndTime with maxEndTime are both measures for probability which can be used interchangeably subject to availability.
<i>ID</i>	MP_Req_0533 (1)
<i>Requirement</i>	If SPATEM.spat.intersections.status is 5 (i.e. fixedTimeOperation), minEndTime, likelyTime and maxEndTime shall be equal, if they are present.
<i>ID</i>	MP_Req_0534 (1)
<i>Requirement</i>	Let <i>tAbsMinEndTime</i> , <i>tAbsLikelyTime</i> and <i>tAbsMaxEndTime</i> be the instants which likelyTime, minEndTime and maxEndTime refer to, they shall suffice the following condition: $tAbsMinEndTime \leq tAbsLikelyTime \leq tAbsMaxEndTime$.

<i>DE/DF</i>	SPATEM.spat.intersections.states.state-time-speed.timing.startTime
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	MP_Rec_0535 (1)
<i>Recommendation</i>	This DE should not be used to set a name of related SPATs.

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.timing.minEndTime</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0536 (1)</i>
Requirement	<p>This DE shall be set for every signal group to the earliest time possible at which the phase state of the respective signal group could change, including unpredictable events like pedestrian crossing or pre-emption for emergency and other priority vehicles (e.g. public transport).</p> <p>Note: That means the minEndTime may be the currentTime + the time it takes to change the signal if a prioritization request occurred at the current time (i.e. as an indication of the safety range based on what can at the very most can happen).</p>
ID	<i>MP_Req_0537 (1)</i>
Requirement	The risks of force majeure such as technical failures shall not be considered in the determination of minEndTime.
ID	<i>MP_Req_0538 (1)</i>
Requirement	<p>minEndTime shall have a value between <i>pTimeMarkMin</i> and <i>pTimeMarkOutOfRange</i> (see section Parameter settings).</p> <p>Note: This means that the value <i>pTimeMarkUnknown</i> (unknown) shall not be used.</p>
ID	<i>MP_Req_0539 (1)</i>
Requirement	<p>For use cases where the end time is unknown (e.g. toll stations), minEndTime shall be set to <i>pTimeMarkUnknown</i> (see chapter 4.2.3.1) to indicate that end time of the current phase is unknown</p> <p>Note: by definition, tollgate clearance depends on the time of the next transaction so it cannot be known in advance.</p>
ID	<i>MP_Req_0540 (1)</i>
Requirement	<p><i>tAbsMinEndTime</i> shall not move to an earlier point in time. It may however progress to a later point in time.</p> <p>Note: In relative terms this means that the remaining time until minEndTime shall not decrease faster than the time passes.</p>
ID	<i>MP_Req_0541 (1)</i>
Requirement	For traffic signal controllers operating fixed time, where the time of change is known, minEndTime shall be accurate to the displayed change of the traffic light within <i>tTimeOfChangeAccuracy</i> (see section Parameter settings).

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.timing.maxEndTime</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0542 (1)</i>
Requirement	This DE shall be used in case of signalised intersection use cases, and shall not be used for toll station use cases.
ID	<i>MP_Req_0543 (1)</i>
Requirement	This DE shall be set to the latest time possible at which the phase state could change (i.e. as an indication of the safety range based on what at the very most can happen).
ID	<i>MP_Req_0544 (1)</i>
Requirement	In case maxEndTime is infinite (e.g. for traffic lights that only change in case of pedestrian requests), the value shall be set to <i>pTimeMarkOutOfRange</i> (see section Parameter settings). Note: This includes the case when the actual maxEndTime is not known.
ID	<i>MP_Req_0545 (1)</i>
Requirement	The value <i>pTimeMarkUnknown</i> (see section Parameter settings) shall not be used.
ID	<i>MP_Req_0546 (1)</i>
Requirement	<i>tAbsMaxEndTime</i> shall not move to a later point in time. It may however progress to an earlier point in time. Note: In relative terms this means that the remaining time until maxEndTime shall not increase.

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.timing.likelyTime</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0547 (1)</i>
Requirement	This DE shall be used in case of signalised intersection use cases, and shall not be used for toll station use cases.
ID	<i>MP_Inf_0548 (1)</i>
Information	Generally, the likelyTime is used to convey the most likely time the phase state changes.
ID	<i>MP_Req_0549 (1)</i>
Requirement	For this DE the value <i>pTimeMarkUnknown</i> (see section Parameter settings) shall not be used.

DE/DF	SPATEM.spat.intersections.states.state-time-speed.timing.confidence																																		
O/M/C/F	Optional																																		
ID	MP_Req_0550 (1)																																		
Requirement	This DE shall be used in case of signalised intersection use cases, and shall not be used for toll station use cases.																																		
ID	MP_Req_0551 (1)																																		
Requirement	<p>Confidence shall be interpreted as the 95% probability that the real phase change occurs within \pm time-interval of the indicated likelyTime.</p> <p>Note: This means that the 95% probability for likelyTime – time-interval \leq phase change time \leq likelyTime + time-interval shall be indicated.</p> <p>The values of confidence are encoded as time-interval classes (in seconds) with the values listed in the table below.</p> <table border="1"> <thead> <tr> <th>Value</th><th>Time-interval</th></tr> </thead> <tbody> <tr><td>0</td><td>>15.0</td></tr> <tr><td>1</td><td>13.5</td></tr> <tr><td>2</td><td>12.0</td></tr> <tr><td>3</td><td>10.5</td></tr> <tr><td>4</td><td>9.0</td></tr> <tr><td>5</td><td>7.5</td></tr> <tr><td>6</td><td>6.5</td></tr> <tr><td>7</td><td>5.5</td></tr> <tr><td>8</td><td>4.5</td></tr> <tr><td>9</td><td>3.5</td></tr> <tr><td>10</td><td>2.5</td></tr> <tr><td>11</td><td>2.0</td></tr> <tr><td>12</td><td>1.5</td></tr> <tr><td>13</td><td>1.0</td></tr> <tr><td>14</td><td>0.5</td></tr> <tr><td>15</td><td>0</td></tr> </tbody> </table> <p>Note: time-interval values are intentionally arranged in such a way to align with the probabilities-scale in the standard.</p>	Value	Time-interval	0	>15.0	1	13.5	2	12.0	3	10.5	4	9.0	5	7.5	6	6.5	7	5.5	8	4.5	9	3.5	10	2.5	11	2.0	12	1.5	13	1.0	14	0.5	15	0
Value	Time-interval																																		
0	>15.0																																		
1	13.5																																		
2	12.0																																		
3	10.5																																		
4	9.0																																		
5	7.5																																		
6	6.5																																		
7	5.5																																		
8	4.5																																		
9	3.5																																		
10	2.5																																		
11	2.0																																		
12	1.5																																		
13	1.0																																		
14	0.5																																		
15	0																																		
ID	MP_Req_0552 (1)																																		
Requirement	If no prediction is available, the confidence value of likelyTime shall be disseminated with the value 0.																																		

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.timing.nextTime</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0553 (1)</i>
Recommendation	This DE should not be used.

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.speeds</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0554 (1)</i>
Requirement	This DF shall be used when DE speed ⁴² is used.

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.speeds.type</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Inf_0555 (1)</i>
Information	Explanatory discription: greenwave (1) = speed for a sequence of coordinated intersections (repeated at each intersection) ecoDrive (2) = speed for current intersection transit (3) = restricted to specific vehicle type

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.speeds.speed</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Opt_0556 (1)</i>
Option	This DE may be used to set the AdvisorySpeed.

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.speeds.confidence</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0557 (1)</i>
Recommendation	This DE should not be used.

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.speeds.distance</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Opt_0558 (1)</i>
Option	This DE may be used to set the distance upstream from the stop bar along the ingressing lane.

⁴² SPATEM.spat.intersections.states.state-time-speed.speeds.speed

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.speeds.class</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Opt_0559 (1)</i>
Option	This DE may be used to set the restriction class.

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.speeds.regional</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0560 (1)</i>
Recommendation	This DE should not be used.

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.regional</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0561 (1)</i>
Recommendation	This DE should not be used.

DE/DF	<i>SPATEM.spat.intersections.states.state-time-speed.regional.stateChangeReason</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0562 (1)</i>
Requirement	This DE shall be used in case of sudden changes in eventState parameters that can extend waiting times, thereby offering a reason for extended waiting times.
ID	<i>MP_Req_0597 (1)</i>
Requirement	<p>The following values shall be used:</p> <ul style="list-style-type: none"> ○ unknown, ○ publicTransportPriority, ○ emergencyVehiclePriority, ○ trainPriority, ○ bridgeOpen, ○ vehicleHeight, ○ weather, ○ trafficJam, ○ tunnelClosure, ○ meteringActive, ○ truckPriority, ○ bicyclePlatoonPriority, ○ vehiclePlatoonPriority

DE/DF	<i>SPATEM.spat.intersections.states.maneuverAssistList</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Rec_0563 (1)</i>
Recommendation	This DF may be used to give information about the connections of the movement state and to convey queue length for speed advisory calculation.
ID	<i>MP_Rec_0564 (1)</i>
Recommendation	If used this DE should list all connections involved in the movement state for the given SignalGroup.

DE/DF	<i>SPATEM.spat.intersections.states.maneuverAssistList.connectionID</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0565 (1)</i>
Requirement	This DE shall be used to give information about the connection involved for the movement state.

DE/DF	<i>SPATEM.spat.intersections.states.maneuverAssistList.queueLength</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0566 (1)</i>
Recommendation	This DE may be used to give information about the queue length available for the given connection.

DE/DF	<i>SPATEM.spat.intersections.states.maneuverAssistList.availableStorageLength</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0567 (1)</i>
Recommendation	This DE should not be used.

DE/DF	<i>SPATEM.spat.intersections.states.maneuverAssistList.waitOnStop</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0568 (1)</i>
Recommendation	This DE should not be used.

DE/DF	<i>SPATEM.spat.intersections.states.maneuverAssistList.pedBicycleDetect</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0569 (1)</i>
Recommendation	This DE should not be used.

DE/DF	<i>SPATEM.spat.intersections.states.maneuverAssistList.regional</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0570 (1)</i>
Recommendation	This DF should not be used.

<i>DE/DF</i>	<i>SPATEM.spat.intersections.states.regional</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Rec_0571 (1)</i>
<i>Recommendation</i>	This DF should not be used.

<i>DE/DF</i>	<i>SPATEM.spat.intersections.maneuverAssistList</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Rec_0572 (1)</i>
<i>Recommendation</i>	This DF should not be used.

<i>DE/DF</i>	<i>SPATEM.spat.intersections.regional</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Req_0573 (1)</i>
<i>Requirement</i>	This regional DF REGION.Reg-IntersectionState-addGrpC can be used to ensure interoperability with existing public transport prioritisation systems.
<i>ID</i>	<i>MP_Rec_0574 (1)</i>
<i>Recommendation</i>	This DF is not recommended to be used on the level of intersections, but is used on the level of movement states.

4.2.4 Traffic Light Control (TLC) FLS

The Traffic Light Control service is one instantiation of the infrastructure services to manage the generation, transmission of SREM messages and SSEM messages. The TLC service supports prioritization of public transport and public safety vehicles (ambulance, fire brigade, etc.) to traverse a signalized road infrastructure (e.g. intersection) as fast as possible or using a higher priority than ordinary traffic participants. The corresponding SREM is sent by an ITS-S (e.g. vehicle) to the traffic infrastructure environment (e.g. R-ITS-S, TCC). In a signalized environment (e.g. intersection) the SREM is sent for requesting traffic light signal priority (public transport) signal pre-emption (public safety). The service may not only be requested for the approaching signalized environment but also for a sequence of e.g. intersections along a defined traffic route. In response to the request the infrastructure (e.g. R-ITS-S/TLC or TCC) will acknowledge with a SSEM notifying if the request has been granted, cancelled or changed in priority due to a more relevant signal request (e.g. ambulance). ([ETSI TS 103 301])

Operational parameters and relevant standards

The TLC FLS including operational parameters is defined in [ETSI TS 103 301], which refers to [ISO/TS 19091], which in turn refers to [SAE J2735]. Data elements, data frames and service parameters shall be used according to the definitions in 4.2.4.1 and 4.2.4.2. The header SREM/SSEM shall be as specified in the data dictionary [ETSI TS 102 894-2].

4.2.4.1 SREM requirements

DE/DF	<i>SREM.srm.timeStamp</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_2576 (1)</i>
Requirement	timeStamp shall be used.

DE/DF	<i>SREM.srm.sequenceNumber</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_2577 (1)</i>
Requirement	sequenceNumber shall be used.

DE/DF	<i>SREM.srm.requests.request.id</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_2578 (1)</i>
Requirement	id shall be the same as of the corresponding target intersection in the related MAPEM

DE/DF	<i>SREM.srm.requests.request.requestId</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0579 (1)</i>
Requirement	requestId in combination with the stable stationId shall be unique for the requesting ITS station and duration of the requested action. In very seldom cases it could occur, that two vehicles use the same combination of requestId and stationId.
ID	<i>MP_Inf_0580 (1)</i>
Information	This ID is used in the corresponding SSEM.

DE/DF	<i>SREM.srm.requests.request.inBoundLane</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0581 (1)</i>
Requirement	In typical use either an approach, a lane or connection shall be given, this indicates the requested path through the intersection to the degree it is known.
ID	<i>MP_Inf_0582 (1)</i>
Information	This mechanism is distinctly different from more traditional prioritisation practices e.g. for public transport, which typically is based on vehicle or line numbers, which are known by the traffic light controller and tied to movements and signal groups. SREM is based on the concept of more specific prioritisation requests which can also extend to other vehicle classes.

DE/DF	<i>SREM.srm.requests.request.outBoundLane</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0583 (1)</i>
Recommendation	In typical use either an approach, a lane or connection should be given, this indicates the requested path through the intersection to the degree it is known.
ID	<i>MP_Inf_0584 (1)</i>
Information	This mechanism is distinctly different from more traditional prioritisation practices e.g. for public transport, which typically is based on vehicle or line numbers, which are known by the traffic light controller and tied to movements and signal groups. SREM is based on the concept of more specific prioritisation requests which can also extend to other vehicle classes.

DE/DF	<i>SREM.srm.requestor.id.stationID</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0585 (1)</i>
Requirement	Shall be identical to the stationID of the CAM message and shall not change during pending SREM.

<i>DE/DF</i>	<i>SREM.srm.requestor.routeName</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Rec_0586 (1)</i>
<i>Recommendation</i>	This DE should be used to provide information route, line and direction of the vehicle.

4.2.4.2 SSEM requirements

<i>DE/DF</i>	<i>SSEM.ssm.timestamp</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0587 (1)</i>
<i>Requirement</i>	timestamp shall be used.

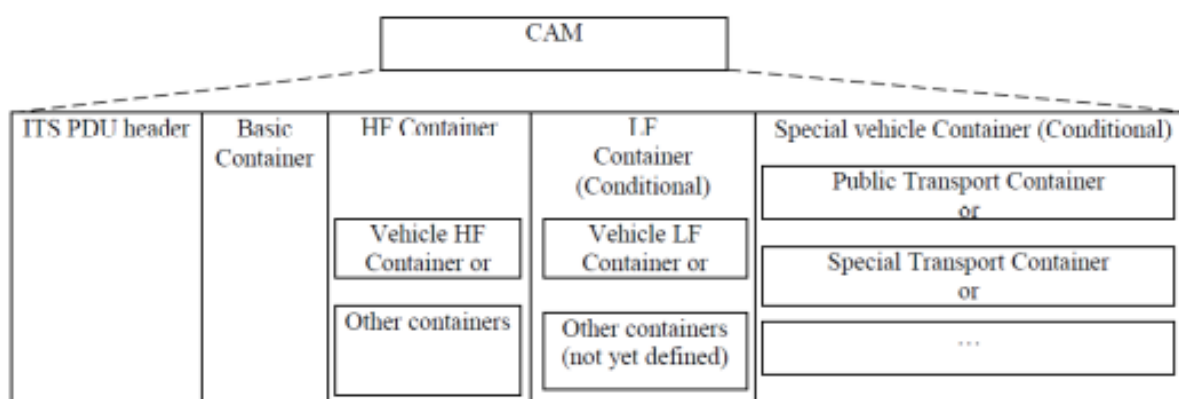
<i>DE/DF</i>	<i>SSEM.ssm.status.sigStatus.requester</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0588 (1)</i>
<i>Requirement</i>	requester shall be used.

4.2.5 Cooperative Awareness Basic Service (CA Basic FLS)

The Cooperative Awareness Basic Service and the Cooperative Awareness Message (CAM) are intended to realize cooperative awareness (i.e. locate vehicles or cooperative infrastructure in real time and signal position and state of vehicles). CAM are transmitted regularly by the V-ITS-S and R-ITS-S, all ITS stations within range can receive and process them.

The following description is based on the ETSI standard [ETSI EN 103 900].

The CAM structure is described in following figure. It is composed of mandatory data (ITS PDU header, Basic container containing in particular the ID and the last geographic positions of the ITS station as well as the High Frequency (HF) container containing the vehicle's fast-changing data) and optional data, which should be specified based on the message's sender.



<i>DE/DF</i>	<i>CAM.header</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0227 (1)</i>
<i>Requirement</i>	The protocolVersion shall be set to 2 and the messageID shall be set to cam(2).

DE/DF	<i>CAM.cam.camParameters.basicContainer.stationType</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0229 (1)</i>
Requirement	<p>The stationType shall be set as follows:</p> <ul style="list-style-type: none"> ○ for completely stationary units (e.g. roadside units): <ul style="list-style-type: none"> ○ roadsideUnit(15) ○ for mobile units and potentially mobile units (e.g. trailers): <ul style="list-style-type: none"> ○ moped(3) ○ motorcycle(4) ○ passengerCar(5) ○ bus(6) ○ lightTruck(7) ○ heavyTruck(8) for normal vehicles using their actual stationType ○ trailer(9) for trailers ○ specialVehicles(10) for special vehicles ○ tram(11) for trams

DE/DF	<i>CAM.cam.camParameters.basicContainer.referencePosition</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0230 (1)</i>
Requirement	The referencePosition shall correspond to the current position of the station. This measurement is made on the temporal basis of GenerationDeltaTime.

DE/DF	<i>CAM.cam.camParameters.basicContainer.referencePosition. positionConfidenceEllipse.semiMajorConfidence</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0305 (1)</i>
Requirement	semiMajorConfidence shall be set to unavailable (4095), if a confidence level of 95% cannot be achieved.

DE/DF	<i>CAM.cam.camParameters.basicContainer.referencePosition. positionConfidenceEllipse.semiMinorConfidence</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0306 (1)</i>
Requirement	semiMinorConfidence shall be set to unavailable (4095), if a confidence level of 95% cannot be achieved.

DE/DF	<i>CAM.cam.camParameters.basicContainer.referencePosition. positionConfidenceEllipse.altitude.altitudeConfidence</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0307 (1)</i>
Requirement	altitudeConfidence shall be set to unavailable (15), if a confidence level of 95% cannot be achieved.

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer. basicVehicleContainerHighFrequency</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0231 (1)</i>
Requirement	The basicVehicleContainerHighFrequency shall be used for potentially mobile units and when using the Infrastructure mobile ITS-G5 System Profile (MSP).

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer. basicVehicleContainerHighFrequency.heading.headingConfidence</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0308 (1)</i>
Requirement	headingConfidence shall be set to unavailable (127), if a confidence level of 95% cannot be achieved.

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer. basicVehicleContainerHighFrequency.speed.speedConfidence</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0398 (1)</i>
Requirement	speedConfidence shall be set to unavailable (127), if a confidence level of 95% cannot be achieved.

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.basicVehicleContainerHighFrequency. driveDirection</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0232 (1)</i>
Requirement	If the ITS station has access to additional information besides GNSS (e.g. gearbox information, reverse light), driveDirection shall be set to forward (0) or backward (1). If the ITS station cannot accurately detect driveDirection, driveDirection shall be set to unavailable (2). This is typical for aftermarket GNSS only based solutions.

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.basicVehicleContainerHighFrequency.vehicleLength.vehicleLengthValue</i>
O/M/C/F	Mandatory
ID	MP_Req_0233 (1)
Requirement	The vehicleLengthValue shall be set to the length of the vehicle including all permanent extensions and excluding other removable extensions (e.g. snow plough) unless the length can be easily known and integrated.
ID	MP_Req_0310 (1)
Requirement	<p>The vehicleLengthValue shall be set as follows:</p> <ul style="list-style-type: none"> ○ In case of ITS station mounted on a trailer: the length of the trailer, ○ In case of ITS station within a towing vehicle: <ul style="list-style-type: none"> ○ if the trailer length is known: the total length of the vehicle including the length of the trailer ○ if the trailer length is unknown: the total length of the vehicle excluding the length of the trailer <p>Note: The approach taken takes into account that currently the effort to detect the presence and extent of e.g. a snow plough is not reflected by any benefit. This might change in the future.</p>

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.basicVehicleContainerHighFrequency.vehicleLength.vehicleLengthConfidenceIndication</i>
O/M/C/F	Mandatory
ID	MP_Req_0309 (1)
Requirement	<p>The vehicleLengthConfidenceIndication shall be set as follows:</p> <ul style="list-style-type: none"> ○ In case of ITS station mounted on a trailer: noTrailerPresent (0), ○ In case of ITS station within a towing vehicle: <ul style="list-style-type: none"> ○ trailerPresentWithKnownLength (1) if the trailer length is known ○ trailerPresentWithUnknownLength (2) if the trailer length is unknown

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.basicVehicleContainerHighFrequency.vehicleWidth</i>
O/M/C/F	Mandatory
ID	MP_Req_0311 (1)
Requirement	The mobile ITS station shall set the vehicleWidth in CAMs it originates to the value of the width without mirrors.

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.basicVehicleContainerHighFrequency.longitudinalAcceleration.confidence</i>
O/M/C/F	Mandatory
ID	MP_Inf_0234 (1)
Information	confidence shall be set to unavailable (102), if a confidence level of 95% cannot be achieved.

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.basicVehicleContainerHighFrequency.curvature</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0235 (1)</i>
Requirement	For aftermarket solutions, curvature shall be calculated based on yawRate. Note: By experience, yawRate from GNSS only is not of a high quality, but given GNSS only aftermarket devices, it is the only way to calculate curvature.

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.basicVehicleContainerHighFrequency.curvatureCalculationMode</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0236 (1)</i>
Requirement	Aftermarket solutions can only calculate curvature using yawRate and therefore shall use yawRateUsed(0).

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.basicVehicleContainerHighFrequency.yawRate</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0237 (1)</i>
Requirement	Aftermarket GNSS only based solutions shall calculate the yawRate using the change of GNSS “Course over Ground” over time. If the aftermarket solution has access to additional information besides GNSS (e.g. gyro, inertial sensor), the yawRate shall be calculated on that basis. Note: By experience, yawRate from GNSS only is not of a high quality, but given GNSS only aftermarket devices, it is the only available data source.

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.rsuContainerHighFrequency</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0238 (1)</i>
Requirement	The rsuContainerHighFrequency shall be used for completely stationary units and when using the Roadside ITS G5 System Profile.

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.rsuContainerHighFrequency.protectedCommunicationZonesRSU</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0239 (1)</i>
Requirement	In case it is intended to communicate information about DSRC protected communication zones (toll stations), this DF shall be used.

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.rsuContainerHighFrequency.protectedCommunicationZonesRSU.expiryTime</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0304 (1)</i>
Requirement	The expiry time shall be specified if the end of operation is known.

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.rsuContainerHighFrequency.protectedCommunicationZonesRSU.protectedZoneRadius</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Inf_0240 (1)</i>
Information	If the radius data element is omitted, the default radius of 55m applies (ETSI TS 102 792).

DE/DF	<i>CAM.cam.camParameters.highFrequencyContainer.rsuContainerHighFrequency.protectedCommunicationZonesRSU.protectedZoneId</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0241 (1)</i>
Requirement	If the same zone is defined in the European Protected Zone database, the same ID shall be used as protectedZoneId. Otherwise, an ID greater than 67108863, which is not used in the database, shall be used.

DE/DF	<i>CAM.cam.camParameters.lowFrequencyContainer.basicVehicleContainerLowFrequency</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0242 (1)</i>
Requirement	This container shall only be used for mobile ITS-S.

DE/DF	<i>CAM.cam.camParameters.lowFrequencyContainer.basicVehicleContainerLowFrequency.vehicleRole</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Rec_0243 (1)</i>
Recommendation	<p>An emergency vehicle in operation having right of way (typically a “blue flashing light” setting) should result in the vehicle role set to emergency(6) and the usage of the EmergencyContainer. Other special roles indicated by warning lights (e.g. “amber/yellow flashing light”) should result in the usage of safetyCar(7) together with the safetyCarContainer or rescue(5) together with the RescueContainer.</p> <p>Details can be found in the “C-ITS service and use case definitions”.</p> <p>Note: vehicleRole⁴³ is also linked to the use of specialVehicleContainers. See MP_Req_0250, 251, 253.</p>

DE/DF	<i>CAM.cam.camParameters.lowFrequencyContainer. basicVehicleContainerLowFrequency.exteriorLights</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0244 (1)</i>
Requirement	If a vehicle is not equipped with a certain light or if the light switch status information is not available, the corresponding bit shall be set to 0. Note: If the vehicleRole ⁴³ is used, the status of the exteriorLights is mandatory – which is problematic for aftermarket devices as they do not have information about the light status.

DE/DF	<i>CAM.cam.camParameters.lowFrequencyContainer. basicVehicleContainerLowFrequency.pathHistory</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Rec_0245 (1)</i>
Recommendation	Road operators should use design method one as specified in Appendix A.5 to [SAE J2945/1].
ID	<i>MP_Opt_0246 (1)</i>
Option	For existing systems, equidistant points may be used instead of design method one. In this case, the default settings are: a maximum of 23 tracking points with a distance of 22.5 m between the points.
ID	<i>MP_Req_0247 (1)</i>
Requirement	After a pseudonym change, pathHistory shall be deleted.

DE/DF	<i>CAM.cam.camParameters.specialVehicleContainer.publicTransportContainer</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0248 (1)</i>
Requirement	The publicTransportContainer shall be used only for specific use cases (Public Transport Vehicle Crossing, Public Transport Vehicle at a Stop) where the vehicleRole is publicTransport(1).

DE/DF	<i>CAM.cam.camParameters.specialVehicleContainer.rescueContainer</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0250 (1)</i>
Requirement	The rescueContainer shall be used only for specific use cases (Emergency or Prioritised Vehicle Approaching using blue lights) where the vehicleRole ⁴³ is rescue(5).

⁴³ CAM.cam.camParameters.lowFrequencyContainer.basicVehicleContainerLowFrequency.vehicleRole

DE/DF	<i>CAM.cam.camParameters.specialVehicleContainer.emergencyContainer</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0251 (1)</i>
Requirement	The emergencyContainer shall be used only for specific use cases (e.g. Emergency or Prioritised Vehicle Approaching using blue lights) where the vehicleRole ⁴³ is emergency(6).

DE/DF	<i>CAM.cam.camParameters.specialVehicleContainer.emergencyContainer.incidentIndication</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0252 (1)</i>
Requirement	In case of incident, ccAndScC associated to the event and described in DENM message profile shall be provided.

DE/DF	<i>CAM.cam.camParameters.specialVehicleContainer.safetyCarContainer</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0253 (1)</i>
Requirement	The safetyCarContainer shall be used only for specific use cases (e.g. Special Vehicles using yellow lights) where the vehicleRole ⁴³ is safetyCar(7).

DE/DF	<i>CAM.cam.camParameters.specialVehicleContainer.safetyCarContainer.incidentIndication</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0254 (1)</i>
Requirement	In case of incident, the ccAndScC associated to the event and described in DENM message profile shall be provided.

4.2.6 Collective Perception (CP) FLS

The Collective Perception Service and the Collective Perception Message (CPM) are intended to share information about the current context of the ITS-S's environment.

“The Collective Perception Message (CPM) enables the interoperable sharing of basic information about the disseminating ITS-S (required for the interpretation of the transmitted data), its sensory capabilities, perceived objects and road-related perception regions. CPMs are generated quasi-periodically as determined by CPM generation events.” ([ETSI TS 103 324]).

The header of CPM shall be the ITS-PDU header as specified in [ETSI TS 102 894-2]. Detailed data presentation rules of the ITS PDU header in the context of DENM shall be as specified in clause B.1 of [ETSI TS 102 894-2].

The relationships of the tables of CPM are depicted in Figure 5.

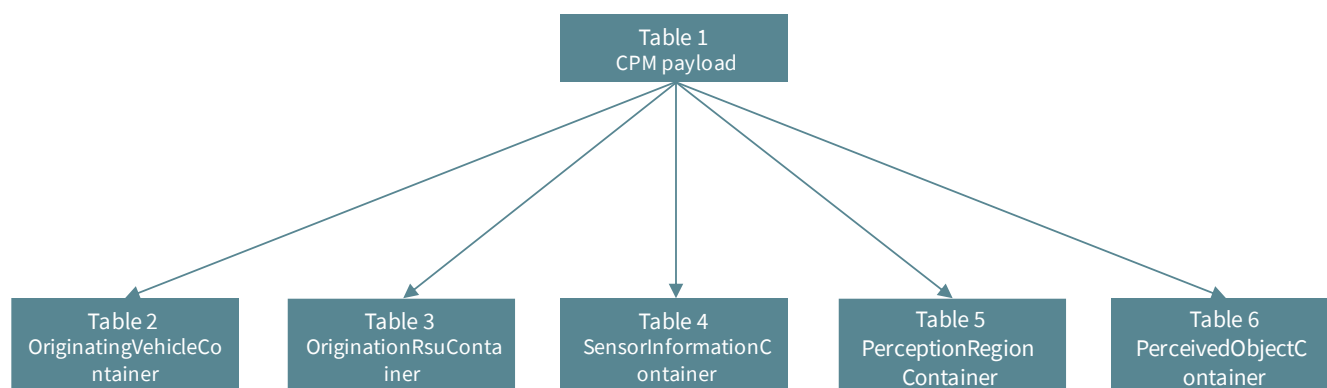
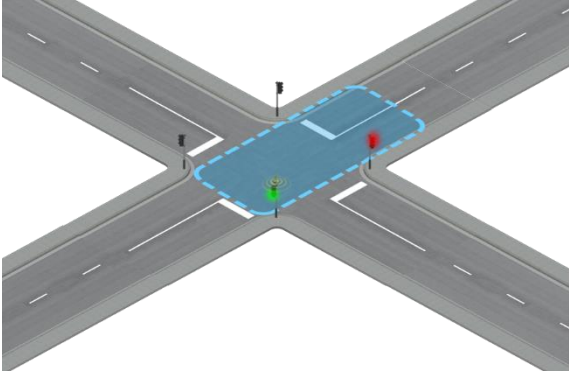
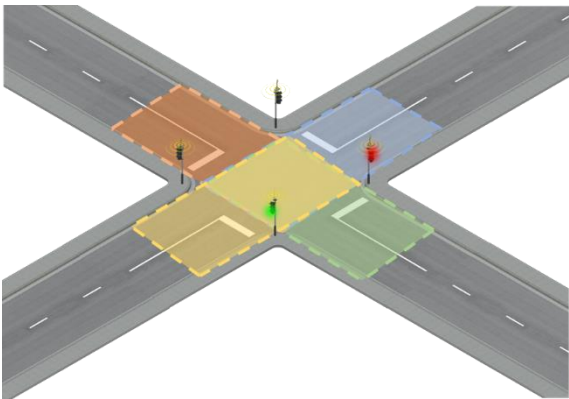
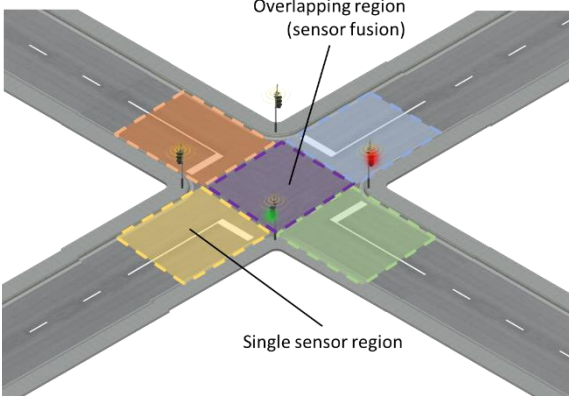


Figure 5 - relationship of CPM data elements tables

Data elements and data frames for CPM shall be used according to the definitions in Table 22. Text that is highlighted in blue corresponds to text from [ETSI TS 103 324].

<i>DE/DF</i>	<i>CollectivePerceptionMessage.payload.cpmContainers.sensorInformationContainer</i>
<i>O/M/C/F</i>	<i>Optional</i>
<i>ID</i>	<i>MP_Req_0255 (1)</i>

<p><i>Requirement</i></p>	<p>Shall be included if the time since a CPM included a SensorInformationContainer is equal or greater than $T_AddSensorInformation$ (defined in [ETSI TS 103 324]), in order to describe:</p> <ol style="list-style-type: none"> the nominal characteristics of single sensors, if these do not overlap and/or there is no data fusion involved  <ol style="list-style-type: none"> the combined nominal characteristics of sensors with (almost) fully overlapping perception region(s), used in sensor system with aggregation  <ol style="list-style-type: none"> the nominal characteristics of the single sensors and of the overlapping perception region(s), in case the overlapping aggregated region(s) is/are a subset of the perception regions of the single sensors 
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	Note: The standard defines the content of this container to contain the static perception capabilities of the sensor in the sense, that it reflects the nominal setup of the sensor system.
<i>ID</i>	<i>MP_Req_0256 (1)</i>
<i>Requirement</i>	<p>So many instances of DF SensorInformation shall be generated that the entire perception region of the sensor with entries that have a homogenous confidence is covered (see sensorRegionShape⁴⁴ and sensorRegionConfidence⁴⁵).</p> <p>Instances of sensorInformation with the same sensorId⁴⁶ dominate each other in increasing order of their position inside the SIC, i.e. instances that are positioned further down in the SIC dominate the instances in front of them.</p>
<i>ID</i>	<i>MP_Inf_0257 (1)</i>
<i>Information</i>	Instances of sensorInformation with the same sensorId ⁴⁶ dominate each other in increasing order of their position inside the SIC, i.e. instances that are positioned further down in the SIC dominate the instances in front of them.

<i>DE/DF</i>	<i>CollectivePerceptionMessage.payload.cpmContainers.sensorInformationContainer.sensorId</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0258 (1)</i>
<i>Requirement</i>	The sensorId ⁴⁶ shall uniquely relate to one sensor (system). This means that if various instances of sensor information related to the same sensor are included in the CPM, they shall have the same sensorId.

<i>DE/DF</i>	<i>CollectivePerceptionMessage.payload.cpmContainers.sensorInformationContainer.sensorType</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0259 (1)</i>
<i>Requirement</i>	ITS-S aggregation (itssAggregation 13) and undefined (0) shall not be used.
<i>ID</i>	<i>MP_Inf_0260 (1)</i>
<i>Information</i>	<p>For all kinds of local aggregation (with and without fusion), the sensor region for this sensor is covered by all involved sensors.</p> <p>localAggregation (12) shall be used for aggregation without fusion, i.e. all objects are considered which are detected by at least one of the involved sensors. This means, the confidence is calculated with the Bayes' theorem considering all individual confidences of all involved sensors.</p> <p>For localAggregation with fusion, a new sensorType will be proposed at ETSI (adding to the CDD: 14 localAggregationWithFusion). In this case, all objects are considered which are detected by all the involved sensors. This means, the confidence is the product of all individual confidences of all involved sensors.</p>

⁴⁴ CollectivePerceptionMessage.payload.cpmContainers.sensorInformationContainer.sensorRegionShape

⁴⁵ CollectivePerceptionMessage.payload.cpmContainers.sensorInformationContainer.sensorRegionConfidence

⁴⁶ CollectivePerceptionMessage.payload.cpmContainers.sensorInformationContainer.sensorId

DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.sensorInformationContainer. sensorRegionShape</i> (Note, this component is currently called <i>perceptionRegionShape</i> in the CPM standard)
O/M/C/F	Mandatory
ID	MP_Req_0261 (1)
Requirement	Shall always be present and indicate a region where the confidence is homogenous, i.e. has a value within $\text{perceptionRegionConfidence} \leq X < \text{MIN}(101, \text{perceptionRegionConfidence} + 10)$ throughout the region.
ID	MP_Rec_0262 (1)
Recommendation	The radial shape should be used.
ID	MP_Req_0263 (1)
Requirement	This component shall define the volume of the perception region, if defined in 3D. If the component is defined in 2D, the 2D shape shall be horizontal and located at the level of the road. The effective 3D shape is the shape that is orthogonally extruded to the specified 2D shape.

DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.sensorInformationContainer. sensorRegionConfidence</i> (Note, this component is currently called <i>perceptionRegionConfidence</i> in the CPM standard)
O/M/C/F	Mandatory
ID	MP_Req_0264 (1)
Requirement	Shall be present and indicates the homogeneous confidence, i.e. the reliable lowest value, which homogeneously applies to the whole region in the sense that $\text{sensorRegionConfidence} \leq X < \text{MIN}(101, \text{perceptionRegionConfidence} + 10)$ for any value X within any location of the whole region.
ID	MP_Inf_0265 (1)
Information	The confidence value reflects detection rate of a typical sample (for that region) of objects against the true number of objects within the sample of the perception region of the sensor. In case c) of MP_Req_0255 the confidence of the fusion region overrides the confidence of the single sensors. It is recommended to use the normalised HOTA metric to calculate the confidence. [Ref: https://autonomousvision.github.io/hota-metrics/]

DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.perceptionRegionContainer</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0266 (1)</i>
Requirement	<p>Shall be included if there is at least one PerceptionRegion DF to be transmitted. A DF PerceptionRegion is used to transmit information:</p> <ul style="list-style-type: none"> about dynamic changes in perception due to environmental influences (aerosol, mist, reflections, dirt on sensors etc.), if the detection thereof is technically supported by the sensor system about actual free spaces, i.e. areas with no detected objects, depending on the use case. <p>For the support of perception region-based assembly.</p>
ID	<i>MP_Req_0267 (1)</i>
Requirement	Perception region-based assembly shall be used.
ID	<i>MP_Req_0268 (1)</i>
Requirement	A PerceptionRegion shall be included for each region for which the confidence differs from the sensorRegionConfidence ⁴⁵ .
ID	<i>MP_Req_0269 (1)</i>
Requirement	If perceived objects remain that are not contained in any of the already defined perception regions, additional perception regions shall be defined so that all perceived objects are contained in perception regions.
ID	<i>MP_Req_0270 (1)</i>
Requirement	A PerceptionRegion shall be included to provide information about free space if intended, i.e. space, where no objects are perceived.
ID	<i>MP_Inf_0271 (1)</i>
Information	So many instances of DF PerceptionRegion shall be generated that the entire “changed” perception region of the sensor with entries that have a homogenous confidence is covered

<i>DE/DF</i>	<i>CollectivePerceptionMessage.payload.cpmContainers.perceptionRegionContainer. perceptionRegionConfidence</i>
<i>O/M/C/F</i>	<i>Mandatory</i>
<i>ID</i>	<i>MP_Req_0272 (1)</i>
<i>Requirement</i>	<p>Shall be present and indicates the changed homogeneous i.e. the reliable lowest value, which homogeneously applies to the whole region in the sense that $\text{perceptionRegionConfidence} \leq X < \text{MIN}(101, \text{perceptionRegionConfidence} + 10)$ for any value X within any location of the whole region.. The confidence value reflects detection rate of a typical sample (for that region) of objects against the true number of objects within the sample of the perception region of the sensor.</p> <p>The confidence of the fusion region overrides the confidence of the single sensors.</p>
<i>ID</i>	<i>MP_Req_0273 (1)</i>
<i>Requirement</i>	Value 101 shall be used to indicate that this region has no changed confidence with respect to the <i>sensorRegionConfidence</i> .
<i>ID</i>	<i>MP_Rec_0274 (1)</i>
<i>Recommendation</i>	Scenarios for typical conditions (e.g. fog, snow, light rain, heavy rain, day, night) should be defined with preassigned confidences.

DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.perceptionRegionContainer. perceptionRegionShape</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0275 (1)</i>
Requirement	perceptionRegionShape shall always be present and indicate a region where the confidence is homogenous, i.e. has a value within perceptionRegionConfidence ⁴⁷ $\leq X < \text{MIN}(101, \text{perceptionRegionConfidence} + 10)$ throughout the region.
ID	<i>MP_Req_0276 (1)</i>
Requirement	perceptionRegionShape shall be defined so that all contained objects can be transmitted in the same CPM.
ID	<i>MP_Req_0277 (1)</i>
Requirement	If the shape is defined in 3D, it shall define the volume of the perception region.
ID	<i>MP_Req_0278 (1)</i>
Requirement	If the shape is defined in 2D, it shall describe as the area of perception and it shall be horizontal and located at the level of the road. In this case and if the CPM contains at least one 3D shape, the effective 3D shape is the shape that is orthogonally extruded to the specified 2D shape. This effective 3D shape shall be used for intersection with other 3D shapes.
ID	<i>MP_Inf_0279 (1)</i>

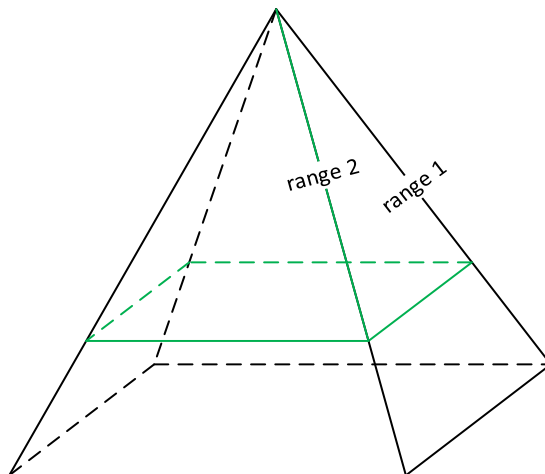
⁴⁷CollectivePerceptionMessage.payload.cpmContainers.perceptionRegionContainer.perceptionRegionConfidence

Information

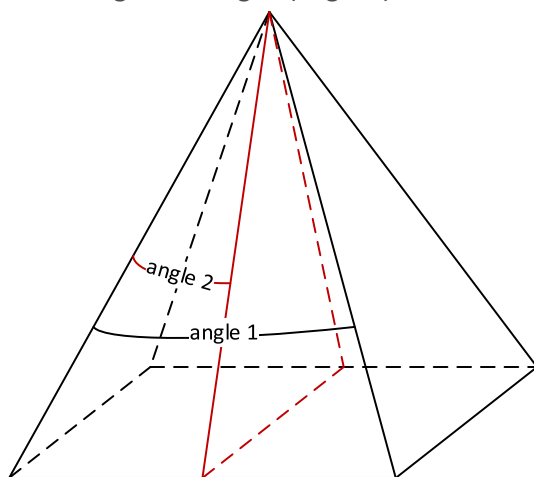
Radial shapes are defined by a shape reference point, an angle and a range. A perceptionRegionShape as a radial shape which affects a part of the sensorRegionShape can be defined by using the same shape

In principle, there are two ways to achieve this.

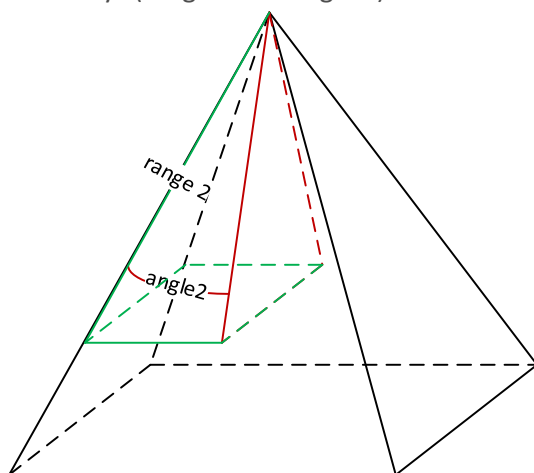
1. the range of the sensorRegionShape is changed (to range 2) while the angle stays unchanged.



2. The angle is changed (angle 2) while the range remains.



Both ways (range 2 and angle 2) can also be used simultaneously.



DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.perceptionRegionContainer.shadowingApplies</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0280 (1)</i>
Requirement	Shall be set to false in any case except in case of radial shapes and polygons and if shadowing applies.

DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.perceptionRegionContainer.numberOfPerceivedObjects</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0281 (1)</i>
Requirement	numberOfPerceivedObjects shall be present and indicate the total number of objects perceived in that region. Depending on inclusion rules, not all of them must be in the CPM.
ID	<i>MP_Req_0282 (1)</i>
Requirement	For actual free spaces, numberOfPerceivedObjects shall be present with value numberOfPerceivedObjects = 0.

DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.perceptionRegionContainer.perceivedObjectIds</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0283 (1)</i>
Requirement	Shall be present if numberOfPerceivedObjects > 0,
ID	<i>MP_Req_0284 (1)</i>
Requirement	If the numberOfPerceivedObjects > 0 but no object is contained due to the inclusion rules, this DF shall be provided with no entry.
ID	<i>MP_Req_0285 (1)</i>
Requirement	There shall be no IDs of perceived objects that are not located within the sensorRegionShape ⁴⁴ .
ID	<i>MP_Req_0286 (1)</i>
Requirement	For actual free spaces (numberOfPerceivedObjects = 0), this DF shall not be used.

DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.perceivedObjectContainer.numberOfPerceivedObjects</i>
O/M/C/F	<i>Mandatory</i>
ID	<i>MP_Req_0288 (1)</i>
Requirement	This component shall contain the total amount of perceived objects independent of perception regions but limited to the sum of the sensor regions within this set of CPMs.

DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.perceivedObjectContainer. perceivedObjects.objectId</i>
O/M/C/F	Mandatory
ID	MP_Req_0289 (1)
Requirement	objectId shall be present as specified in [ETSI TS 103 324].

DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.perceivedObjectContainer. perceivedObjects.objectAge</i>
O/M/C/F	Mandatory
ID	MP_Req_0290 (1)
Requirement	objectAge shall be present as specified in [ETSI TS 103 324].

DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.perceivedObjectContainer. perceivedObjects.objectPerceptionQuality</i>
O/M/C/F	Mandatory
ID	MP_Req_0291 (1)
Requirement	objectPerceptionQuality shall be present as specified in [ETSI TS 103 324]. It shall be calculated according to 7.1.8.6 in [ETSI TS 103 324] considering the perceptionRegionConfidence of the most dominant perceptionRegion as sensor or system specific detection confidence at time <i>t</i> : <i>ct</i> .

DE/DF	<i>CollectivePerceptionMessage.payload.cpmContainers.perceivedObjectContainer. perceivedObjects.sensorIdList</i>
O/M/C/F	Forbidden
ID	MP_Req_0292 (1)
Requirement	sensorIdList shall not be used.

4.2.7 Parking Availability (PA) FLS

The PA service is one instantiation of the infrastructure services to manage the generation, transmission of POIM-PA messages. “PA service provides real time generic information about the PARKING Place, its management, the aggregated status of the parking place, its detailed status (e.g. per space) and Related POIs. Parking Availability Messages (POIMs-PA) are composed of containers (mandatory and optional) which transport information (data elements) which are considered necessary for the receiving ITS-S to select an appropriate parking and act (e.g. reservation) to secure a parking space” [ETSI TS 103 916].

The POIM structure is described in following Figure 6. The PAS is a POI which starts with the **POIM PDU header** and is composed of mandatory data (**Management container** containing service provider identifier and block ID and **GeneralParkingPlace** container containing the geographic position and name of parking place as well as **ParkingStatus** container that provides the current opening status and aggregated current occupancy of the parking place). Optionally, there are **ParkingSupplyCapabilities** container that can be used to provide the location and status information of each parking space of defined parking areas and **RelatedPOI** container to refer POIM-PA to other POI Information Blocks.

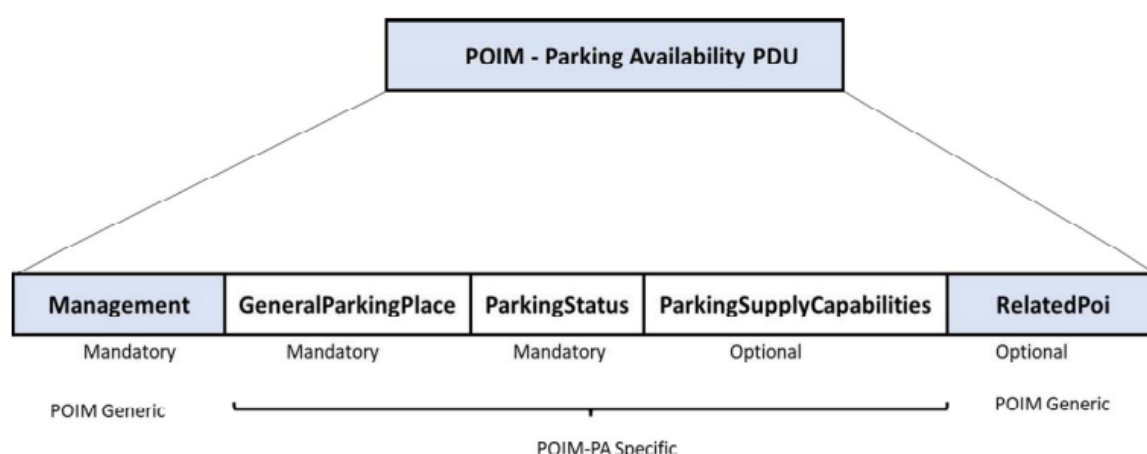


Figure 6 The header and the data elements of the POIM-PA message payload are defined in [ETSI TS 103 916]

Data elements, data frames and service parameters for POIM-PA shall be used according to the definitions in the following section.

4.2.7.1 POIM-PA general elements

Add a requirement on POIM.payload.parkingAvailability.managementContainer.linkedMapems (optional): this component may be used to map all intersections which give access to the whole parking.

DE/DF	<i>POIM.payload.parkingAvailability.aggregatedStatus.currentOccupancy</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Inf_0293 (1)</i>
Information	This DE can be used to provide occupancy rate, trend, aggregated number of total and free spaces of a parking facility with confidence level.
ID	<i>MP_Req_0294 (1)</i>
Requirement	May only be provided only if the entire facility has areas and spaces of the same type. e.g. personal car parking spaces only. Otherwise detailedStatus ⁴⁸ shall be used.

DE/DF	<i>POIM.payload.parkingAvailability.aggregatedStatus.detailedStatus</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Inf_0295 (1)</i>
Information	This DE can be used to provide a more detailed occupancy information based on the vehicle types, reservation types, loadTypes, parking fee types.
ID	<i>MP_Req_0296 (1)</i>
Requirement	Shall be provided, unless currentOccupancy ⁴⁹ is used.

DE/DF	<i>POIM.payload.parkingAvailability.detailedStatus</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Inf_0297 (1)</i>
Information	This component is a list of “parking areas”, used to provide detailed topology and status information about the parking areas and their individual parking spaces.
ID	<i>MP_Req_0298 (1)</i>
Requirement	This component shall be provided when the parking facility is divided into distinct parking areas of different characteristics and/or the status of each individual parking space is available.

DE/DF	<i>POIM.payload.parkingAvailability.detailedStatus.orientation</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Req_0299 (1)</i>
Requirement	This component shall not be used if the parking spaces do not have a common orientation. The orientation of individual parking space can be provided using spacesDetailed ⁵⁰ .

⁴⁸ POIM.payload.parkingAvailability.detailedStatus

⁴⁹ POIM.payload.parkingAvailability.aggregatedStatus.currentOccupancy

⁵⁰ POIM.payload.parkingAvailability.detailedStatus.spacesDetailed

DE/DF	<i>POIM.payload.parkingAvailability.detailedStatus.accessViaLane</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0300 (1)</i>
Recommendation	accessViaLane is currently under revision at ETSI and will be improved later. Should not be used for now.

DE/DF	<i>POIM.payload.parkingAvailability.detailedStatus.reservationType</i>
O/M/C/F	<i>Optional</i>
ID	<i>MP_Rec_0301 (1)</i>
Recommendation	This DF should not be used if the parking spaces have different reservation types. In such cases, spacesDetailed ⁵⁰ should be used.

DE/DF	<i>POIM.payload.parkingAvailability.detailedStatus.spacesBasic</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0302 (1)</i>
Requirement	To provide the status of individual parking space, either this DF or spacesDetailed ⁵⁰ shall be used, depending on the granularity of information available for each parking space.

DE/DF	<i>POIM.payload.parkingAvailability.detailedStatus.spacesDetailed</i>
O/M/C/F	<i>Conditional</i>
ID	<i>MP_Req_0303 (1)</i>
Requirement	To provide the status of individual parking space, either this DF or spacesBasic ⁵¹ shall be used, depending on the granularity of information available for each parking space.

⁵¹ POIM.payload.parkingAvailability.detailedStatus.spacesBasic

4.2.8 Operational Specifications / Triggering Conditions

This section describes the information management DENM and IVIM. CAM, SPATEM, MAPEM, SREM, SSEM will be investigated for a later release. Note, that different triggering conditions do not cause interoperability issues. If the information enclosed in the messages is interoperable, different update or cancellation mechanisms do not cause semantic problems. However, the following principles shall be applied to all messages:

1. Messages shall be updated within the validity duration or before the validity time runs out.
2. To render a message invalid either a cancellation for the rest of the remaining validity duration shall be sent or the validity shall be let run out.
3. Negation shall never be used.

4.2.9 Management Entity

The Management Entity is not relevant for the messages sent from the roadside to vehicle interface. The Management Entity is relevant for configuration of a R-ITS-S and for the split in functionality between R-ITS-S and C-ITS-S. The central to roadside interface is however not in scope of this document.

4.2.10 Security Principles

The Security Principles chapter comprises all functions required for secured message generation, i.e. signature generation, key and certificate handling, as well as authentication (verification) of received messages.

To allow continuous operation of these security functions, not only functions and processes on an isolated ITS station have to be considered, but additionally the interface towards the Public Key infrastructure (PKI) must be addressed. This covers communication with Certificate Authorities (CA) for initial enrolment of ITS stations and periodic certificate requests, as well as details related to re-keying and certificate renewal, i.e. cryptographic parameters, validity times and protocols. Several of these aspects are covered by the Certificate Policy issued by the European Commission, which serves as a normative reference for all C-ROADS implementations.

Beyond the “Security Entity” described above, additional measures are required. Only those aspects that are specific to the introduction and operation of C-ITS equipment and FLSs can and will be detailed by Task Force 1 (TF1), other IT security requirements may be mentioned for reference but without any claim for completeness.

Such additional, rather generic “cybersecurity” aspects must be ensured by every road operator for all existing systems independent of cooperative systems. A non-exhaustive list of generic requirements comprises for example tamper-proof infrastructure components with secured interfaces, access restrictions, appropriate documentation and logging, plausibility checks on received data and misbehaviour detection, e.g. theft and access violation. Typically, all of the above is addressed by an ISMS (Information Security Management Systems), e.g. according to [ISO/IEC 27001] or other standards available.

Since these aspects are core responsibilities of any operator of IT networks/components, they are not addressed in depth within C-ROADS’ TF1.

5. Geonetworking settings

The Geonet destination area (as defined by GeoAreaPos and Distance in the GBC packet header) shall be set in a way that it at least includes the eventPosition / referencePosition, detectionZonesToEventPosition / detectionZones and eventZone / relevanceZones of the message. The destination area shall have a maximum size of 80 km² (RS_BSP_255 max size of geonet destination area in BSP).

Note: The centre of the destination area does not need to be on the eventPosition / referencePosition.

For short-range communication, the GeoAdhoc router reference position within the SO PV (source position vector) in the GBC packet header should be set to the position of the transmitting RSU to enable forwarding within the Geonet destination area.

For long-range communication, the GeoAdhoc router reference position within the SO PV (source position vector) in the GBC packet header should be set at an offset of the eventPosition / referencePosition to enable forwarding within the Geonet destination area on short-range communication.

6. References

All references that are used in this document are defined in the C-Roads_WG2_References document.

All normative references within a standard referenced in this document are automatically included and will not be listed separately. Only if a normative reference is out of date because a newer version of the reference standard is supported, the newer reference is listed and marked accordingly.