Automotive Requirements on IVIM

CAR 2 CAR Communication Consortium

About the C2C-CC

Enhancing road safety and traffic efficiency by means of Cooperative Intelligent Transport Systems and Services (C-ITS) is the dedicated goal of the CAR 2 CAR Communication Consortium. The industrial driven, non-commercial association was founded in 2002 by vehicle manufacturers affiliated with the idea of cooperative road traffic based on Vehicle-to-Vehicle Communications (V2V) and supported by Vehicle-to-Infrastructure Communications (V2I). The Consortium members represent worldwide major vehicle manufactures, equipment suppliers and research organisations.

Over the years, the CAR 2 CAR Communication Consortium has evolved to be one of the key players in preparing the initial deployment of C-ITS in Europe and the subsequent innovation phases. CAR 2 CAR members focus on wireless V2V communication applications based on ITS-G5 and concentrate all efforts on creating standards to ensure the interoperability of cooperative systems, spanning all vehicle classes across borders and brands. As a key contributor, the CAR 2 CAR Communication Consortium works in close cooperation with the European and international standardisation organisations such as ETSI and CEN.

Disclaimer

Document information

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Table 1: Document information

Changes since last version

Date	Changes	Edited by	Approved
12/03/2021	No changes	Release Management	Steering Committee
16/12/2020	Initial release	Release Management	Steering Committee

Table 2: Changes since last version

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1 Introduction

Other (informational) **RS_ARI_1**

This document is part of the documentation within the Work Item F0020 “Automotive Requirements for IVIM”. It is the main working document containing identified requirements to the IVIM from an automotive perspective.

It shall serve as an extension to already existing requirements on IVIM in the C-Roads profiles and specifications.

2 Scope

Other (informational) **RS_ARI_2**

The present document provides requirements related to the features of a C-ITS station transmitting IVIM to enable interoperability. The requirements in this document are intended as an addition to existing requirements in [ISO 19321], [TS 103 301] and the C-Roads profile.

In this document only, highway use cases were considered, use cases on other road types or in urban areas may need different profiling. Apart from that, the requirements in this document are independent of the specific use case and shall therefore apply to all highway use cases of the In-Vehicle-Signage Service.

Furthermore, the requirements are focussed on the functional level, specifications on the lower communication levels are out of scope of this document. Also, for the functional level, these requirements don’t claim to be complete.

In some cases, requirements are written in a way which let the implementation open, for example if they refer to very specific implementations which may depend on specific national regulations. Those requirements have to be further detailed by anybody implementing that requirement. Beside these special requirements all other requirements can be further detailed, too.

3 Conventions used

Other (informational) (RS_BSP_152) **RS_ ARI_3**

Conventions used in this and other C2C-CC specification documents can be found in [C2CCC ConV].

4 Definitions

Definition (RS_BSP_193) **RS_ARI_9**

'C-ITS time' or 'time base' means the number of elapsed International Atomic Time (TAI) milliseconds since 2004-01-01 00:00:00.000 Coordinated Universal Time (UTC)+0 as defined in [EN 302 636-4-1]. Timestamps as defined in [TS 102 894-2] follow this time format.

Definition **RS_ARI_10**

The '*station clock'* means a clock representing Cooperative Intelligent Transport Systems (C-ITS) time in a C-ITS station (see RS_RSP_006).

Definition (RS_BSP_429) **RS_ARI_11**

Information provided with a *'confidence level'* of 95 % means that the true value is inside the confidence interval or the confidence area for at least 95 % of the data points in a given statistical base.

Definition (RS_BSP_500) **RS_ARI_12**

A *'confidence interval'* is specified by the estimated value plus/minus the confidence value.

Definition **RS_ARI_13**

An *'instant'* denotes a point on the time axis, often also referred as a "moment in time" (see also IEC 60050).

Definition **RS_ARI_15**

The *'relevance area'* (or relevance zone) is the area on the road for which the signage information is applicable. Each separate signage information is associated a specific relevance zone. The concept of an IVI relevance zone is the equivalent of an eventHistory used for DENMs.

Definition **RS_ARI_16**

The 'awareness area' (or detection zone) is the area where drivers have to be informed about upcoming relevant signage information. The concept of an IVI detection zone is the equivalent of a DENM trace.

5 Parameter settings

Table 3: Parameter settings RS_ARI_22

Parameter	Value	Unit	Description	Min. Value	Max. Value	Source Document
pRepetitionInterval	500	ms	Interval for the IVI repetition service	--	--	--
pIdUniquenessRadius	20	km	Radius around the originating station within which the tuple serviceProviderID-IviIdentificationNumber shall be unique	--	--	--
pIdReuseBlockingTime	24	H	Minimum blocking time before a previously used IviIdentificationNumber may be reused by a service provider			
pRepetitionDuration	5	Min	Duration over which a message shall be repeated	--	--	--
pLongitudinalOffsetSignPosition	3	m	Maximum longitudinal offset to the actual position of the physical sign	--	--	--
pNodeOffset	1	m	Maximum offset between two nodes describing the same geographical position	--	--	--
pMaxNumberofNodesPerZone	100	--	Maximum number of deltaPositions per segment / zone	--	--	--
pDistanceRefPosToSignPos	3	m	Maximum distance between the referencePosition in GLC and the actual position of the sign or gantry	--	--	--
pMinDetectionZoneLength	800	m	Minimum length of a detection zone for highway use cases	--	--	--
pLateralNodeOffset	3	m	Maximum lateral offset to the center of the lane /carriageway for the deltaPositions in polygonalLine and the referencePosition	--	--	--
*pLateralNodeOffset*AD	1	m	Maximum lateral offset to the center of the lane /carriageway for the deltaPositions in polygonalLine and the referencePosition if automated driving shall be supported	--	--	--

pLaneAngleDeviation	5	°	Maximum angle between the connection of the node points and the corresponding tangent to the lane centre	--	--	--
pMaxPerpendDistLaneCentre	10	m	Maximum perpendicular distance between the linear connection of two consecutive lane nodes and the actual centre of the lane	--	--	--

6 General understanding of the IVIM

6.1 Purpose of the In-Vehicle Signage use cases

The purpose of the In-Vehicle Signage (IVS) is to enable the receiving vehicle to know at any time and condition all the relevant signage information, based on time and location, but also based on characteristics and type of the vehicle. Receivers can filter sign information based on time, geographical and other relevance criteria (e.g. to only show information relevant ahead to the driver).

6.2 Purpose of the different containers in IVIM

This chapter provides a short introduction to the three most relevant containers in IVIM: Management Container, Geographic Location Container and General IVI Container. See also Figure 1 for a simplified representation of the IVIM.

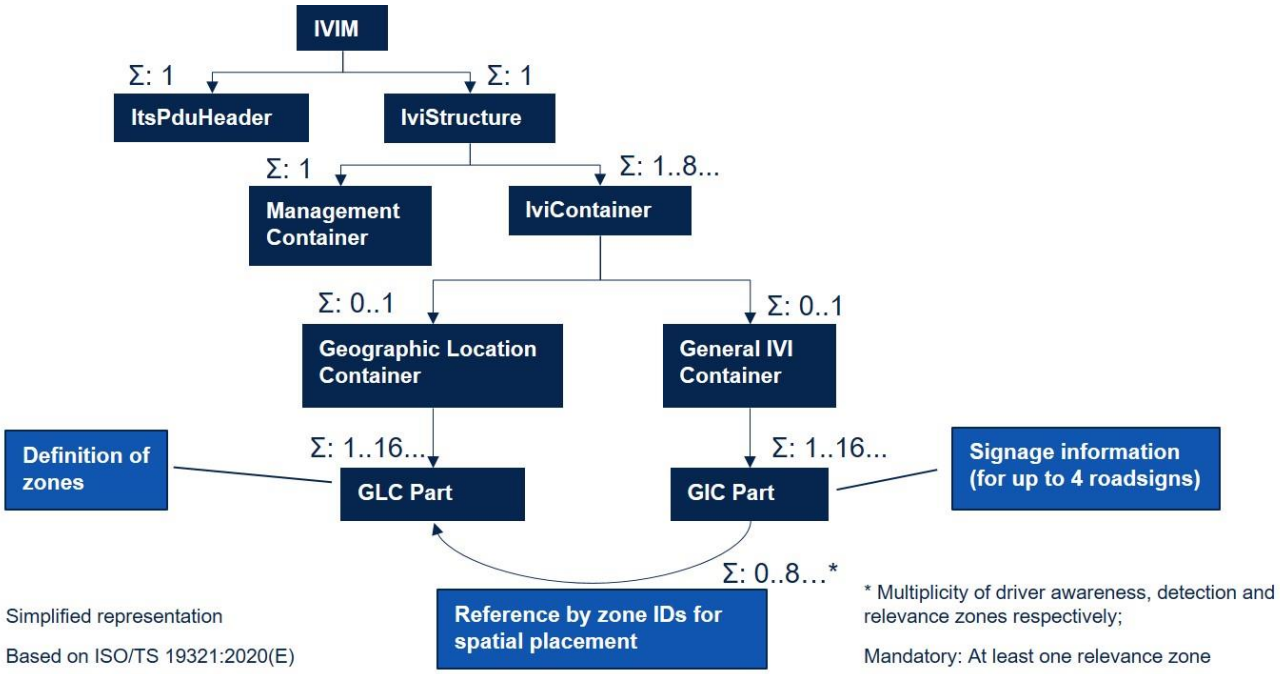


Figure 1: Simplified and shortened representation of IVIM

6.2.1 Management Container

The Management container is mandatory and provides the receiving vehicles with information necessary to handle the entire IVI message, unambiguously identify it (*ServiceProviderId*, *iviIdentificationNumber*) as well as to decide on its further processing and determine the status and time validity of its content (e.g. iviStatus, timestamp, validFrom, validTo, etc.)

6.2.2 Geographic Location Container

The Geographic Location Container (Glc) describes essential information for receiving vehicles to understand where and how the information provided in the IVI Application Container applies.

It is formed by a part which is common to all the parts of the Application Container plus a sequence of GlcParts that can be specific to the distinct parts of the application container. GlcParts are used to represent detection and relevance zones (following the definitions provided in [C2CCC Glos]). According to C-Roads specifications, at least one detection zone and one relevance zone shall be provided for each IVI message. Each GlcPart is described, among others, by a zoneId (unambiguously identifying the zone), and a Zone (defining the geographical-shape of the zone)

6.2.3 General IVI Container

The General IVI Container (Gic) provides the signage information to be processed by vehicles. It is a sequence of *GicParts*, each defining a given piece of signage information. This information refers to Glc information for its spatial relevance. For this, each *GicPart* contains, among others, *detectionZoneID* and *relevanceZoneId* lists indicating respectively the detection and relevance zones that apply to this *GicPart*. Moreover, each *GicPart* contains the *iviType* (e.g. regulatory info or other kind of info), the *vehicleCharacteristics* (i.e. for which kind of vehicles the info applies) and the specific signage information to communicate (e.g. road sign identifiers *roadSignCodes* or text messages *extraText*, etc.)

7 Requirement specifications

7.1 IVIM Automotive Requirements

7.1.1 Transmission

Other (informational) **RS_ARI_14**

The following requirement on IVIM apply in addition to the relevant standards ([TS 103 301 v1.3.1] – to be updated to refer to the new ISO TS 19321:2020, the intention is to use the updated version, [ISO/TS 19321:2020]) and the C-Roads [C-ITS Message Profiles and Parameters, Release 1.7].

Details:

Tested by:

Requirement **RS_ARI_67**

IVIM shall be repeated with a repetition interval of *pRepetitionInterval*.

Details:

Tested by:

Other (informational) **RS_ARI_38**

Signs which indicate the end of a specific or all regulations / restrictions should not be transmitted explicitly as individual signs in an IviStructure. The meaning of these signs is implicitly given through the ending of the relevance zone of corresponding signs.

If transmitted, all requirements given in this document shall apply.

Note: It is recommended not to transmit the aforementioned signs separately. One reason being that the relevance zone of such signs could stretch along several kilometres.

Details:

Tested by:

7.1.2 IviStructure

Requirement **RS_ARI_70**

An IviStructure shall provide the legal statement as displayed by static signs or gantries.

Note: This implies that the IviStructure doesn't need to exactly represent what is depicted on the gantry/sign but needs to provide all information required to represent the regulation as indicated by the gantry/sign.

Details:

Tested by:

Requirement **RS_ARI_17**

An IviStructure having an iviStatus other than “cancellation” shall contain at least one instance of GeographicLocationContainer.

Details:

Tested by:

Requirement **RS_ARI_18**

An IviStructure having an iviStatus other than “cancellation” shall contain at least one instance of GeneralIviContainer.

Details:

Tested by:

Requirement **RS_ARI_19**

For every GicPart the IviStructure shall contain at least one instance of GeographicLocationContainer describing all the zones the GicParts refer to.

Note: This implies that each IviStructure shall be self-contained.

Details:

Tested by:

Requirement **RS_ARI_20**

The IviStructure should not contain any instances of LayoutContainer and TextContainer.

Note: If present, these containers may be ignored by receivers. The containers AutomatedVehicleContainer and RoadSurfaceContainer are currently not considered and may therefore also be ignored by receivers.

Details:

Tested by:

Requirement **RS_ARI_21**

If in vehicle information shall or need to be transmitted in separate IVIMs, the following prioritization shall be applied (number one having the highest priority):

1) Information applying to the same lane should be contained in a single message.
2) Information applying to the same direction of travel should be contained in a single message.
3) Information applying to the same local area should be contained in a single message.

Details:

Tested by:

Requirement **RS_ARI_25**

If there are multiple physical signs showing the same information applicable to the same road segment (e.g. one in a distance, one directly at the location of danger), only one IviStructure and GicPart shall be transmitted for all signs.

Details:

Tested by:

Requirement **RS_ARI_52**

At every point in time every combination of RsCode and relevanceZoneIds contained in an IviStructure shall be unique for that IviStructure.

Note: This means, that the combination of RsCode and relevance zone shall not be duplicated in in more than one IviStructure at any given point in time. This also excludes a situation as shown in Figure 2.

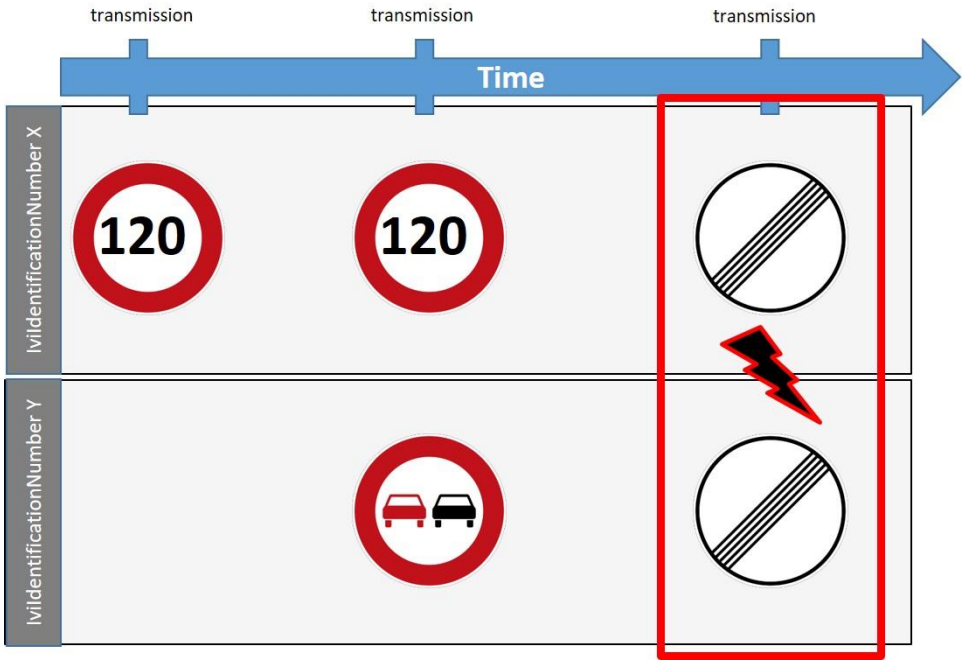


Figure 2: No duplicate information in separate IviStructures, example

Details:

Tested by:

Requirement **RS_ARI_53**

All in-vehicle information to be conveyed via IVIM should be transmitted in as few separate IviStructures as possible.

Details:

Tested by:

Requirement (preliminary) **RS_ARI_60**

An IviStructure shall provide the total number of lanes of the concerned direction on the road segment where the zones as described in the IviStructure are located.

Note: The means how to do this are still in discussion.

Details:

Tested by:

7.1.3 ManagementContainer

Requirement **RS_ARI_58**

The tuple of ServiceProviderID and IviIdentificationNumber shall be unique at every given point in time within a radius of at least *pIdUniquenessRadius* around the transmitting C-ITS station.

Details:

Tested by:

Requirement **RS_ARI_59**

When a service provider has used an iviIdentificationNumber for an IviStructure, a minimum blocking time of at least *pIdReuseBlockingTime* shall pass before the same iviIdentificationNumber may be used again.

Details:

Tested by:

Requirement **RS_ARI_56**

The timestamp shall be present and set to the time of information generation by the service provider (as defined in [TS 103 301]).

Note: This also holds, if the iviStatus is already set to “update”. When a new content change occurs, timeStamp shall be set to the point in time of the generation of the new information.

Details:

Tested by:

Requirement **RS_ARI_62**

The component validFrom shall be present in an IviStructure if the contained information is not yet applicable at the point in time when the message is transmitted.

Details:

Tested by:

Requirement **RS_ARI_63**

The component validFrom shall be omitted in an IviStructure if the contained information is applicable at the point in time when the message is transmitted.

Details:

Tested by:

Requirement **RS_ARI_71**

The component validTo may only be used to indicate the validity duration of the information contained in the IviStructure, if it is ensured that the actual validity duration will not surpass the indicated validTo time.

Note 1: This means, that validTo shall not be shorter than the actual validity duration of the information. This prevents, that vehicles travelling in the relevance zone wrongly cancel the information to the driver when validTo times out only because an update of the validTo is not received.

Note 2: Example of a scenario that could benefit from using validTo: Speed limit for purposes of noise reduction over night, e.g. 10 p.m. to 6 a.m. In this scenario the validity duration is deterministic and can be conveyed via validTo thus lifting the need for a separate cancellation message.

Note 3: Example of a scenario where a different usage than specified here can lead to critical situations: The component validTo is set to a time only some minutes in the future and is updated every time before timing out. In such cases vehicles, that have passed the gantry and are already out of the RSU coverage, but yet in the relevance zone, would disable the received IVI road signs upon reaching the validTo time, even if the RSU has updated the validTo and still transmits the road signs.

Details:

Tested by:

Requirement **RS_ARI_37**

If in vehicle information shall or need to be transmitted in separate IVIMs following RS_ARI_21 due to message size restrictions, the data element connectedIviStructures shall be present and used to connect at least all messages applying to the same traffic direction.

Details:

Tested by:

Other (informational) **RS_ARI_64**

For better understanding of the following requirements, Figure 3 provides a state machine for the usage of iviStatus including references to the relevant documents and requirements for the respective state transitions.

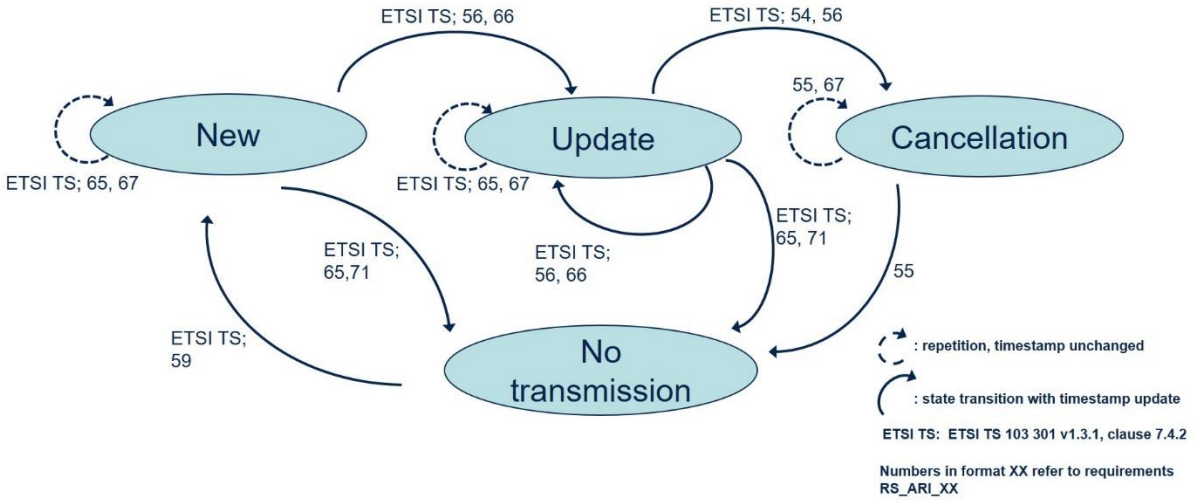


Figure 3: State machine for iviStatus

Details:

Tested by:

Requirement **RS_ARI_65**

An IviStructure with status “new” or “update” shall be repeated as long as all information contained remain unchanged and the validity duration indicated in the component validTo hasn’t yet passed.

Details:

Tested by:

Requirement **RS_ARI_66**

The component iviStatus shall be set to “update” whenever the service provider changed the information in the given IviStructure (other than a cancelation, see also [TS 103 301]).

Details:

Tested by:

Requirement **RS_ARI_54**

Whenever all the information given in an IviStructure is not valid any more (i.e. the information isn’t shown any more on the gantry) before validTo (if present) is reached, the IviStructure shall be transmitted with iviStatus “cancellation”.

Details:

Tested by:

Requirement **RS_ARI_55**

An IviStructure with status “cancellation” shall be repeated for *pRepetitionDuration* starting from the point in time of the first transmission of the cancellation IVIM.

Details:

Tested by:

Requirement **RS_ARI_57**

An IviStructure with status “cancellation” shall consist of the ManagementContainer only.

Details:

Tested by:

7.1.4 Geographic Location Container

Requirement **RS_ARI_30**

If the IviStructure corresponds to a physical sign/gantry, the referencePosition in GLC shall be located in the middle of the carriageway at the position of the sign/gantry. The (longitudinal) offset shall be at most *pLongitudinalOffsetSignPosition*. (See also RS_ARI_28)

Note: In order to support use cases where there is no physical sign, a corresponding suitable requirement may be defined in the future.

Details:

Tested by:

Requirement **RS_ARI_29**

The referencePosition in GLC shall be located in the middle of the carriageway with a maximum lateral offset to the true middle of the carriageway of *pLateralNodeOffset*.

Details:

Tested by:

Requirement **RS_ARI_32**

An instance of GLC shall consist of at least two GlcParts.

Note: This ensures that there are at least two zones for representation of detection and relevance zone of information contained in the GeneralIviContainer, respectively.

Details:

Tested by:

7.1.4.1 Geographic Location Container Part

Requirement **RS_ARI_31**

The zoneId in GlcPart shall be unique throughout the entire IviStructure (i.e. this also applies, if multiple GLCs are used within one IviStructure).

Details:

Tested by:

Requirement **RS_ARI_39**

To describe a zone, the component segment shall be used.

Details:

Tested by:

Requirement **RS_ARI_72**

The number of deltaPositions per segment shall be limited to *pMaxNumberofNodesPerZone*.

Details:

Tested by:

Requirement **RS_ARI_40**

In all instances of IVI.IviStructure.optional.glc.parts.zone.segment.line in an IviStructure, only either the component deltaPositions or the component deltaPositionsWithAltitude shall be used.

Details:

Tested by:

Requirement **RS_ARI_61**

The first deltaPosition contained in PolygonalLine shall refer to the reference position given in the corresponding GLC.

Note: See RS_ARI_76 for a better understanding.

Details:

Tested by:

Requirement **RS_ARI_75**

The referencePosition shall not be part of the zone itself.

Note: This means that the first deltaPosition in a zone shall describe the first node of the respective zone. If a zone shall begin at the referencePosition, the first deltaPosition shall be set to (0, 0). See RS_ARI_75 and RS_ARI_76 for further information.

Details:

Tested by:

Other (informational) **RS_ARI_76**

The graphic below shows the problematic implications when including the referencePosition in the zone description. For individual zones per lane the inclusion of the reference position would "distort" the zone causing possible problems for interpretation on vehicle side, therefore the first deltaPosition is considered to be the very first node of the zone.

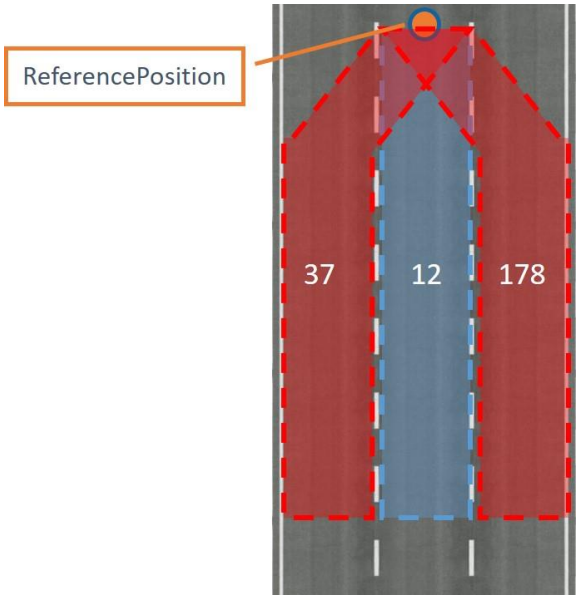


Figure 4: "Distortion" of zones when including the referencePosition

Details:

Tested by:

Other (informational) **RS_ARI_74**

Requirements RS_ARI_29, RS_ARI_30, RS_ARI_61 and RS_ARI_75 specify polygonal lines in a very generic way in order for them to be applicable to all possible scenarios and settings. The graphic below shows the implications for different.

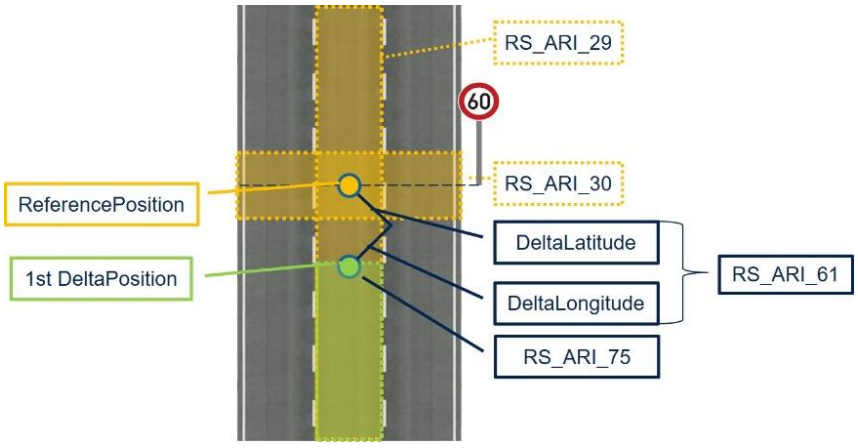


Figure 5: Placement of the referencePosition and definition of the first deltaPosition

Details:

Tested by:

Requirement **RS_ARI_42**

The delta positions in PolygonalLine shall be sorted starting from the zone's extremity that is closest to the reference position in ascending order according to the distance to this extremity along the course of the zone.

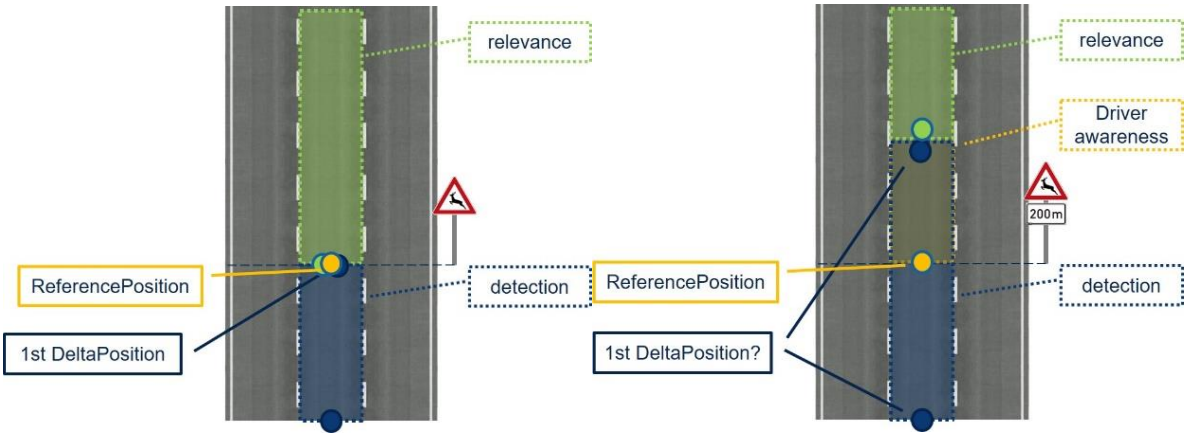
Note: That way, zones are always sorted in direction of traffic or against the direction of traffic. See RS_ARI_77 for a better understanding.

Details:

Tested by:

Other (informational) **RS_ARI_77**

Requirements RS_ARI_42 is phrased in a very generic way. This is necessary for cases where the referencePosition isn't located at the borders between the zones but actually in the middle of a zone. This occurs for example, when a driverAwarenessZone is used (for driverAwarenessZone, see RS_ARI_26). Without the driverAwarenessZone, the previous requirements make sure that the referencePosition is located at the border between detectionZone and relevanceZone.



Details:

Tested by:

Other (informational) (RS_ARSM_31) **RS_ARI_45**

DeltaPositions in PolygonalLine should correspond to the centre of the lane or carriageway – depending on whether the zone describes a lane or the entire carriageway.

Details:

Tested by:

Requirement (RS_ARSM_32) **RS_ARI_46**

The absolute lateral offset of node points to the centre of the lane or carriageway shall be less than *pLateralNodeOffset*.

Details:

Tested by:

Requirement (RS_ARSM_94) **RS_ARI_47**

Let $\vec{a}$ be the vector representing the linear connection of two delta positions, and $\vec{p}$ be the vector representing the shortest distance of vector $\vec{a}$ to the center of the lane/carriageway (that is, $\vec{p}$ is perpendicular to the tangent of the center line of the lane/carriageway at the foot of the dropped perpendicular).

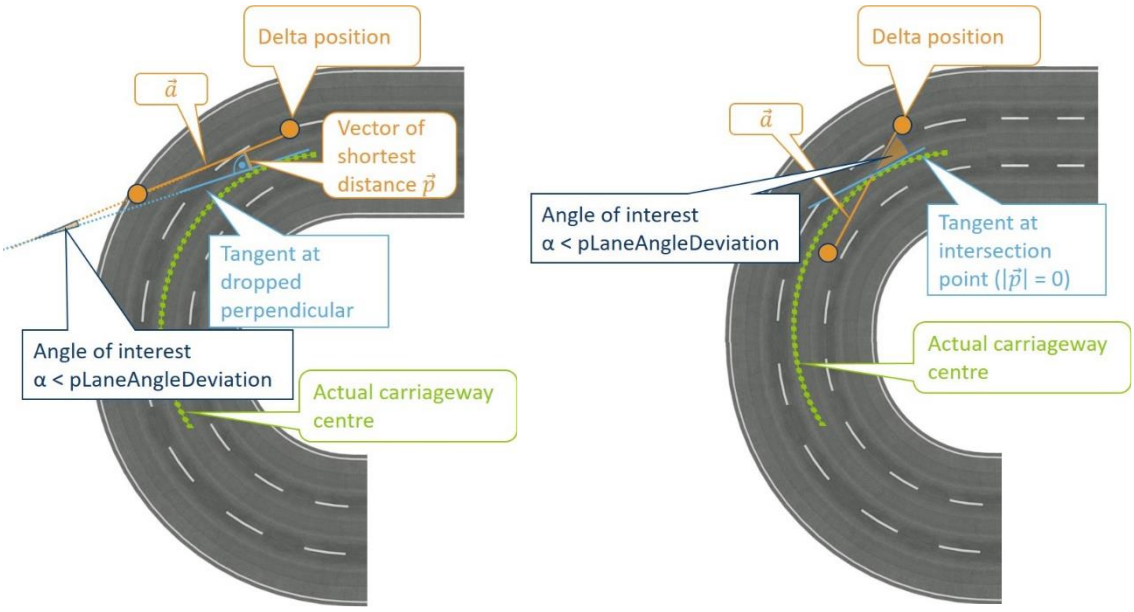
Then for $|\vec{p}| > 0$ it shall always hold that

$$\cos^{-1}\left(1 - \frac{\vec{a}*\vec{p}}{|\vec{a}|*|\vec{p}|}\right) \leq pLaneAngleDeviation.$$

For $|\vec{p}| = 0$ (i.e. $\vec{a}$ crosses the lane/carriageway centre) the angle α between $\vec{a}$ and the tangent to the lane/carriageway centre at the intersection point with the lane centre shall be less than *pLaneAngleDeviation*.

Note: In less formal wording this means that the angle between the linear connection of two node points and the corresponding tangent to the lane/carriageway centre shall not be greater than *pLaneAngleDeviation.*

Note: See drawings below for a better understanding (exemplary for a polygonalLine describing the centre of the carriageway):



Details:

Tested by:

Requirement (RS_ARSM_34) **RS_ARI_48**

The perpendicular distance between the linear connection of two delta positions and the centre of the lane/carriageway shall be less than *pMaxPerpendDistLaneCentre*.

Details:

Tested by:

Requirement **RS_ARI_50**

The data element laneWidth shall be provided if the corresponding zone describes a single lane, and may be used in all other cases.

Details:

Tested by:

7.1.5 MAP Location Container

Requirement **RS_ARI_37**

The MAP Location Container shall not be used for highway use cases.

Note: This container may be used at intersections where a MAPEM is transmitted anyway, for such use cases this needs to be profiled explicitly.

Details:

Tested by:

7.1.6 General IVI Container Part

Requirement **RS_ARI_36**

All zoneIds present in the components detectionZoneIds, driverAwarenessZoneIds and/or relevanceZoneIds within an instance of GicPart shall reference zones which are all described in the same GLC.

Details:

Tested by:

Requirement **RS_ARI_34**

In every instance of GicPart the data element *detectionZoneIds* shall be present and contain at least one entry referencing to an existing zone ID in a GLC.

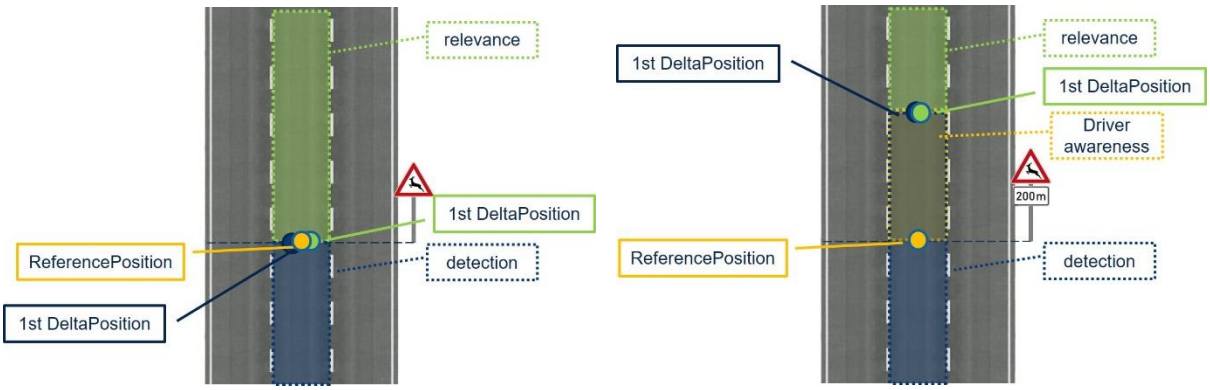
Details:

Tested by:

Requirement **RS_ARI_23**

The detection zone shall be defined in such a way that it leads up to the corresponding relevance zone. This means that the first point in the detection zone shall geographically coincide with the first point in the relevance zone with a maximum offset of *pNodeOffset*.

Note: For a better understanding see the graphics below.



Details:

Tested by:

Requirement **RS_ARI_51**

The detection zone in a GicPart shall have a length of at least *pMinDetectionZoneLength*.

Details:

Tested by:

Requirement **RS_ARI_26**

An instance of driverAwarenessZoneIds shall be present in all GicParts which refer to a physical sign that is located before the start of the relevance zone.

Details:

Tested by:

Requirement **RS_ARI_27**

The driver awareness zone in a GicPart (i.e. the combination of all zones referred to in the instance of *driverAwarenessZoneIds*) shall represent the complete area between the location of the physical sign and the start of the relevance zone, if the sign's applicability doesn't start at the position of the sign but in a certain distance.

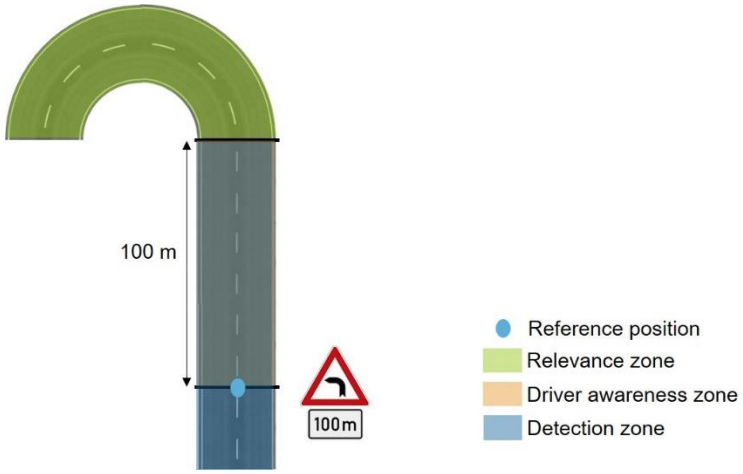


Figure 6: Sign applies in a distance

Details:

Tested by:

Requirement **RS_ARI_24**

If defined, a driver awareness zone shall be part of the detection zone (i.e. geographically contained within the detection zone).

Details:

Tested by:

Requirement **RS_ARI_35**

In every instance of GicPart the data element *relevanceZoneIds* shall be present and refer to a nonempty set of zones described in a GLC.

Details:

Tested by:

Requirement **RS_ARI_69**

The zoneIDs in the components relevanceZoneIds, detectionZoneIds and driverAwarenessZoneIds shall be ordered in form of a vectorised matrix.

Note: This means that consecutive zones constitute one matrix column and shall be sorted accordingly. See Figure 7 for a better understanding.

Example 1: All zones shown in the picture constitute one relevanceZone for one sign/information, then the set of zoneIDs in relevanceZoneIds shall be ordered as follows: {37, 49, 4, 12, 85, 23, 178, 19, 7}

Example 2: (Artificial but illustrative) Zones 37, 12, 178, 49 and 19 constitute the relevance zone, zone 85 is a driverAwarenessZone and zones 85, 4, 23 and 7 constitute the detectionZone for one sign/information. Then the lists of IDs shall be ordered as follows:

- relevanceZoneIds: {37, 49, 12, 178, 19}
- driverAwarenessZoneIds: {85}
- detectionZoneIds: {4, 85, 23, 7}

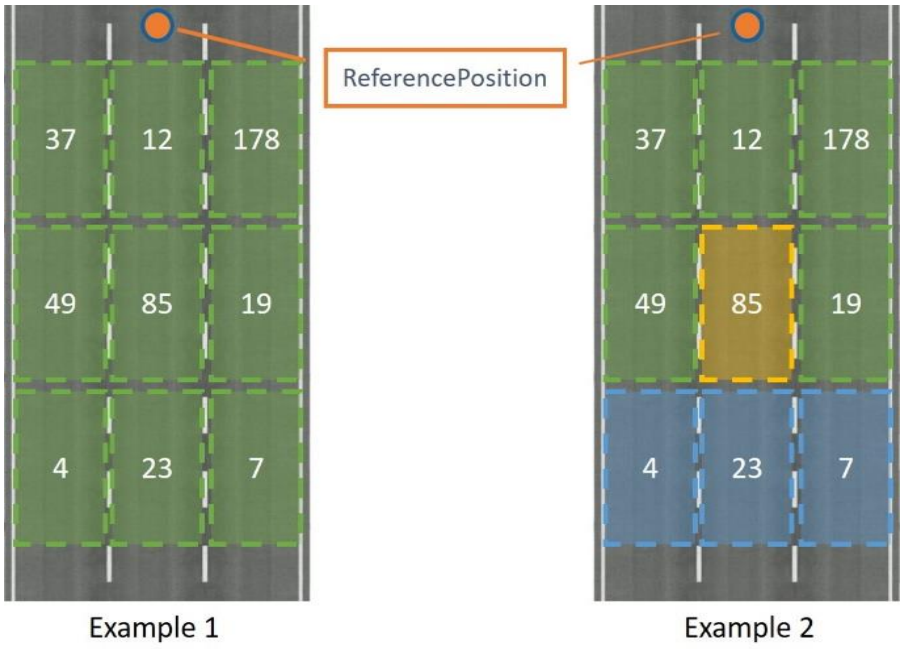


Figure 7: "Vectorization" of zones

Details:

Tested by:

Requirement **RS_ARI_43**

For each set of consecutive zones (along the path of the road segment) referenced in *relevanceZoneIds* in an instance of GicPart, there shall be a corresponding consecutive set of zones referenced in *detectionZoneIds*, which fulfils requirement RS_ARI_23 .

Details:

Tested by:

Requirement **RS_ARI_33**

The relevanceZone in a GicPart (i.e. the combination of all zones referred to in the instance of *relevanceZoneIds*) shall represent the complete road segment where the traffic rules according to the sign described in GicPart are applicable.

Note: If the relevanceZone ends and no further signs are transmitted via IVIMs, this means, that from the last point of the relevanceZone downstream, the previous roadsign transmitted via IVIM don't apply any more. For a better understanding, see Figure 8.

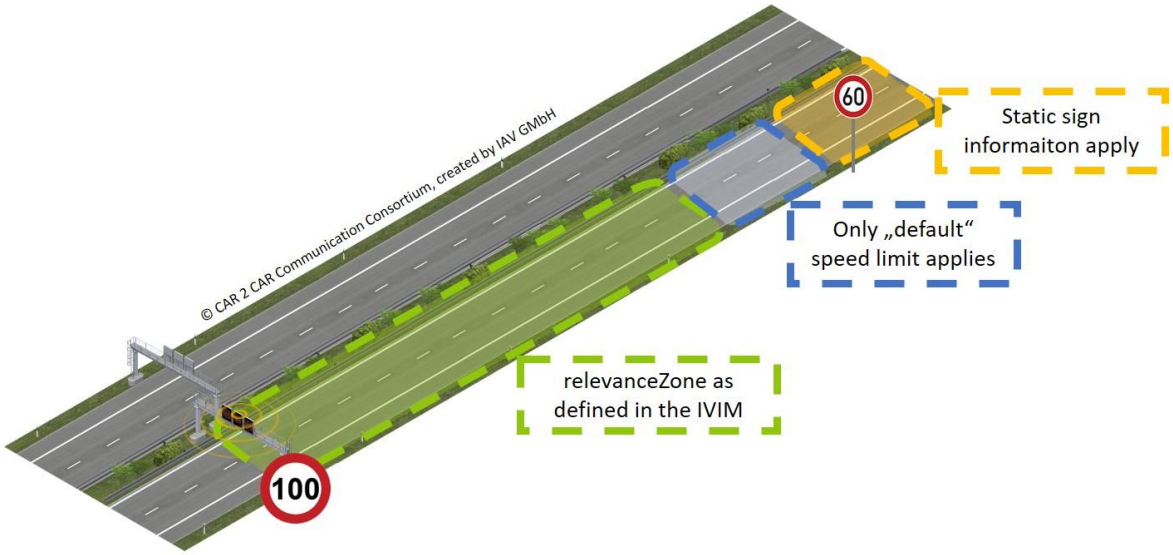


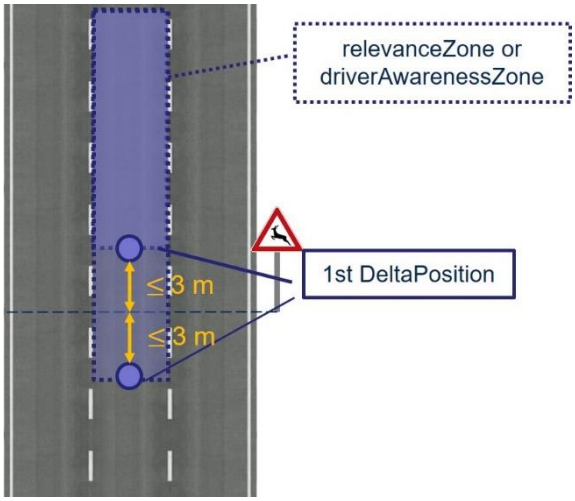
Figure 8: When the relevanceZone ends, this means that the corresponding traffic rules no longer apply; in such an artificial example this means that there is a short road segment with "default" speed limit up to the next sign

Details:

Tested by:

Requirement **RS_ARI_28**

The longitudinal position w.r.t. the carriageway of the first node of the set of zones referenced by *relevanceZoneIds* (or by *driverAwarenessZoneIds*, if used), shall coincide with the longitudinal position of the physical sign, with a maximum offset of *pLongitudinalOffsetSignPosition* if the traffic rule according to the sign is applicable starting from the position of the sign.



Details:

Tested by:

Requirement **RS_ARI_44**

The data element *direction* shall be present in every instance of GicPart in an IviStructure.

Details:

Tested by:

Requirement **RS_ARI_68**

The component iviType shall be set in accordance with the service categories as defined in ISO 14823. The following mapping shall be used:

iviType	Service category
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)

Details:

Tested by:

Requirement **RS_ARI_73**

RSCodes that apply to multiple lanes shall occur only once in an IviStructure (i.e. in only one single GicPart) with indication of the concerned lanes in the component applicableLanes.

Note: This implies that it is not allowed to repeat the same road sign in separate GicParts, each of them associated to a given applicableLane. It serves the purpose of data minimization.

Details:

Tested by:

7.2 Open questions and subjects

7.2.1 Usage of zoneHeading

According to current C-Roads specifications, the usage of zoneHeading in GlcPart is mandatory (see [C-ITS Message Profiles and Parameters, Release 1.7], Table 10).

The profile defines it as “Effective direction of applicability of the sign at the Reference Position, indicating the traffic direction”. C2CCC’s understanding is, that this information shall be given through “direction” in GIC.

Furthermore it is not clear, how this value will be determined and how it is defined – will it be the heading between the “first” two nodes of the zone? What is the intended added value of this information? E.g. we are not sure if the enabling of a differentiation between the zones on a highway and the zones on a ramp would work in all situations (see figure below).

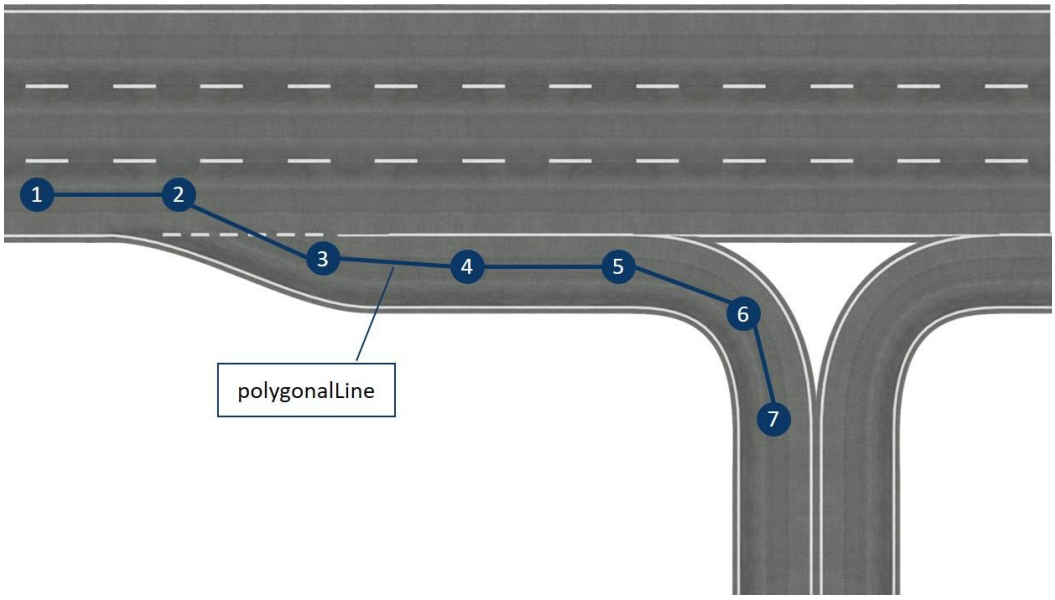


Figure 9: Motorway exit ramp; heading of the first two nodes wouldn't differ from the heading of zones on the motorway (representation simplified to ease understanding)

Some clarification in the specifications is needed for us to understand how to make use of the data element.

8 Annex

This annex contains a table for IVIM showing which data elements are mandatory according to the standard (CEN/ISO), this document and the C-Roads profile in Release 1.7.

Legend:

- The number of "+" in the column "Layer" and the shading of the row represents the layer / level of the corresponding data element within the message.
- "-": This data element is not mentioned in the respective document.
- "O": This data element is optional.
- "M": This data element is mandatory.
- "O/M": This data element is mandatory only under certain conditions which are defined in the respective document.
- "C": This data element is an option within a "Choice".
- "NU": (C-Roads specific) This data element is not used in C-Roads.
- "F": The respective document forbids the usage of this data element.
- "O/F": This data element is forbidden under certain conditions which are defined in the respective document.
- "O/F/M": This data element is mandatory only under certain conditions and forbidden und other conditions which are defined in the respective document.

8.1 IVIM mandatory and optional data elements

Layer	Data element / data field in and IviStructure	ISO 19321	C2C-CC (this document)	C-Roads (Release 1.7)	Combined
+	managementContainer	M	-	M	M
++	serviceProviderId	M	M	M	M
++	iviIdentificationNumber	M	M	M	M
++	timeStamp	O	M	M	M
++	validFrom	O	O/F/M	O	O/F/M
++	validTo	O	O/F	M	O/F
++	connectedIviStructures	O	O/M	NU	O/M
++	iviStatus	M	M	M	M
++	connectedDenms	O	-	-	O
+	iviContainers (sequence of IviContainer)	O	O/M	M	M
++	geographicLocationContainer	C	O/M	M	O/M

+++	referencePosition	M	M	M	M
++++	latitude	M	-	-	M
++++	longitude	M	-	-	M
++++	positionConfidenceEllipse	M	-	-	M
++++	altitude	M	-	-	M
+++	referencePositionTime	O	-	NU	
+++	referencePositionHeading	O	-	NU	
+++	referencePositionSpeed	O	-	NU	
+++	parts (sequence of GlcParts)	M	M	M	M
++++	zoneId	M	M	M	M
++++	laneNumber	O	-	O/M	O/M
++++	zoneExtension	O	-	NU	
++++	zoneHeading	O	-	M	M
++++	zone	O	M	M	M
+++++	segment	C	M	M	M
++++++	line	M	M	M	M
+++++++	deltaPosition	C	C	M	M
+++++++	deltaPositionsWithAltitude	C	C	?	?
+++++++	absolutePositions	C	F	F	F
+++++++	absolutePositionsWithAltitude	C	F	F	F
++++++	laneWidth	O	O/M	O/M	O/M
+++++	area	C	-	F	F
++++++	…				
+++++	computedSegment	C	-	F	F
++++++	…				
++	generalIviContainer (sequence of GicParts)	C	O/M	C/M	O/M
+++	detectionZoneIds	O	M	M	M

+++	Its-Rrid	O	-	NU	
+++	relevanceZoneIds	O	M	M	M
+++	direction	O	M	M	M
+++	driverAwarenessZoneIds	O	O/M	NU	O/M
+++	minimumAwarenessTime	O	-	NU	
+++	applicableLanes	O	-	O/M	O/M
+++	iviType	M	M	M	M
+++	iviPurpose	O	-	NU	
+++	laneStatus	O	-	O	O
+++	vehicleCharacteristics	O	-	O	O
++++	…				
+++	driverCharacteristics	O	-	NU	
+++	layoutId	O	-	NU	
+++	preStoredlayoutId	O	-	NU	
+++	roadSignCodes (sequence of RSCode	M	M	M	M
++++	layoutComponentId	O	-	O	O
++++	code	M	-	M	M
+++++	viennaConvention	C	-	F	F
++++++	…				
+++++	iso14823	C	-	M	M
++++++	…				
+++++	itisCodes	C	-	F	F
++++++	…				
+++++	anyCatalogue	C	-	F	F
++++++	…				
+++	extraText (sequence of Text)	O	-	O	O
++++	layoutComponentId	O	-	M* (due to error in	O*

				previous ISO version)	
++++	language	M	-	-	M
++++	textContent	M	-	-	M
++	roadConfigurationContainer	C	-	NU	
+++	…				
++	textContainer	C	F	NU	
+++	…				
++	layoutContainer	C	F	NU	
+++	…				
++	automatedVehicleContainer	C	-	NU	
+++	…				
++	mapLocationContainer	C	F	NU	
+++	…				
++	roadSurfaceContainer	C	-	NU	
+++	…				