Milestone 3 – Common set of upgraded specifications for ITS-G5

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Terms and abbreviations

Term / Abbreviation	Definition
AC	Advisory Committee
AL	Activity Leader
ASR	Action Status Report
bPVD	basic Probe Vehicle Data
CAM	Cooperative Awareness Message
C-ITS	Cooperative ITS
CMT	Core Management Team
DE	Data Element
DF	Data Frame
DZ	Detection Zone
EC	European Commission
GA	Grant Agreement
GLOSA	Green Light Optimisation Speed Advisory
GNSS	Global Navigation Satellite System
INEA	Innovation and Networks Executive Agency
IPR	Intellectual Property Right
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITSS	Intelligent Transportation System Station
IVI	In-Vehicle Information
IVS	In-Vehicle Signage
CMT	Core Management Team
DENM	Decentralized Environmental Notification Message`
HMI	Human Machine Interface
ML	Milestone Leader
MS	Member State
PC	Project Coordinator
PVD	Probe Vehicle Data
TIC	Technical & Interoperability Coordinator

R-ITSS	Roadside Intelligent Transportation System Station
RWS	Rijkswaterstaat
RWW	Road Works Warning
RZ	Relevance Zone
V-ITSS	Vehicle Intelligent Transportation System Station

1 Executive summary

Interoperability between vehicle and roadside ITS stations from different countries is a key challenge for the European deployment of C-ITS systems. First steps of cross border interoperability are to analyse differences between standards chosen by countries and then to analyse how the different use cases use these standards. In InterCor we have analysed the usage of Road Works Warning (RWW), In-Vehicle-Signage (IVS), Green Light Optimisation Speed Advice (GLOSA) and basic Probe Vehicle Data (b-PVD) in France and The Netherlands. A second step is to harmonise the profiles being used in these countries to maximise interoperability. This document presents the result of this harmonisation. The result is supported by all 4 member states: Not only France and The Netherlands, who already have implementations operational in their countries, but also the United Kingdom and Belgium support the result and have confirmed they will use the harmonised profile.

2 Introduction

2.1 Purpose of this document

This document presents common specifications for the four Member States regarding RWW, IVS, PVD and GLOSA. This document has a limited scope, as it does not cover the complete C-ITS field nor does it describe all communication layers involved. In section 4, the harmonised InterCor profile on the Facility layer is described. For the other layers, like the Network & Transport and the Access layer, we refer to the national profiles (see section 3.2). For the security layer, we refer to InterCor Activity 2.1c (and the corresponding Milestone 5).

2.2 InterCor Contractual References

InterCor (Interoperable Corridors) links the C-ITS corridor initiatives of the Netherlands C-ITS Corridor Netherlands-Germany-Austria and the French one defined in SCOOP@F, and extending to the United Kingdom and Belgium C-ITS initiatives.

InterCor is an action co-financed by the European Union under the Grant Agreement number INEA/CEF/TRAN/M2015/1143833. The Project duration is 36 months, effective from the 1st of September 2016 until the 31st of August 2019. It is a contract with the Innovation and Networks Executive Agency (INEA), under the powers delegated by the European Commission.

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3 General considerations

3.1 Legend

The tables in chapter 4 contain the following profile statuses.

- Mandatory. This DF, DE or container is mandatory in the standard and is thus always provided.
- Profiled. For this DF, DE or container specific choices have been made in the profile even though they are optional in the standard. They can be either always included (i.e. used) or never included (i.e. not used).
- Optional. This DF, DE or container is optional in the standard as well as in the profile.
- Used. This DF, DE or container is used. The profile makes a distinction between DFs, DEs and containers that will be actively used and those that will not be. Although they may be mandatory, these DEs do not always contain an actual value. The CAM standard [CAM] allows that they may be set at 'unknown' or 'not available'. When labelled as 'used', the profile assumes that these DEs do contain actual values.
- Not used. This DF, DE or container is optional or even mandatory in the standard but not used.

3.2 Input documents

The following public / confidential documents have been used for this Milestone report.

- For France: SCOOP_2.4.1_Common set of functional and technical specifications_V2.00 – May 2016
- For the Netherlands: DUTCH C-ITS CORRIDOR PROFILE V3.0 – May 2016
- For GLOSA:
    - 170629 MAP profile v1.2.docx
    - 170629 SPAT Profile v1.2.docx
    - 170720 addendum SPAT profile v1.2 - TimeIntervalCOnfidence
    - NL_Deliverable-F-iTLC-Architecture_GLOSA-V1.2.pdf
- For Standards analysis in InterCor see: InterCor_A2.1.a_001_04052017_v1.5

For RWW and IVS we used the first two documents and the results from the first TESTFEST, organised by InterCor (hosted by the Dutch part of the C-ITS Corridor project), to harmonise the profiles for RWW and IVS.

For GLOSA, the Dutch MAP and SPAT profiles, referred above, are the InterCor SPAT and MAP profiles.

bPVD is about collecting data from ITS-V, there is no issue for interoperability, as we already agreed on the Standard of CAM to be used in InterCor. The section on bPVD in the next chapter presents the “wish list” of data wanted by road operator related to CAM messages from vehicles.

4 Facility layer

4.1 Use of DENM vs IVI

Car manufacturers have expressed that they prefer a clear distinction between information on actual lane closures, road works and obstructions in general (which require safety warnings) and supplementary information on for instance speed information.

Therefor messages according to both the DENM as well as the IVI standard are used and so the information on road works is divided over these two message sets. The core of the RWW information (e.g. lane closures, obstacles) is transmitted by means of DENM messages, the supporting information (e.g. on (VMS) signs on lane closure and speed limits) is transmitted by means of IVI messages.

4.2 Road Works Warning (RWW)

4.2.1 DENM profile

Table 1: RWW DENM profile

DENM Standard	**Description**			
Field	Meaning	Status	Content	Value
Header		Mandatory		
protocol-Version	Version of the protocol.	Mandatory	Fixed value, current version is 1.	Set to 1
messageID	Indicates the type of message.	Mandatory	Fixed value, examples are DENM (1), CAM (2), IVI (6), etc. Here (1) is used.	Set to 1.
stationID	This is the ID of the station broadcasting the message.	Mandatory		Set by application.
management container		Mandatory		
actionID	The actionID consists of DEs originatingStationID (stationID) and sequenceNumber. The sequenceNumber starts at	Mandatory	The actionID will not change for DENMs relating to the same event. I.e. the actionID will remain the same, even if there are	not pre-defined, set by system (consistent with

DENM Standard	Description			
Field	Meaning	Status	Content	Value
	the first unused value and is increased for each additional DENM message. Together the elements form a unique identifier for each DENM message.		updates for the event / DENM. Identical messages broadcasted from different R-ITS-Ss will have different stationIDs but identical actionIDs.	standard).
detection-Time	Timestamp at which an event or event update/termination is detected. The DENM message shall be updated as soon as the functional configuration of the road works layout changes (i.e. position of the trailer, etc.) or when its age is greater than or equal to half of the validity duration.	Mandatory	Initially this DE shall be set to the time the event was detected. For the DENM update, this DE shall be the time at which the event update is detected. For the DENM termination, this DE shall be the time at which the termination of the event is detected. The detectionTime shall initially be set to the time that the application, that creates the DENM, receives the information on the road works, i.e. the moment the road work starts at a functional level. The detectionTime time will be updated to extend the time the message is valid. The value for repetitionDuration shall be set to the same value as validityDuration. This ensures that the DENM is repeated by the originating ITS station as long as the message is valid. The value for the repetitionInterval shall be set in accordance with the applicable Decentralized Congestion Control (DCC) algorithm. Note: While the approach described works, it is a bit counterintuitive. It could be argued that the detection time should remain fixed (i.e. the event started only once or when it changes) and so that value should not change. Another, less counterintuitive, approach would be to update/extend the validityDuration before	detectionTime is initially set at the start time of the event, then reset after expiration of half of validityDuration. repetitionDuration equal to validityDuration. repetitionInterval between 0.25 and 1 sec for TC=3.

DENM Standard	Description			
Field	Meaning	Status	Content	Value
			it expires. This approach is not followed as it the standard appears to suggest to follow the first approach.	
reference-Time	This DE refers to the time at which a new DENM, an update DENM or a cancellation DENM is generated. This DE is maintained by the DEN basic service of the originating ITS-S. The parameter referenceTime is the identifier for DENM update referring to a specific actionID. The referenceTime represents the time at which a DENM is generated by the DEN basic service, after receiving the application request. For each DENM update, the referenceTime shall be updated and the value shall be greater than the referenceTime value of the previous DENM update for the same actionID.	Mandatory	Following the DENM standard, the referenceTime shall be set to the time the DENM message is encoded by the application.	Set by application.
termination	This DF is used to cancel the DENM from the originating ITS-S (cancellation) or another ITS-S (negation).	Optional	In order to end the communication a termination message will be sent when RWW is supported by a TCC. If the originating stationID is the same as the ID of the station that terminates the message, a cancellation message shall be sent. If it is another station, the negation option shall be used. When RWW is not supported by a TCC, this field is optional.	Set by application.
event-Position	This DF is of type ReferencePosition (DF A.124 from [Dictionary]). It contains the coordinates (WGS 84) of the position of the event.	Mandatory	DENM messages focus on the safety related aspects. DENMs thus primarily communicate the position of obstacles. Within this RWW profile it has therefore been decided to define the event position as the point where a lane	Set by application.

DENM Standard	Description			
Field	Meaning	Status	Content	Value
			(including the hard shoulder) is physically blocked (e.g. by a sign, trailer, cone, etc.).. The accuracy should be on the level of a lane, but shall at least be on the accuracy level of the carriageway.	
	Altitude and confidence DEs.	Mandatory	Altitude and confidence DEs are not used and thus set to the values corresponding with 'unavailable'.	Unavailable.
relevance-Distance	The distance within which the event is considered relevant to the receiving ITS-S starting from the event position.	Profiled	This DE is probably not used by the users/OEMs and is therefore not used in the message. Also, without a map, it is hard to determine the distance (over the road) to the event-Position. Therefore, it is unclear how this value should be used/interpreted.	Not used
relevance-Traffic-Direction	The traffic direction along which the event information is relevant for the receiving ITS-S. Thus, the direction along which the receiving ITS-Ss may encounter the event. Therefore, it is also the direction along which the DENM should be disseminated. As an example, for an accident on a motorway, the relevant traffic direction of a DENM related to the event may be the upstream direction of the accident location. While for the accident occurred in rural two-way roads, the relevanceTrafficDirection may be both traffic directions (including also the opposite carriageway).	Profiled	Fixed value. For highways, this value is set to upstream traffic. (This is the opposite direction with respect to the eventPositionHeading (in case of RWW)). This DF indicates for which traffic direction the message is relevant (from the perspective of the eventPosition).	Set to 1 (upStreamTraffic).
validity-Duration	The time at which the message should be deleted with an offset since detectionTime. The validityDuration is set by the originating ITS-S. Therefore, it represents an estimation of how long the event may	Profiled	The DE validityDuration is set at a fixed value.	Set by application.

DENM Standard	Description			
Field	Meaning	Status	Content	Value
	persist. It implies the duration over which the DENM should be kept at the DEN basic service of the receiving ITS-S and the DENM dissemination be maintained in the relevance area or destination area, until the expiration of validityDuration. This DE may be renewed by the originating ITS-S, if the pre-set expiry time has reached to its limit and the originating ITS-S detects that the event persists. The DE is represented as a time offset in the unit of second since detectionTime.			
transmission-Interval	This DE informs the receiving ITS-Ss about the intended transmission interval of two consecutive DENM transmissions. It is used for the forwarding ITS-S operation.	Profiled	RWW has no fixed update frequency of information.	Not used.
stationType	This defines the type of the station broadcasting the DENM.	Mandatory	Fixed value, set to 15 (roadSideUnit). This is true for both fixed R-ITS-S and portable R-ITS-S.	Set to 15 for R-ITSS and 10 for road operator V-ITSS
situation container		Profiled		
information-Quality	This can be set to one of eight different values (0..7). ETSI does not specify what the different values mean.	Profiled	There is no clear consensus on what the values 1 – 7 should mean. Those values will have to reflect the overall quality/reliability of the information in the message. What that quality is, depends largely on the processes of the road authority. Since each road authority has different processes, it is very likely the values are determined in a different way as well. A well-defined approach for using this value is needed, but currently unavailable. It can be set to 0 (unavailable) or 1 – 7, (the exact meaning) depending	Set by application.

DENM Standard	Description				
Field	Meaning		Status	Content	Value
				on the country providing it.	
eventType	This DF consists of a DE causeCode and subCauseCode.		Profiled	Fixed value. The causeCode is set to 3 (road works). The subCauseCode is set to 3 for slowMovingRoad-Maintenance. For shortTermStationaryRoadworks, which correspond to 'Short Term Mobile' and 'Short Term Static' respectively 4 is used in NL and 0 in France. also 0 is used for long term stationary roadworks. 'Unplanned (ad-hoc) Road Works' is either 3 or 4.	causecode set to 3. subCauseCode set to 3, 4 or 0
eventHistory	The DF consists of a list of event points which represents the dimension of a plain event in a predefined order.		Optional	This profile optionally uses this DE when the endpoint of the physical blockage can be determined. If so, it describes the start of a blockage to the end of the blockage, or to the start of a new blockage (another DENM).	Set by application.
location container			Profiled		
eventSpeed	This DF can be used for mobile road works, determining the speed of the trailer.		Profiled	This DF is not used, not even in case of mobile road works.	Not used.
eventPosition-Heading	The heading direction of the event.		Profiled	It is set to the downstream direction at the eventPosition.	Set by application.
traces	This DF consists of minimum 1, maximum 7 traces of type PathHistory. These traces consist of points describing the path towards the eventPosition. These are used by	First trace point.	Profiled	The first trace point is the point closest to the event position. This point is positioned in the middle of the carriageway as far away as possible upstream from the event position, taking into account the curved road. This point is coded as an offset delta position with regard to the event position.	Set by application (see Annex B for details).

DENM Standard	Description				
Field	Meaning		Status	Content	Value
	approaching vehicles to determine whether the DENM is relevant or not. The maximum number of points a trace can hold is assumed to be 40.				
		Additional trace points.	Optional	Additional trace points are defined as offsets or delta positions with respect to their previous trace points. The trace points will be listed in upstream order, thus also defining the event heading. The last trace point is preferably at least 1.5 km upstream of the event position. Additional trace points are also positioned in the middle of the carriageway.	Set by application (see Annex B for details).
alacarte container			Optional		
lanePosition	This DE indicates on which lane the eventPosition is positioned.		Optional		Set by application.
roadWorks container (container within alacarte container)			Optional		
closedLanes	The closedLanes DF consists of two DEs: hardShoulderStatus and drivingLaneStatus. The hardShoulderStatus indicates whether the hard shoulder is available for driving, stopping or is closed. The drivingLaneStatus, counting from the outside, is a sequence of bits indicating whether the lane is closed (1) or not (0).		Optional	The Common Data Dictionary [Dictionary] holds the following definition of the drivingLaneStatus data element which is used in the DENM [DENM] standard: “DrivingLaneStatus ::= BIT STRING { outermostLaneClosed(1), secondLaneFromOutsideClosed(2) } (SIZE (1..14))”. It is assumed that the first	Set by application.

DENM Standard	Description			
Field	Meaning	Status	Content	Value
			bit (LSB, the bit on the right) is a 'don't care' (dc) bit. The value for the outermost driving lane (lane 1) is encoded by the second bit of drivingLaneStatus and so on. All lanes are encoded. The bit string has a constant length, trailing zeros are not omitted. This is in accordance with the Request for Change (number 7296) on this issue, as delivered to ETSI. In case of a 'plusstrook', an extra narrow lane on the left side, that lane is always included with the correct status set (0=open or 1=closed) in drivingLaneStatus. In case of a hard shoulder temporarily used as a normal lane (also known as 'hard shoulder running'), the hard shoulder shall be included as a regular lane in drivingLaneStatus if it is in use. If this lane is in use, hardShoulderStatus shall, since the hard shoulder as such no longer exists, not be used. If available, it is valid only at the eventPosition	
speedLimit	This is the speed limit in km/h. This limit is valid from the startingPointSpeedLimit.	Optional	It is the lowest speedLimit at the eventPosition.	Set by application.
incident-Indication	See eventType in the situation container.	Profiled		Not used.
startingPoint-SpeedLimit	This describes the position from which the speed limit (see speedLimit) is valid as an offset from the eventPosition (see above) as ΔLatitude, ΔLongitude, ΔAltitude in 1/10th of a micro degree.	Optional	This point is on the accuracy level of a carriageway. It is only used when the starting point is different than the eventPosition.	Set by application.
trafficFlow-Rule	This DE indicates whether vehicles shall merge to the left (3) or right (2).	Optional	Merge to the left (3) or the right (2). Values 0 and 1 indicating passage rules are not used.	Set at 2 or 3 when used

DENM Standard	Description			
Field	Meaning	Status	Content	Value
reference-Denms	This is a sequence of up to 8 actionIDs. As described above in the actionID DF from the management container, an actionID forms a unique ID for a given DENM. This sequence shall hold the other DENMs which belong to the same road works (if more than 1 is used).	Optional	A DENM shall not reference to itself.	Set by application.
linkedCause / recommnended path		Profiled	France will add these fields	optional
Other DFs / DEs	All other DFs and DEs in the DENM standard, not mentioned above.	Profiled	These frames and elements are not used.	Not used

4.2.2 Remarks on RWW

For RWW a few observations have to be made, open for discussion:

- Whether to use the filed “closed lanes” or not depends and is part of a broader discussion. It depends if one choses DENM to be as complete as possible (with topographic information) or to keep it as simple as possible and put road topology info in IVI or MAP. Do IVI and DENM complement each other? Do they overlap? What choice to make?
- (intended) usage of reference DENMs is not clear.

4.3 In-Vehicle Signage (IVS)

This chapter describes the profile for the (limited subset of the) In-Vehicle Signage (IVS) use case. This subset is primarily intended for additional information in case of road works. See section 3.1, for the meaning of the references and Annex B for an overview.

4.3.1 IVI Profile

Table 2: IVI Profile

IVI Standard	Description			
Field	Meaning	Status	Content	Value
Header		Mandatory		
protocol-Version	Version of the protocol.	Mandatory	Fixed value. Current version is 1.	Set to 1.
messageID	Indicates the type of message.	Mandatory	Fixed value. Examples are DENM (1), CAM (2), IVI (6), etc. Here (6) is used.	Set to 6.
stationID	This is the ID of the station broadcasting the message.	Mandatory		Set by application.
Management container		Mandatory		
service-ProviderId	Identifies the organization that provides the IVI by using the DE Provider; contains a country code according to [CC].	Mandatory	Numbers shall be assigned on national basis. See [Num] for registration. Country-code: FR for France, NL for Netherlands Issueridentifier: unclear, to be discussed with C-Roads partners.	Set by application.
ivi-Identification-Number	Identifier of the IVI Structure, as assigned by the Service Provider using the DE IviIdentificationNumber. This component serves as the ID of the message (New/Update/Cancel) and can be used by other related messages as a reference.	Mandatory	Unique identifier per IVI message	Set by application.
timestamp	This DE is the timestamp of the generation of the IVI message or the last change in information content. The message is valid from this time if validFrom is omitted.	Profiled	The timestamp when the message was generated, both for new, update or cancel.	Set by application.
validFrom	This component may hold the Start time of the validity period of the message.	Optional	An IVI message should be sent from the moment a sign is valid until it is not valid anymore. When the validity or value of a sign changes, this is seen as an update message and not a triggering condition. All	Set by application.

IVI Standard	Description			
Field	Meaning	Status	Content	Value
			signage information should always be sent to a vehicle the moment the information is available.	
validTo	End time of the validity period of the message duration.	Profiled	This DE shall always be used to determine the validity. An update shall be sent when the validity of a part of a sign is changed. For example, when the maximum speed limit is reduced during rush hour or when trucks are allowed to overtake during off-peak hours.	Set by application.
connected-IviStructures (1..8)	This component holds a list of other iviIdentificationNumbers identifying other IVI messages.	Optional	This component can be used to link various IVI messages to each other.	Set by application.
iviStatus	This component holds the status of the IVI Structure. This can be set to; new, update, cancellation or negation. Is used for message handling.	Mandatory	New, Update, Cancellation: used. Negation: not used	Set by application.
Geographic Location Container		Profiled		
reference-Position	Any suitable position which serves as reference for the polygonal line, using the DE ReferencePosition.	Profiled	This DE is used as a reference point for all zones within GLC (Geographical Location Container). The Reference point for IVI is defined at the middle of the carriageway, at a gantry, and is the first point of zone definitions for Relevance Zone and Detection Zone.	Set by application.
referencePosition Heading	Direction of the Reference Position, if dynamic, using the DE Heading.	Profiled	Used to identify trafficDirection. The Traffic direction value is needed because the sequence of points in a zone is not defined and can therefore not serve as basis for determining the heading of the zone. The reference position heading is defined	Set by application.

IVI Standard	Description			
Field	Meaning	Status	Content	Value
			in the downstream direction (note: ZoneHeading of Relevance Zone is not used; the information is covered in the reference position heading field)	
Parts (1..16)	GlcPart (1..16). Up to 16 parts can be defined in one Geographic Location Container.	Profiled	Minimal one GLC with Relevance Zone and Detection Zone for a gantry, with referencePosition.	Set by application.
zoneId	Identifier of the definition of the zone, using the DE Zid.	Profiled	Up to 32 IDs can be defined within one IVI structure. There will always be minimal one Relevance Zone and one Detection Zone.	Set by application.
zoneHeading	Applicable heading of the zone, e.g. the effective direction of applicability of the sign, at the Reference Position, using the DE Heading.	profiles	Reference position heading is used instead of zoneheading	Not used.
zone	Definition of a zone using the DF Zone. The DF Zone consisting of the choice DF Segment (with open PolypgonalLine), Area (with closed PolygonalLine) or ComputedSegment.	Profiled	For IVI in the context of road works the DF Segment with DE PolygonalLine is used (open PolygonalLine).	Set by application.
segment/ polygonal/ deltaPositions	A sequence of delta positions with respect to the previous position, with latitude and longitude, as coded by the data element deltaPosition. The first point is given by the referencePosition in the locationContainer.	Profiled	This sequence of points is defined on carriageway level and shall be in the middle of the carriageway. There shall be at least one delta position per zone, besides the reference point. The string of points defined in this component defines a zone (e.g. RZ or DZ). IVI allows four choices for defining a polygonalLine with respect to a reference position. In order to be similar to the DENM profile, IVI will use delta positions.	Set by application.

IVI Standard	Description			
Field	Meaning	Status	Content	Value
segment/ laneWidth	The data element LaneWidth contains the width of the lane in centimetres measured at the reference position. Only used when a single lane is referenced within the zone.	Optional		Set by application.
General IVI Application Container (1..16 GicParts)		Mandatory		
detection-ZoneIds (1..8)	List of Identifier(s) of the definition(s) of the Detection Zone(s), using the DE Zid.	Profiled	This is the area in which the IVI message should be detected. This DE shall refer to at least one detection zone.	Set by application.
revelance-ZoneIds (1..8)	List of Identifier(s) of the definition(s) of the Relevance Zone(s), to which the IVS Container applies, using the DE Zid.	Profiled	This is the area in which the IVI message is applicable. This DE shall refer to at least one relevance zone.	Set by application.
direction	Direction of relevance within the relevance zone using the DE direction.	Profiled	Fixed value. Is always set to sameDirection (0) with respect to the referencePositionHeading.	Set to 0.
minimum-Awareness-Time	Time in tenths of seconds before the vehicle enters the relevance area, in which the IVI should be available as a minimum.	Profiled		Not used.
applicable-Lanes (1..8)	List of identifiers of the lane(s) to which the IVI Container applies using the DE LaneNumber/LanePosition.	Profiled	The road signs included in RSCode below apply to these lanes. If applicable to all lanes on a carriageway this DE may be absent. For IVI in the context of road works however this list will always be provided for ‘day 1’.	Set by application.
iviType	Priority of the Container information within the overall context of IVI. This DE is used to determine the	Mandatory	This shall be set to 1 for IVI with regulatory information. Immediate danger would be 0. IVI in the context of road	Set by application.

IVI Standard	Description			
Field	Meaning	Status	Content	Value
	priority of the IVI message.		works is however by defintion used as supporting information, additional to DENM. Other options 0-4 are also supported.	
iviPurpose	This informes the receiving ITS-S on how the message should be used. This can be, Safety, Environmental or TrafficOptimisation.	Profiled	This DE is overlapping with iviType (see above) and therefor not used.	Not used.
laneStatus	Indicates the lane status (e.g. open, closed, mergeR) of the applicableLanes.	Optional	This field may be set at 'closed' for lanes closed with a red cross sign, at 'mergeR' for lanes with an arrow sign pointing right, etc. Note that this field should be consistent with the roadSignCode (e.g. when set at 'closed' the roadSignCode should denote a sign with a red cross or equivalent).	Set by application.
complete-Vehicle-Characteristics	Characteristics of vehicle, for which the IVI is applicable. The applicable regulations, such as limits, are defined as part of the roadSignCode component. Can be used to communicate vehicle restrictions within the relevance zone.	Optional		Set by application.
roadSign-Codes (1..4)	This component specifies which road signs are applicable for a Relevance Zone. Road sign codes are dependent on the referenced classification scheme. A sending ITS-S should select the road sign from a catalogue which is known to be supported by a receiving ITS-S. Additional attributes to the road sign code can be added as provided by the	Mandatory	In order to link a roadSigncode to the correct roadsign, a common library should be used. Within IVI the DF RSCode can be used to set the library. Prechosen libraries are; Vienna Convention, ISO14823, SAE J2540. This profile uses ISO14823 [RoadSign].	Set by application

IVI Standard	Description			
Field	Meaning	Status	Content	Value
	options in the Data Frame RSCode.			
RSCode	The data frame RSCode shall contain the definition of the road sign code. It allows different options pointing to different pictogram catalogues.	Mandatory	For IVI in the context of road works the following signs will be included: red cross, white arrow pointing right, white arrow pointing left, end of restrictions, speed limit 50, speed limit 70, speed limit 90, green arrow pointing down. Additionally a speed limit of 80 is included.	Set by application
extraText (1..4)	List of text lines associated to the ordered list of road sign codes. Each piece contains language code plus extra, limited-size text in the selected language using the DF text.	Optional	Can be used to send a message for clarification or additional information.	Set by application.
Other DFs / DEs	All other DFs and DEs in the DENM standard, not mentioned above.	Profiled	These frames or elements are not used.	Not used

4.3.2 Remarks on IVS

For IVS a few observations have to be made, open for discussion

- How to use the DE countryCode and issuerIdentifier in the DF serviceProvider is unclear, to be discussed with C-Roads partners. For now, a proposal for France and The Netherlands has been made; FR, NL for countryCode, are free to choose value for issuerIdentifier
- Why is IVI identification number not defined similar to as DENM action ID? How can one relate/link DENM and IVI messages and vice versa?
- A table for Road sign codes is requested from C-Roads for all countries with consistent values for ISO14823. All C-Roads countries should use the same library to avoid vehicles having several libraries uploaded on-board.

- How to define language of text? How to send text in multiple languages (e.g. FR and EN). It is far from straightforward how to implement this (how to translate, how to decide what language to use, ...)?

4.4 GLOSA

For GLOSA the profiles for SPAT and MAP will be used. The following three documents contain the profiles and an addendum for TimeIntervalConfidence.

1. 170629 MAP profile v1.2.docx
2. 170629 SPAT Profile v1.2.docx
3. 170720 addendum SPAT profile v1.2 – TimeIntervalCOnfidence

These documents are Dutch documents; their content is accepted by the other InterCor partners as the InterCor output for GLOSA.

4.5 Basic Probe vehicle data (bPVD)

b-PVD is about collecting data from ITS-V, there is no issue for interoperability between implementations in different countries foreseen. We already agreed on Standard of CAM to be used in InterCor, which is the data to be collected.

The national road operators of France and The Netherlands have provided a list of parameters they think will be useful to them. They will adapt their use case to data that is really provided.

The wish list of parameters is presented in the table below.

Table 3: Wish list for bPVD

Field	Usage
header	
protocolVersion	Used
messageID	Used
stationID	Used
cam	
generationDeltaTime	Used
basic-container	
stationType	Used

Field		Usage
referencePosition	Latitude	Used
	Longitude	Used
	positionConfidenceElipse	Not used
	Altitude	Not used
highFreqContainer		Usage
heading	HeadingValue	Used
	headingConfidence	Not used
speed	speedValue	Used
	speedConfidence	Not used
driveDirection		Used
vehicleLenght	vehicleLenghtValue	Used
	vehicleLenghtConfidenceIndication	Not used
vehicleWidth		Not used
Longitudinal- Acceleration	longitudinalAccelerationValue	Used Not used
	longitudinalAccelerationConfidence	
curvature		Not used
curvatureCalculation- Mode		Not used
yawRate		Not used
accelerationControl		Not used
lanePosition		Not used
steeringWheelAngle		Not used
lateralAcceleration		Not used
verticalAcceleration		Not used
performanceClass		Not used
cenDsrcTollingZone		Not used
rsuContainerHigh- Frequency		Not used
LowFrequencyContainer		Usage
basicVehicleContainer-LowFrequency	vehicleRole	Not used in the Netherlands, used in France
	exteriorLights	Used
	pathHistory	Not used
specialVehicleContainer		not used

5 Bibliography

The following public / confidential documents have been used for this Milestone report.

- For France: SCOOP_2.4.1_Common set of functional and technical specifications_V2.00 – May 2016
- For the Netherlands: DUTCH C-ITS CORRIDOR PROFILE V3.0 – May 2016
- For GLOSA:
    - 170629 MAP profile v1.2.docx
    - 170629 SPAT Profile v1.2.docx
    - 170720 addendum SPAT profile v1.2 - TimeIntervalCOnfidence
    - NL_Deliverable-F-iTLC-Architecture_GLOSA-V1.2.pdf
- For Standards analysis in InterCor see: InterCor_A2.1.a_001_04052017_v1.5

Annex A: Standards specifications for InterCor Project

The table below describe the standards used in the in France and The Netherlands. There are still two standards of the version used. As the analysis, have shown that this will have no interoperability issue, we decided to keep the two versions in the table.

Table 4: Standards' list for InterCor

N°	Standard	Title	InterCor
N°1	EN 302 5711	Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive	1.2.1 (2013-09) or 2.0.0 (2016-03)
N°2	EN 302 663	Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band	1.2.1 (2013-07)
N°3	TS 102 724	Intelligent Transport Systems (ITS); Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band	1.1.1 (2012-10)
N°4	TS 102 792	Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range	(2012-10) or 1.2.1 (2015-06)
N°5	EN 302 636-4-1	Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality	1.2.1 (2014-07)
N°6	EN 302 636-5-1	Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol	1.2.1 (2014-08)
N°7	EN 302 637-2	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service	1.3.2 (2014-11)

[1] A new version (V2.1.1) was published on the 8th of June 2017. This standard will be analysed later and included in next versions of this deliverable.

N°8	EN 302 637-3	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service	1.2.2 (2014-11)
N°9	EN 302 931	Intelligent Transport Systems (ITS); Vehicular Communications; Geographical Area Definition	1.1.1 (2011-07)
N°10	TS 102 894-2	Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary	1.2.1 (2014-09)
N°11	TS 101 539-1	Intelligent Transport Systems (ITS); V2X Applications; Part 1: Road Hazard Signalling (RHS) application requirements specification	1.1.1 (2013-08)
N°12	TS 102 638	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Definitions	1.1.1 (2009-06)
N°13	ETSI TS 103 301	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services.	1.1.1 (2016-11)
N°14	ETSI TS 103 175	Intelligent Transport Systems (ITS); Cross Layer DCC Management Entity for operation in the ITS G5A and ITS G5B medium.	1.1.1 (2015-06)
N°15	ETSI TS 102 687	Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part.	1.1.1 (2011-07)
N°16	ETSI TS 103 248	Intelligent Transport Systems (ITS); GeoNetworking; Port Numbers for the Basic Transport Protocol (BTP)	1.1.1 (2016-11)
N°17	ISO TS 19321	Intelligent transport systems -- Cooperative ITS -- Dictionary of in-vehicle information (IVI) data structures.	2015-04-15
N°18	CEN ISO/TS 19091-3	"Intelligent transport systems — Co-operative ITS - Using V2I and I2V Communications for Applications Related to Signalized Intersections.	2016
N°19	SAE J2735	Dedicated Short Range Communications (DSRC), Message Set Dictionary	March 2016

Annex B: Traces and Zones

Traces

Traces are determined with respect to the event position. The trace defines the path leading to the event position.

A trace shall be defined by delta positions. There shall be at least one trace point. The delta towards the event position is part of the trace. The first trace point shall reference to the event position. Additional trace points shall refer to the previous point in the list. Note that the event position itself is not a trace point

All trace points shall be positioned in the middle of the carriageway. The first trace point shall be positioned as far away as possible upstream from the event position (to make the angle between the first trace section (called delta 1 in the figure below) and the road itself as small as possible).

Trace points shall be defined in the upstream direction, i.e. the first trace point shall be closest to the event position and the last point the most upstream.

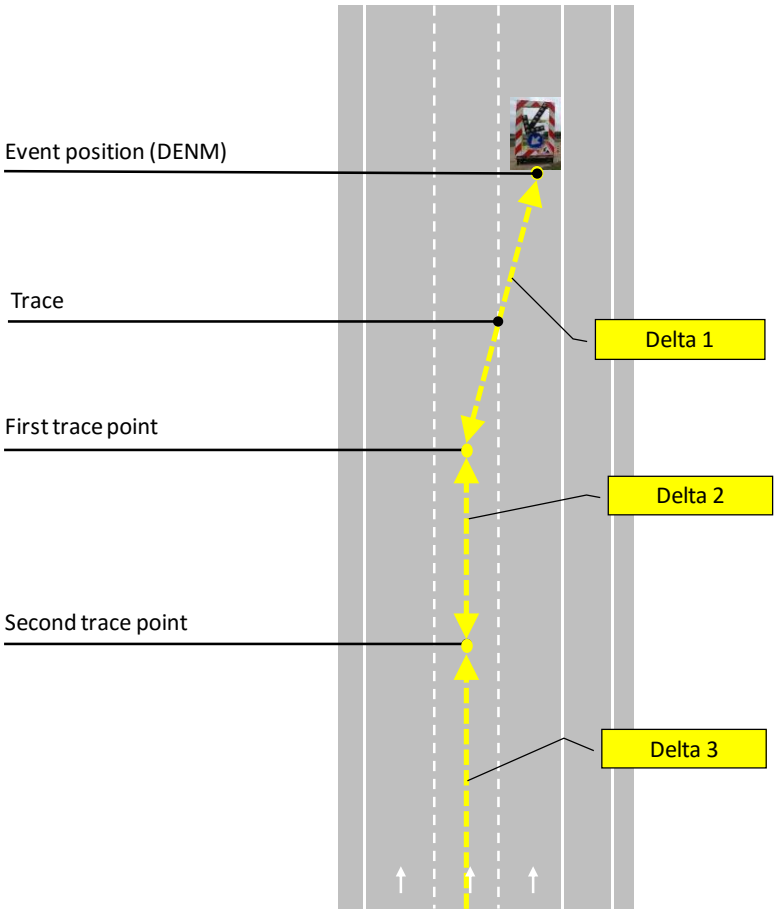

Figure 1: Traces description

There may be multiple traces, i.e. there can be more than one path leading to the event position (e.g. the main carriageway and a ramp).

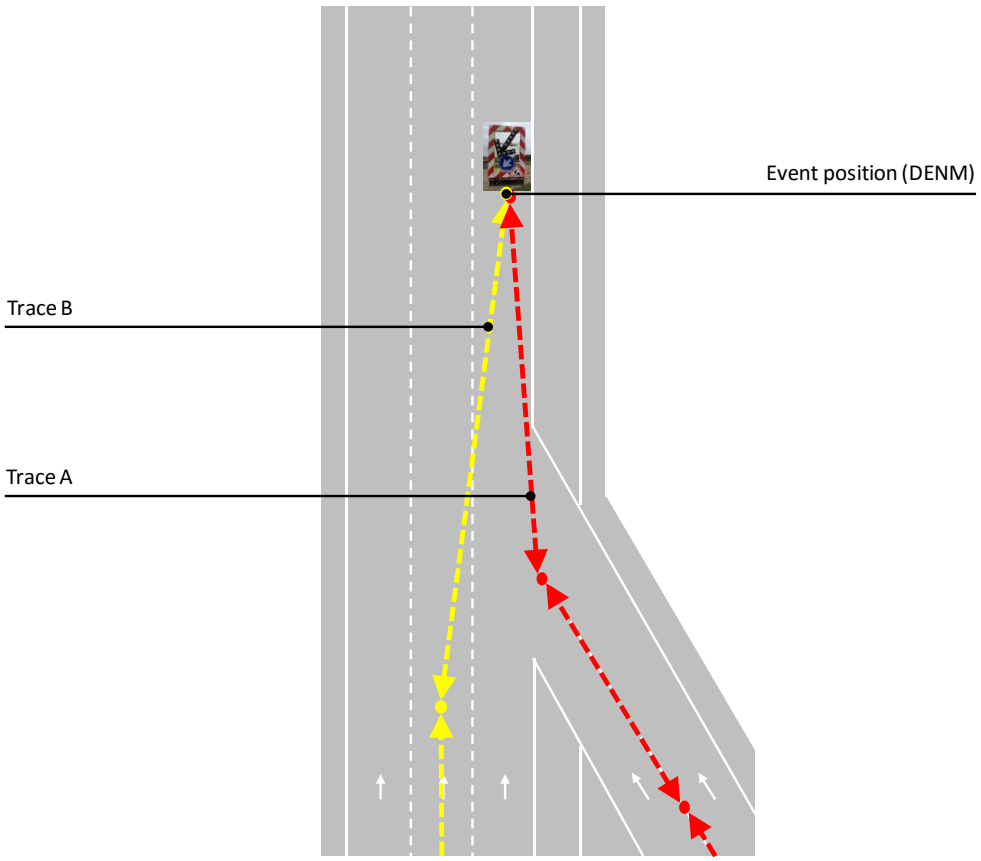

Figure 2: Example of multiple traces

Determining trace and zone points

In case of a straight road, no intermediate trace or zone points are needed. An intermediate point shall be added when the line between two consecutive points falls outside of the carriageway or when the delta does not fit in the maximum value of the data element.

Additional trace and zone points shall be positioned in the middle of the carriageway. Trace or zone points will be defined on the accuracy level of a carriage way, not on lane accuracy.

When calculating the distance between two positions using GNSS coordinates (e.g. delta positions), it is recommended that the great-circle or orthodromic distance method is used. Care shall be taken to avoid large rounding errors on low-precision floating point systems; these can be avoided, e.g. with the haversine formula.

The definition of delta position uses delta latitude, delta longitude and delta altitude. Longitude and latitude deltas are defined in tenths of micro degrees and have a range of -

131071..131072 (0.0131071..0.0131072 degrees). The distance in meters per degree depends on whether it refers to latitude or longitude and on the distance from the equator.

As an example, that means for the Netherlands that the horizontal (west-east and vice versa) maximum distance between two delta positions is about 880 meters. The maximum vertical (north-south and vice versa) distance is about 1450 meters.

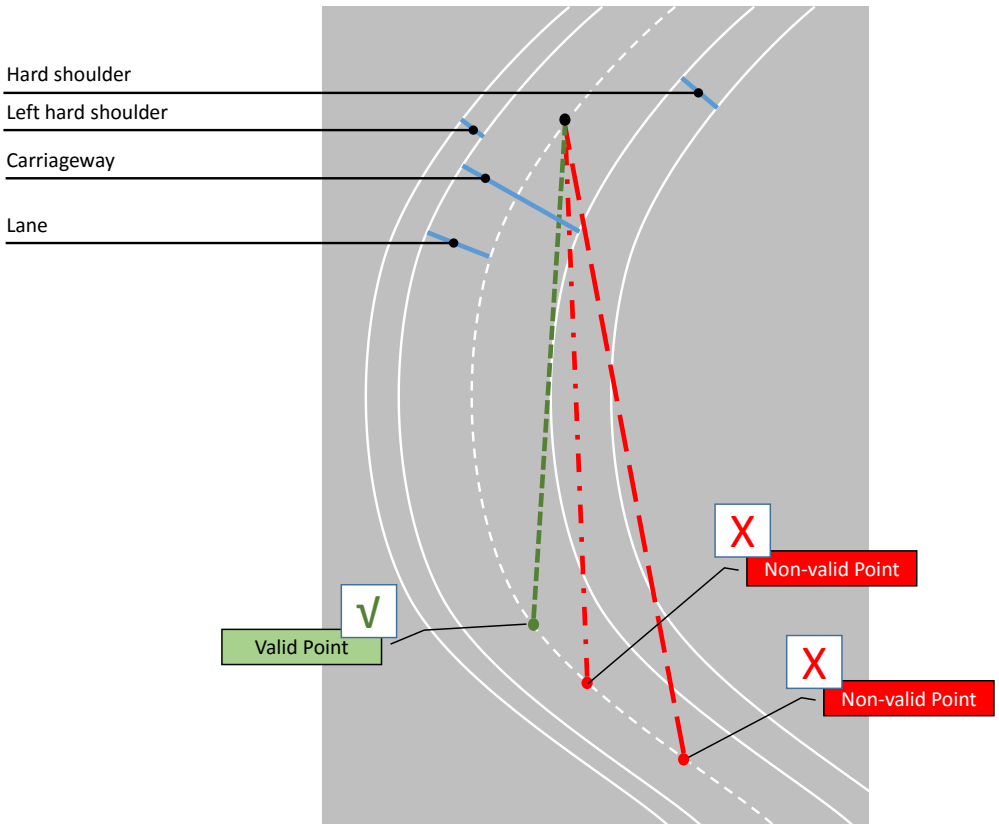

Figure 3: Example of valid point for traces

The V-ITS-S shall, based on its position with respect to the trace or zone, decide whether the DENM or IVI message is relevant or not.

The lateral distance to the trace/zone by definition can be the width of the carriageway, to the left as well as to the right.

The DENM or IVI messages do not include (or include very limited) information on the width of the carriageway or other information on the distance with respect to the trace or zone.

The V-ITS-S shall determine the distance to the trace/zone autonomously, based on all information it has available. Note that this may range from no information at all to additional information from other sources such as digital maps, MAP messages, etc.

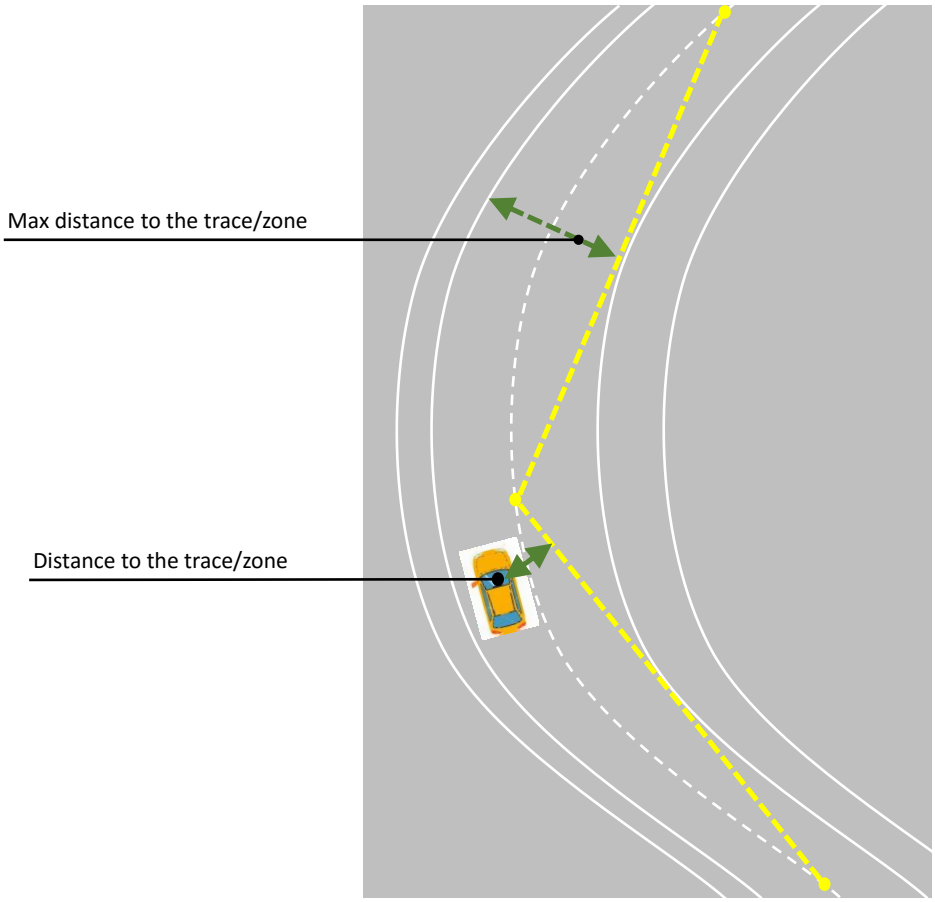

Figure 4: Distance of the vehicle to the Trace

Zones

The IVI standard uses a method with “zones” instead of “traces” and “eventhistory” as used in DENM.

The IVI information is split in an Application Container with info on relevant road signs and the geographical information is defined in Geographical Location Container. Geographical location is mapped to application data via one or more zone id(s) (Zid).

Several zones may be defined:

- Relevance zone: part of the road network for which the information in the Application Container is valid
- Detection zone: part of the road network that is passed by a vehicle in approach of the relevance zone
- Driver awareness zone: part of the road network on which a message is presented to inform drivers of upcoming situations

- Minimal dissemination zone: part of the road network where the IVI message can be received by the potentially targeted vehicles

Zones are determined with respect to a single reference position. A zone can be defined with 3 methods:

- Segment: open line of type PolygonalLine (and optionally lanewidth) where an open line is defined as a line where start point and end points are not the same point
- Area: closed PolygonalLine (closed line, i.e. line starts and ends on the same point, i.e. the reference point)
- ComputedSegment

A PolygonalLine can be defined via

- deltaPositions (sequence of deltaPoistions (with deltaLatitude and deltaLongitude)
- deltaPositionsWithAltitude
- absolutePostions
- absolutePositionsWithAltitude

IVI Profile: explanation of use of zones in InterCor

For IVI, there shall be at least one relevance zone (RZ) and one Detection Zone (DZ) defined. Multiple relevance and detection zones may be used, to refer to the right part of the road network, e.g. when a road splits into two segments, or when a road merges into one segment.

A zone will be defined by a segment via a PolygonalLine with deltaPositions. The first delta position refers to the reference position. Additional delta positions shall refer to the previous point in the list. A zone shall consist of at least two zone points, i.e. the reference position and one delta position. Note that the first delta position is part of the zone.

Zone points are listed in a predefined order, with the reference point as first point. This applies to all zones, independently of whether they are detection zones or relevance zones (or both).

A zone definition will not include a zone heading, giving the orientation of the zone with regards to the North. The referencePositionHeading is used to define the sign effective direction i.e. the downstream traffic direction, see Figure 5.

Below are examples given of definitions for referencePosition, referencePositionHeading and zones for IVI with Variable Message Signs for dynamic lane status and dynamic speed limit on gantries on a highway.

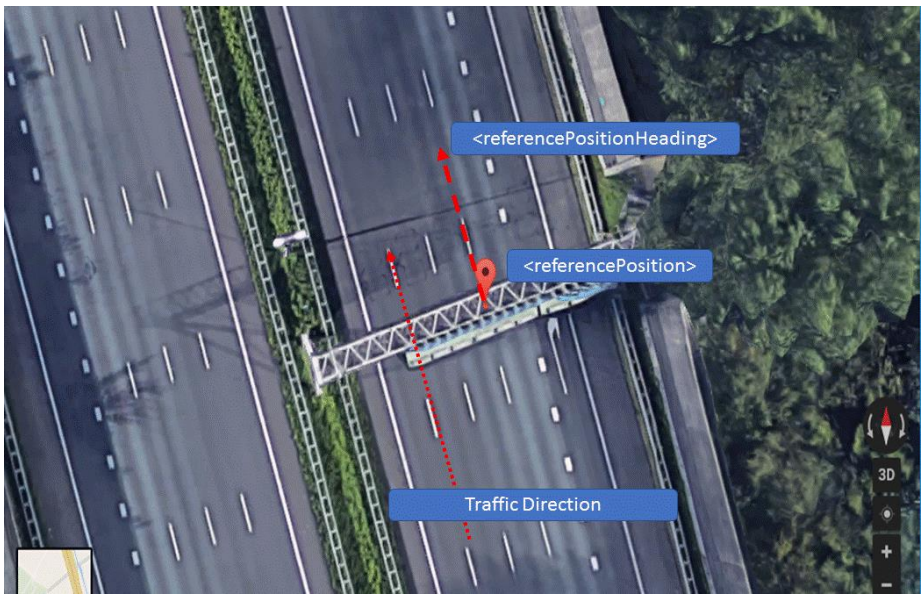

Figure 5: Example of referencePosition and referencePosistionHeading in IVI GLC related to position of gantry on a highway

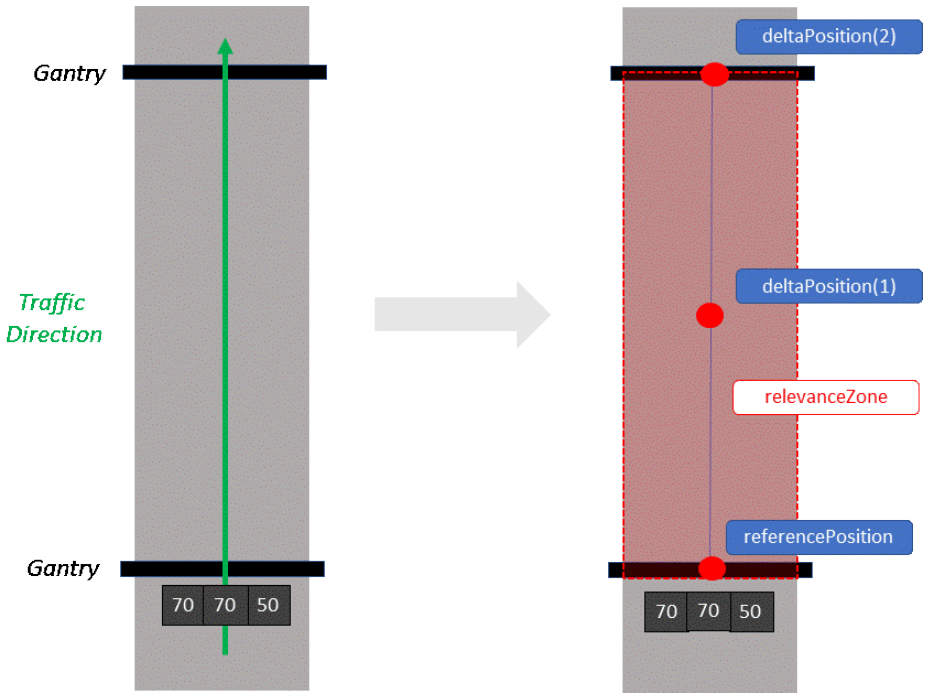

Figure 6: Example of definition of relevanceZone via segment with polygonal line with 2 deltaPositions

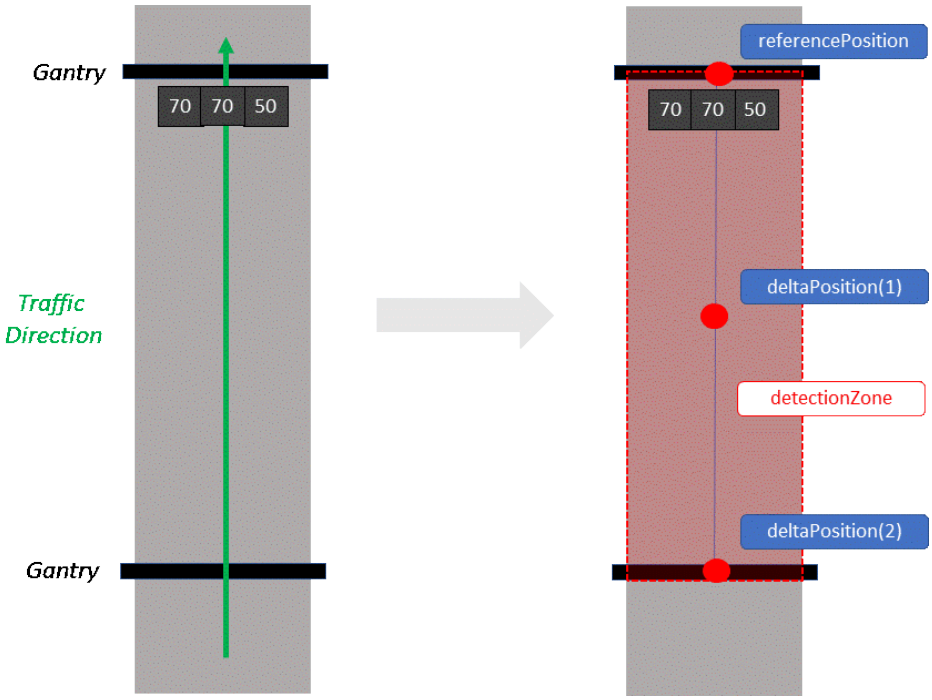

Figure 7: Example of definition of detectionZone via segment with polygonal line with 2 deltaPositions

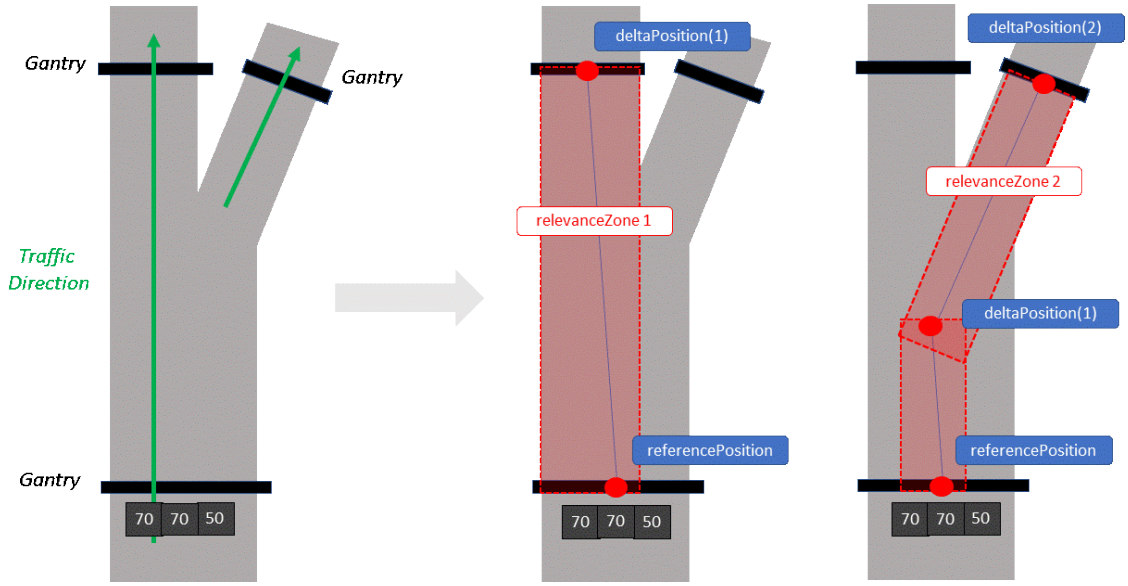

Figure 8: Example of definition of 2 relevanceZones (with polygonal line with deltaPositions) when carriageway splits

The relevance zone at a ‘last’ gantry on a highway cannot be defined to the next gantry. In this case, a relevance zone with 1 deltaPoint will be included, in downstream direction (i.e. traffic direction). The same applies to the detection zone of a ‘first’ gantry. In this case, a detection zone with 1 deltaPoint will be included, in upstream direction.

