DUTCH C-ITS CORRIDOR PROFILE

Colophon

Published by	Rijkswaterstaat | Programma's, Projecten en Onderhoud | Realisatiebureau ITS
Content	Cooperative ITS Corridor project | Technical team, MAPtm, TNO
Editorial	Cooperative ITS Corridor project | Technical team
Date	12-05-2017
Status	Final
Version number	3.0

Contents

1 Introduction

1.1 Background

The Cooperative ITS Corridor project is a cooperation between Germany, Austria and the Netherlands for the deployment of Cooperative services, as described in the Memorandum of Understanding (MoU) on Cooperative ITS Corridor Joint deployment [MoU].

On June 10th 2013, the Ministers of the three countries agreed to start the deployment of initial Cooperative ITS (C-ITS) services on the corridor Rotterdam – Frankfurt – Vienna. Eventually, details regarding the ITS infrastructure have to be shared and agreed upon between all involved parties, including actors from the automotive industry.

The MoU focusses on two specific Cooperative ITS use cases to be deployed on the corridor: Road Works Warning (RWW) and Probe Vehicle Data (PVD). Additionally the Dutch Ministry of Transport has decided to extend the scope of the project with a third use case: Collision Risk Warning (CRW).

Recently the Dutch Cooperative ITS Corridor project has been lined up with the InterCor initiative. InterCor aims at streamlining C-ITS implementation in four EU member states (the Netherlands, Belgium, UK and France) linking the different national initiatives towards a harmonized strategic rollout and the use of common specifications. InterCor focusses on RWW and PVD, but also on In-Vehicle Signage (IVS). This use case has therefore been added to this document.

This document is a deliverable from the Dutch Cooperative ITS project, extended with InterCor scope.

1.2 Objective

This document gives an overview of standardisation needs for these C-ITS use cases for the roadside interface using ITS-G5 communication for first deployment (‘day 1’) in the Netherlands.

The standards allow a wide range of implementation possibilities. The objective of this report is to limit the possibilities within these standards to those required and feasible for the Cooperative ITS Corridor project in the Netherlands (known as profiling).

The objective of this document is to provide a clear reference for actors supplying V-ITS-S systems (also referred to as OBUs), allowing them to build their systems in such a way that they are compatible with R-ITS-S systems (also referred to as RSUs) in the Netherlands.

This document furthermore serves as a baseline for harmonisation of the roadside interface across actors supplying R-ITS-S systems (e.g. road operators) as well as actors supplying V-ITS-S systems (e.g. automotive industry).

1.3 Legend

The chapters containing the actual profiles describe how the data frames (DFs), data elements (DEs) and containers in the DENM, IVI and CAM standards are used within the Dutch use cases.

The description of the DFs and DEs can be found in [DENM], [IVI] and [CAM]. The description of the DEs and DFs in this document makes use of the descriptions in these standards.

The descriptions are accompanied by Excel files, shown in the annexes. The Excel files show the full DENM [DENM], IVI [IVI] and CAM [CAM] structures and profiled DF and DE. The Excel files show the different statuses of the DFs and DEs as follows:

- *Italic*: these are optional in the standard;
- Underlined: one of these can be chosen (OR);
- **Bold**: required by the standard;
- Grey: optional within the profile;
- Dark orange: profiled and used;
- Light orange: profiled and not used.

The tables use the following references with respect to the 'status' within the profile. Note that the use of 'status' may differ for RWW, IVS, CRW or bPVD. For RWW, IVS and CRW information the profile choices are made by the road operator, for bPVD information the choices are made by others.

- 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 (RWW, IVS or CRW) profile even though they are optional in the standard. They can be either always included or specifically 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 within the (bPVD) profile. 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' in the (bPVD) profile, the profile assumes that these DEs do contain actual values. These DEs, in other words, are on the Dutch 'wishlist'.
- Not used. This DF, DE or container is optional or even mandatory in the standard but not used in the (bPVD) profile.

1.4 Abbreviations

Abbreviation	Meaning
AG	Amsterdam Group
bPVD	basic Probe Vehicle Data
CAM	Cooperative Awareness Message
C-ITS	Cooperative ITS
C-ITS-S	Central ITS Station (equivalent to Central Unit (CU))
CRW	Collision Risk Warning
DE	Data Element
DENM	Decentralized Environmental Notification Message
DF	Data Frame
DZ	Detection Zone
ePVD	extended Probe Vehicle Data
GNSS	Global Navigation Satellite System
HMI	Human Machine Interface
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITS	Intelligent Transport System
IVI	In-Vehicle Information
IVS	In-Vehicle Signage
MoU	Memorandum of Understanding
OBU	Onboard Unit (equivalent to V-ITS-S)
PVD	Probe Vehicle Data
R-ITS-S	Roadside ITS Station (equivalent to Roadside Unit)
RSU	Roadside Unit (equivalent to R-ITS-S)
RWS	Rijkswaterstaat
RWW	Road Works Warning
RZ	Relevance Zone
V-ITS-S	Vehicle ITS Station (equivalent to Onboard Unit)

1.5 References

Reference	Description, URL
[AG-FD]	Amsterdam Group, Road Works Warning Functional Description, Version 1.0
[AG-MS]	Amsterdam Group, Message Set and Triggering Conditions for Road Works Warning Service
[AL]	ETSI 302 663. Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band.
[AT-DE-NL Profile]	Cooperative ITS Corridor project (AT-DE-NL), Roadside ITS G5 Profile, V1-0_1, 24-10-2016.
[BTP]	ETSI EN 302 636-5-1 V1.2.1 (2014-08). Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol
[C2C]	CAR 2 CAR Communication Consortium; C2C-CC Basic System profile; Version 1.1.0; Date 21.12.2015 (not public).
[CAM]	ETSI EN 302 637-2 v1.3.2 (2014-11). Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service.
[CC]	ISO 3166-1:2013 Codes for the representation of names of countries and their subdivisions; Part 1: Country codes.
[Channel]	ETSI TS 102 724. Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band.
[Concept]	RWS, Description of the System Concept, June 2016
[CROW96A]	CROW, Maatregelen op autosnelwegen | Werk in uitvoering 96a (CROW 96a)
[DCC]	ETSI TS 102 687 (2011-07). Decentralized Congestion Control Mechanisms for ITS-G5 (DCC)
[DENM]	ETSI EN 302 637-3 v1.2.2 (2014-11). Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service.
[Dictionary]	ETSI TS 102 894-2 v1.2.1 (2014-09). Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary
[DSRC]	ETSI 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.
[GAD]	ETSI 302 931 V1.1.1 (2011-07). Intelligent Transport Systems (ITS); Vehicular Communications; Geographical Area Definition.
[GN]	ETSI EN 302 636-4-1 V1.2.1 (2014-07). 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.
[ICRW]	ETSI TS 101 539-2. Intelligent Transport Systems (ITS); V2X Applications; Part 2: Intersection Collision Risk Warning (ICRW) application requirements specification.
[IVI]	ISO TS 19321:2015 (2015-04-15). Dictionary of in-vehicle information (IVI) data structures.
[LCRW]	ETSI TS 101 539-3 V1.1.1 (2013-11). Intelligent Transport Systems (ITS); V2X Applications; Part 3: Longitudinal Collision Risk Warning (LCRW) application requirements specification.
[LLC]	IEEE/ISO/IEC 8802-2-1998. IEEE International Standard for Information technology; Telecommunications and information exchange between systems; Local and metropolitan area networks; Specific requirements; Part 2: Logical Link Control.
[LMAN]	IEEE 802-201. Standard for Local and Metropolitan Area Networks: Overview and Architecture.
[MoU]	Memorandum of Understanding (MoU) on Cooperative ITS Corridor Joint deployment.
[Num]	ISO 14816:2005 Road transport and traffic telematics; Automatic vehicle and equipment identification; Numbering and data structure.
[RA]	IEEE Registration Authority at http://standards.ieee.org/develop/regauth/ethertype/eth.txt
[Radio]	ETSI 302 571. Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU.
[RHS]	ETSI TS 101 539-1 V1.1.1 (2013-08). Intelligent Transport Systems (ITS); V2X Applications; Part 1: Road Hazard Signalling (RHS) application requirements specification.
[RoadSigns]	ISO/TS 14823. Traffic and travel information; Messages via media independent stationary dissemination systems; Graphic data dictionary for pre-trip and in-trip information dissemination systems. Temporal version 21_July_2016. http://standards.iso.org/iso/ts/14823/
[SHC]	ETSI TS 103 097 V1.1.1 (2013-04). Intelligent Transport Systems (ITS); Security; Security header and certificate formats.
[Standards]	Overview of Standards for First Deployment of C-ITS.
[WLAN]	IEEE 802.11-2012. IEEE Standard for Information technology; Telecommunications and information exchange between systems Local and metropolitan area networks; Specific requirements; Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification.

1.6 Document history

Version	Date	Changes
2.0	22/09/2016	Addition of CRW and IVI
2.1	28/10/2016	Parallel to this 'Dutch C-ITS Corridor Profile', the Austrian, German and Dutch partners have together drawn up a similar profiling document 'Cooperative ITS Corridor Roadside ITS G5 Profile' (V1-0_1), dated 24-10-2016 [AT-DE-NL Profile]. In version 2.1 the Dutch (NL) profile is aligned (e.g. use of ISO 14823 instead of Vienna Convention) with this joint (AT-DE-NL) profile. Both profiles are compatible.
3.0	05/05/2017	Major changes and additions with respect to version 2.1 are given in blue. This version 3.0 now includes: • Textual improvements • Additions and corrections based on experiences in fieldtests, demonstrators, etc. • Definition of traces and zones revised. • Extended profiling on Network&Facility and Access layers. • Choices on roadsign codes. This version 3.0 of the Dutch (NL) profile is intended to be compatible (but not identical) with the previous version 2.1 as well as with the joint (AT-DE-NL) profile [AT-DE-NL Profile]. Some differences (such as, in IVI, no longer denoting zone1 as detection zone and denoting detection zones mandatory) can already be identified. Compatibility can therefore not be guaranteed and will have to be re-investigated.

2 Scope

This document has a limited scope, it does not cover the complete C-ITS field nor does it cover the views of all parties. This chapter describes the specific scope of this document.

2.1 Assumptions

This profile is based on the following assumptions:

1. Traces and zones are assumed to be carriageway based.
2. The 'location container' is always used and, within this container, traces are always used.
3. The 'situation container' is always used.
4. The 'alacarte container' (including DEs lane position, closed lanes, traffic flow rule) is optional in RWW (not used in CRW).
5. Propagation will not be used in 'day 1'.
6. R-ITS-S (RSUs) will not send CAM messages.
7. The value (1) for Traffic Class is for DENM the optimal value for the long term but for 'day 1' the value (3), which implies a higher repetition interval and a lower broadcasting frequency, is more appropriate.
8. For first deployment ('day 1') it is expected that only CAM messages and no DENM messages will be broadcasted by the vehicles and that buffering is not feasible.

2.2 Dutch point of view

The standards are profiled from the Dutch point of view, which is formed by Rijkswaterstaat (RWS). This document for the moment expresses the point of view of the Netherlands only.

The document 'Description of the System Concept' [Concept] describes the specific constraints and pre-conditions in the Netherlands. These are of influence on the choices made in this profile, e.g. on how zones and traces are defined.

The most relevant Dutch constraints and conditions are:

- The focus is on highways only. Provincial motorways and city roads are not included.
- National guidelines are leading. In the Netherlands, CROW 96a provides guidelines on how to set up road works safety measures. Road works layouts are depicted in the CROW publication 'Werk in uitvoering 96a' [CROW96A]. These layouts are the primary input for profiling the message standards.
- Dutch highways include very specific dynamic lanes, on the right (hard shoulder running) as well as on the left side (narrow extra lane). These lanes are usually available for driving during rush hour, but closed when traffic volume is low.
- Most highways are equipped with a fixed, gantry-based, signalling system which is used for the IVS use case.

In parallel this document has been aligned with the German and Austrian partners [AT-DE-NL Profile] and will be extended with the partners in InterCor. It may in future also be extended to cover a broader Dutch context (e.g. include more use cases).

2.3 Use cases RWW, IVS, CRW and bPVD

The scope of this document includes Road Works Warning (RWW), In-Vehicle Signage (IVS), Collision Risk Warning (CRW) and (basic)Probe Vehicle Data (bPVD).

An extensive description of the RWW, CRW and bPVD use cases can be found in the document 'Description of the System Concept' [Concept] of the Dutch Cooperative ITS Corridor project. In summary:

- Road Works Warning (RWW) is performed by sending DENM messages from roadside beacons (R-ITS-Ss) warning road users for upcoming road works.
- In-Vehicle Signage (IVS) is performed by sending IVI messages from roadside beacons (RSUs) informing road users on upcoming traffic measures and speed limits. For the moment this use case is limited to signs in the context of road works.
- Probe Vehicle Data (PVD) is performed by collecting CAM messages containing information on the current situation on the road sent from passing vehicles to the roadside infrastructure (R-ITS-Ss).
  Using the CAM standard [CAM], many properties and/or attributes of vehicles can be broadcasted (and received by a R-ITS-S).
  The Dutch Cooperative ITS Corridor project has defined a basic Probe Vehicle Data (bPVD) as well as an extended Probe Vehicle Data (ePVD) use case [Concept]. The first use case makes use of a subset of CAM messages that are standard emitted by vehicles. The latter entails data collection (buffering) while the vehicle is out of range of an R-ITS-S. When in range, the data is transmitted for a more detailed picture of the status on the road. Note that both use cases strongly depend on the automotive industry. They are based on data that needs to be provided by the vehicle manufacturers. Without their involvement and willingness to act, these use cases will not be feasible.
  The scope is therefore for the moment be limited to the basic Probe Vehicle Data (bPVD) use case only.

- Collision Risk Warning (CRW) concerns sending DENM messages from roadside beacons (R-ITS-Ss) alerting road users for a traffic inspectors vehicle standing still and protecting an incident. In the message the traffic inspectors vehicle protecting the incident is considered to be the obstacle. The message will be derived from a broader system (called 'Flister') that in parallel alerts the road user via cellular (connected) streams.

Profiling the standards for the use cases within the Cooperative ITS Corridor project and InterCor is done with practical applications and the specific task of the Dutch Cooperative ITS Corridor project in mind. The focus in this document is therefore on these RWW, IVS, CRW and (b)PVD use cases only.

2.4 Roadside interface

This document focusses on the 'vehicle-to-roadside' (V2I) and 'roadside-to-vehicle' (I2V) interface only, i.e. the communication between R-ITS-S and V-ITS-S. Other interfaces such as 'central-to-roadside' are not included.

This document furthermore only covers communication via ITS-G5 ('cooperative', wifi-P). Other communication streams such as cellular are not included.

2.5 Road works types

The DENM and IVI standards are profiled for the road works types 'Short Term Static', 'Short Term Mobile' and 'Unplanned (ad-hoc)' of Road Works Warning. The road works type 'Long Term Road Works' is not part of this document.

2.6 DENM, IVI and MAP

It is envisaged that in future C-ITS use cases will make use of a layered structure consisting of DENM (and CAM), IVI as well as MAP messages. This layered approach will ensure that any vehicle can receive the basic safety related information and that in parallel more advanced ITS-stations can perform more advanced tasks (e.g. autonomous driving).

DENM will provide the ground floor of the layered approach. That is, for example, the position of road works related obstacles, the availability of lanes (from a physical perspective) and possibly the speed limit at the location of the obstacle. The primary goal of the DENM is to convey information about physical obstacles in order to avoid collisions.

The IVI layer will enhance the DENM information with additional regulatory information, which in the case of road works exists primarily of extended geographical information (e.g. closed zones, merging zones) and additional speed limits. IVI focusses on rules and regulations and conveys signage information. As a result, the V-ITS-S informs the road user on where additional speed limits begin and end and where one is allowed to drive or not (in contrast to where one can or cannot drive which is encoded in the DENM).

The MAP layer will complete the information on the road works zone. MAP is provided as the third layer. It will contain all the topological information around the road works zone, including changes due to the road works (i.e. where one could drive). This information is seen to be crucial for future autonomous driving.

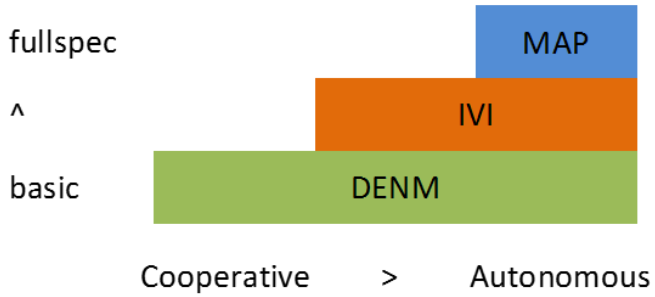


Figure: three-layered RWW approach

The approach described above can be summarized as follows:

- DENM provides safety related information to prevent accidents (i.e. where one can and cannot drive).
- IVI provides regulatory information to ensure conformance to traffic laws and to prevent traffic violations (i.e. where one is allowed to drive).
- MAP provides topological information to give the complete picture around the road works (i.e. where one could drive best depending on one's goal).

It is important to note that each layer can be used independently of the others. This is important since not all V-ITS-Ss will support all layers. It is expected that the DENM message, as a minimum, will be understood by all future C-ITS equipped vehicles. As a result, the risk of accidents involving road works obstacles is minimized, which is the primary purpose of the RWW use case. More sophisticated V-ITS-Ss will in future also be able to understand the 'nice to have' IVI and MAP messages.

The layered approach enables sending and receiving of all three layers in parallel. The Dutch Cooperative ITS Corridor project for the moment only includes DENM and IVI. MAP is not yet included and will have to be added in a later stage.

2.7 Framework (layers)

Standards range from data standards, management standards, security standards to standards of a very technical nature, according to the following framework (layers):

- Management Entity
- Application layer
- Facility layer
- Network&Transport layer
- Access layer
- Security Entity

On the Facility layer the RWW, IVS and CRW use cases focus on the DENM [DENM] and IVI [IVI] standards whereas the bPVD use case focusses on the CAM [CAM] standard. All three standards are used to broadcast information: DENM and IVI from the road side and CAM from the vehicle. These standards provide the framework for the functional content of the use cases. All three standards are part of the Facility layer.

All layers, not only the Facility layer but also the Network&Transport and Access layer are profiled. When for instance choices on distances, areas and message forwarding, etc. are made within the Facility layer, they also impact the Network&Transport Layer (GeoNetworking).

The table below gives an overview of the relevant standards [Standards].

Nr	Name
Management Entity (and architecture)	
ETSI EN 302 665	Communications Architecture
ETSI TS 102 965	Application Object Identifier: Registration
Application Layer	
ETSI TS 102 638	Basic Set of applications (BSA): Definitions
ETSI TS 101 539-1	V2X Applications; Part 1; Road Hazard Signaling (RHS) app. req. spec.
Facility Layer	
ETSI TS 102 894-1	Facility layer structure; functional requirements and specifications
ETSI TS 102 637-1	Basic Set of Applications (BSA); Part 1: Functional Requirements
ETSI EN 302 637-2	Cooperative Awareness Basic Service (CAM)
ETSI EN 302 637-3	Decentralized Enviromental Notification Message (DENM)
ETSI TS 102 894-2	Common Data Dictionary (CDD)
ISO TR 20025	Probe Data Application and System requirements
ETSI EN 302 895	Vehicular Communications; BSA: Local Dynamic MAP-(LDM)
ISO TS 17419	ITS-AID (Application ID)
ISO TS 18750	Extended Infrastructure oriented Local Dynamic MAP-(LDM)
ETSI TS 102 890-2	Service Anouncement Message (SAM)
ISO TS 19321:2015	Dictionary of in-vehicle information (IVI) data structures
Network&Transport Layer	
ETSI EN 302 636-1	GeoNetworking: Requirements
ETSI EN 302 636-2	GeoNetworking: Scenarios
ETSI EN 302 636-3	GeoNetworking: Network Architecture
ETSI EN 302 636-4-1	GeoNetworking: Media-Independent Functionality
ETSI TS 102 636-4-2	GeoNetworking: Media-Independent Functionality for ITS-G5
ETSI EN 302 636-5-1	GeoNetworking: Basic Transport Protocol
ETSI EN 302 931	Geographical Area Definition
Access Layer	
ETSI EN 202 663	Access layer spec. for ITS operating in the 5 GHz frequency band (ITS-G5)
ETSI TS 102 687	Decentralized Congestion Control Mechanisms for ITS-G5 (DCC)
ETSI TS 102 724	Harmonized Channel Specifications for ITS-G5
ETSI EN 302 571	Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band
ETSI TS 102 792	Mitigation techniques to avoid interference between CEN DSRC and ITS-G5
IEEE 802.11	Lower Layer specifications (ensuring ITS in 5.9 GHz)
Security Entity	
ETSI TS 102 867	Stage 3 mapping for IEEE 1609.2
ETSI TS 102 940	ITS communications security architecture and security management
ETSI TS 102 941	Trust and Privacy Management
ETSI TS 102 942	Access control
ETSI TS 102 943	Confidentiality services
ETSI TS 103 097	Security header and certificate formats for ITS G5

Table: Standards overview.

3 Facility Layer

3.1 Road Works Warning (RWW)

This chapter describes the profile for the Road Works Warning (RWW) use case. See §1.3 Legend for the meaning of the references and Annex C for an overview.

3.1.1 RWW DENM Profile

DENM standard		Profile		
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.

DENM standard		Profile		
Field	Meaning	Status	Content	Value
management container		Mandatory		
actionID	The actionID consists of DEs originatingStationID (stationID) and sequenceNumber. The first is set to the ID of the station first encountered by a vehicle. The sequenceNumber starts at the first unused value and is increased for each additional DENM message. Together the elements form a unique identifier for each DENM message.	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 updates for the event / DENM. Identical messages broadcasted from different R-ITS-Ss will have different stationIDs but identical actionIDs.	Set by application.
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. The detectionTime time will thus be updated to extend the time the message is valid.	Mandatory	For the DENM repetition, this DE shall remain unchanged. 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. This will generally be the time when the trailer or truck mounted attenuator is in position. The detectionTime shall be reset when the DEM message is updated. 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	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		Profile		
Field	Meaning	Status	Content	Value
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).	Profiled	In order to end the communication a termination message will be sent. 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.	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 is physically closed. This will generally be the position of the trailer. The accuracy shall be on the level of a lane (not carriageway).	Set by application.
	Altitude and confidence DEs.	Mandatory	Altitude and confidence DEs are not used and thus set to the values corresponding with 'unavailable'.	Unavailable.

DENM standard		Profile		
Field	Meaning	Status	Content	Value
relevance-Distance	Together with relevanceTrafficDirection, this DE forms the relevance area. The relevance area is a geographic area in which information concerning the event is identified as relevant for use. This DE shall be used by the V-ITS-S to determine the alert point, i.e. the point where the information is actually presented to the road user.	Profiled	Based on an average speed of 100 km/h and the time in which the information should be available (i.e. 36 sec before the event position) this value will be set to either 'lessThan1000m' (4) in case of simple road works or 'lessThan5km' (5) in case of road works accompanied by overhead variable message signs on gantries.	Set to 'lessThan1000m' (4) or 'lessThan5km' (5).
relevance-Traffic-Direction	This DF indicates for which traffic direction the message is relevant (from the perspective of the sender).	Profiled	Fixed value. For highways this value is set to upstream traffic.	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 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.	Profiled	The DE validityDuration is set at a fixed value. The DENM message is stopped by means of a direct termination message.	Set to 720 (seconds).

DENM standard		Profile		
Field	Meaning	Status	Content	Value
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	For first deployment (‘day 1’) forwarding will not be used.	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.

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	AG has defined a method to use the DE informationQuality. This method focusses on the way the coordinates in the message are obtained. It however gives limited information about the accuracy of the location(s). Potential recipients of the message might decide to trust the coordinates or not based on the method they are obtained. AG specifies the possible values for informationQuality depending on the way the event is detected and validated. This might be different for each RWW type depending on the actual situation on the field. Following options are determined as indicators for the quality of transmitted information: a) eventPosition: planned position (by road operator) b) eventPosition: simple GNSS c) eventPosition: differential GNSS d) eventPosition: validated position (map-matched position) e) traces: planned position (by road operator) f) traces: simple GNSS g) traces: differential GNSS h) traces: validated positions (map-matched traces) i) event automatically approved by traffic / road	The DE information-Quality shall be set as follows (as proposed by AG): 0. (Not defined) 1. (a AND e / planned by road operator) 2. (b AND f / simple GNSS) 3. (c AND g / differential GNSS) 4. (d AND h / validated positions) 5. (d AND h AND i / system approved) 6. (d AND h AND j / operator approved) 7. (Not defined).

DENM standard		Profile		
Field	Meaning	Status	Content	Value
			works management system j) event manually approved by a traffic / road works management system The quality levels of eventPosition and traces are in ascending order, so that the list of indicators above fulfils relations a < b < c < d (for eventPosition) and e < f < g < h (for traces).	
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 either 3 (slowMovingRoad-Maintenance) or 4 (shortTermStationaryRoadworks) which correspond to 'Short Term Mobile' and 'Short Term Static' respectively. 'Unplanned (ad-hoc) Road Works' is either 3 or 4.	causecode set to 3. subCauseCode set to 3 or 4.
eventHistory	This is a sequence of points, which together form a path from the eventPosition to the end of the road works or, if it exists, the eventPosition of the next related DENM (downstream). It therefore defines the (length of the) area for which the DENM is valid. Which DENMs are related is defined by the DF referenceDenms. The maximum number of points is 23.	Profiled	Experience has shown that this DE in practice has limited added value. It also proves difficult to determine its proper value. This profile therefore does not use this DE.	Not used.

DENM standard			Profile		
Field	Meaning		Status	Content	Value
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	Not used because of a possible conflict with traces.	Not used.
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 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, the minimum number of points is 1.	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).
		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.

DENM standard		Profile		
Field	Meaning	Status	Content	Value
roadWorks container (container within alacarte container)		Optional		
closedLanes	The closedLanes DF consists of two DEs: hardShoulderStatus and drivingLaneStatus. The hardShoulderStatus indicates whether the (outer) 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 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 'spitsstrook', i.e. a hard shoulder is 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.	Set by application.
speedLimit	This is the speed limit in km/h. This limit is valid from the startingPointSpeedLimit (see below) up to the last point in the eventHistory.	Optional	If multiple speed limits exist within a collection of DENMs (via referenceDenms, see below), the speed limit belonging to the last passed startingPointSpeedLimit is valid. In case not all lanes at the eventPosition have the same speed limit, the lowest speed limit or none shall be used.	Set by application.

DENM standard		Profile		
Field	Meaning	Status	Content	Value
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	The default value for the speed limit starting point is the (middle of the carriageway at the) eventPosition. This point is on the accuracy level of a carriageway.	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.
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.

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

3.2 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. In previous versions of this document this limited set was taken up as part of the RWW use case. With the introduction of the InterCor initiative this subset is now taken up as part of the IVS use case. See §1.3 Legend for the meaning of the references and Annex D for an overview.

3.2.1 IVS IVI Profile (for road works)

IVI standard		Profile		
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.	Code for Netherlands NEN is 0011001001 plus ProviderID.
ivi-Identification-Number	This DE is the identifier of the IVI Structure, as assigned by the Service Provider. This component serves as the ID of the message and can be used by other related messages as a reference.	Mandatory		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 standard repetition rates are used for IVI signage messages.	Set by application.

IVI standard		Profile		
Field	Meaning	Status	Content	Value
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 signage information should always be sent to a vehicle the moment the information is available.	Set by application.
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. Road works in the Netherlands generally use multiple gantries with dynamic signs, together forming one traffic measure. When each gantry relates to one individual IVI message, this data element may be used to link these messages together into one traffic measure.	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		Set by application.

IVI standard		Profile		
Field	Meaning	Status	Content	Value
Geographic Location Container		Profiled		
reference-Position	Any suitable position which serves as a reference for the definition of a zone.	Profiled	This DE is used as a reference point for all zones within the IVI message. Note that flexibility is limited due to the limitations of the DE delta position values.	Set by application.
Parts (1..16)	GlcPart (1..16). Up to 16 parts can be defined in one Geographic Location Container.	Profiled		Set by application.
zoneId	Identifier of the definition of the zone, using the DE Zid. Up to 32 IDs can be defined within one IVI structure. There shall be at least 1 zone (i.e. a relevance zone).	Profiled		Set by application.
zoneHeading	Applicable heading of the zone.	Profiled	The zoneHeading 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 zone heading is defined in the downstream direction.	Set by application.
zone	Definition of a zone using the DF Zone consisting of the choice DF Segment, DE PolygonalLine or DF ComputedSegment.	Profiled	For IVI in the context of road works the DF Segment is used.	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 as the delta position with respect to 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 two points. 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		Profile		
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.	Profiled		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.	Optional	This is the area in which the IVI message should be detected.	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).	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 priority of the IVI message.	Mandatory	This shall be set to 1 which is regulatory information. Immediate danger would be 0. IVI in the context of road works is however by defintion used as supporting information, additional to DENM.	Set to 1.
iviPurpose	This informes the receiving ITS-S on how the message should be used. This can be, Safety, Environmental or TrafficOptimisation.	Profiled	Fixed value. Altough IVI is used for supporting information, the purpose is safety. The value is therefore set to Safety (0).	Set to 0.

IVI standard		Profile		
Field	Meaning	Status	Content	Value
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 options in the Data Frame RSCode.	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 to [RoadSign].
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 (see Annex A for details).
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

3.3 basic Probe Vehicle Data (bPVD)

This chapter describes the profile for CAM [CAM] for the basic Probe Vehicle Data (bPVD) use case. See §1.3 Legend for the meaning of the references and Annex E for an overview.

3.3.1 bPVD CAM Profile

CAM standard				
Field		Meaning	Standard	Profile
header			**Mandatory**	**Used**
protocolVersion		Version of the protocol. Current version is 1, thus field is set to 1.	Mandatory	Used
messageID		Indicates the type of message. Examples are DENM (1), CAM (2), IVI (6), etc. Here 2 is used.	Mandatory	Used
stationID		This is the ID of the station (vehicle) broadcasting the message.	Mandatory	Used
cam			**Mandatory**	**Used**
generationDeltaTime		Timestamp belonging to the referencePosition.	Mandatory	Used
basic-container			**Mandatory**	**Used**
stationType		This DE can be 0 or 4 – 10. Other values indicate vehicles that are not allowed on the highway.	Mandatory	Used
referencePosition	Latitude	This DF is of type ReferencePosition (DF A.124 from [Dictionary]). It contains the coordinates (WGS 84) of the ITS station (vehicle).	Mandatory	Used
	Longitude			
	positionConfidenceElipse			Not used
	Altitude			Not used

CAM standard				
Field		Meaning	Standard	Profile
highFreqContainer			**Mandatory**	**Used**
heading	headingValue	The (compass) direction of the vehicle, in 1/10th of a degree.	Mandatory	Used
	headingConfidence		Mandatory	Not used
speed	speedValue	Speed of the vehicle in cm/s.	Mandatory	Used
	speedConfidence		Mandatory	Not used
driveDirection		The direction the vehicle is travelling in: forward (0), backward (1) or unavailable (2).	Mandatory	Used
vehicleLenght	vehicleLenghtValue	Length of the vehicle in steps of 10 cm (1 equals 10 cm).	Mandatory	Used
	vehicleLenghtConfidenceIndication		Mandatory	Not used
vehicleWidth		The vehicle width in 10 cm steps (1 equals 10 cm). Required by the standard but not part of the wish list.	Mandatory	Not used
Longitudinal-Acceleration	longitudinalAccelerationValue	The longitudinal (forward / backward) acceleration of the vehicle in steps of 0.1 m/s^2.	Mandatory	Used
	longitudinalAccelerationConfidence		Mandatory	Not used
curvature		The curvature of the vehicle trajectory. Required by the standard but not part of the wish list.	Mandatory	Not used
curvatureCalculation-Mode		The calculation mode for the curvature. Required by the standard but not part of the wish list.	Mandatory	Not used
yawRate		The rate the vehicle is spinning around its centre of mass. Required by the standard but not part of the wish list.	Mandatory	Not used
accelerationControl			Optional	Not used
lanePosition			Optional	Not used
steeringWheelAngle			Optional	Not used
lateralAcceleration			Optional	Not used
verticalAcceleration			Optional	Not used
performanceClass			Optional	Not used
cenDsrcTollingZone			Optional	Not used
rsuContainerHigh-Frequency			Optional	Not used

CAM standard				
Field		Meaning	Standard	Profile
lowFrequencyContainer			*Optional*	*Used*
basicVehicleContainer-LowFrequency	vehicleRole	The role of the vehicle (e.g. public transport). This is set in accordance with [Dictionary] (usually 0-default). Required because of the use of the lowFrequencyContainer but not part of the wish list.	Optional	Not used
	exteriorLights	This DE is a sequence of bits (bit string) of size 8. Each bit holds the status of the exterior light switches of a vehicle (e.g. fogLightOn, leftTurnSignalOn, etc.).	Optional	Used
	pathHistory	This DF can hold up to 40 points (pathPoints) of where the vehicle has been, optionally with an accompanying timestamp (pathDeltaTime). The timestamp would allow for speed calculation between the points. Required because of the use of the lowFrequencyContainer but not part of the wish list.	Optional	Not used
specialVehicleContainer			*Optional*	*Not used*

3.4 Collision Risk Warning (CRW)

The Dutch Ministry of Transport has decided to add a third use case called Collision Risk Warning (CRW) to the scope of the Cooperative ITS Corridor project. This chapter describes the profile for this Collision Risk Warning (CRW) use case. See §1.3 Legend for the meaning of the references and Annex F for an overview.

3.4.1 CRW DENM Profile

DENM standard		Profile		
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 first is set to the ID of the station first encountered by a vehicle. The sequenceNumber starts at the first unused value and is increased for each additional DENM message. Together the elements form a unique identifier for each DENM message.	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 updates for the event / DENM. Identical messages broadcasted from different R-ITS-Ss will have different stationIDs but identical actionIDs.	Set by application.

DENM standard		Profile		
Field	Meaning	Status	Content	Value
detection-Time	Timestamp at which an event or event update/termination is detected. The DENM message shall be updated as soon as the event changes or when its age is greater than or equal to half of the validity duration. The detectionTime time will thus be updated to extend the time the message is valid.	Mandatory	For the DENM repetition, this DE shall remain unchanged. 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 traffic inspectors vehicle is in position. The detectionTime shall be reset when the DEM message is updated. 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	detectionTime 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.
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.

DENM standard		Profile		
Field	Meaning	Status	Content	Value
termination	This DF is used to cancel the DENM from the originating ITS-S (cancellation) or another ITS-S (negation).	Profiled	In order to end the communication a termination message will be sent. 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.	Set by application.
event-Position	This DF is of type ReferencePosition (DF A.124 from [Dictionary]2). 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. Similar to RWW, this will for this use case be the point where a lane is physically closed and thus the position of the traffic inspectors vehicle. The accuracy shall be on the level of a lane (not carriageway). For this use case this will generally be the hard shoulder.	Set by application.
	Altitude and confidence DEs.	Mandatory	Altitude and confidence DEs are not used and thus set to the values corresponding with 'unavailable'.	Unavailable.
relevance-Distance	Together with relevanceTrafficDirection, this DE forms the relevance area. The relevance area is a geographic area in which information concerning the event is identified as relevant for use.	Profiled	Based on an average speed of 100 km/h and the time in which the information should be available (i.e. 36 sec before the event position) this value is set to the fixed value 'lessThan1000m' (4).	Set to 'lessThan1000m' (4).
relevance-Traffic-Direction	This DF indicates for which traffic direction the message is relevant (from the perspective of the sender).	Profiled	Fixed value. For highways this value is set to upstream traffic.	Set to 1 (upStreamTraffic).

DENM standard		Profile		
Field	Meaning	Status	Content	Value
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 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.	Profiled	The DE validityDuration is set at a fixed value. The DENM message is stopped by means of a direct termination message.	Set to 720 (seconds).
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	For first deployment (‘day 1’) forwarding will not be used.	Not used.
stationType	This defines the type of the station broadcasting the DENM.	Mandatory	Fixed value. This is set to 15 (roadSideUnit). This is true for both fixed R-ITS-S and portable R-ITS-S. Note that although CRW is related to a (traffic inspectors) vehicle, it is seen to be I2V rather than V2V, i.e. the sending ITS-S is seen to be a RITS-S rather than a VITS-S.	Set to 15.

DENM standard		Profile		
Field	Meaning	Status	Content	Value
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	AG has defined a method to use the DE informationQuality. See also the RWW profile.	The DE information-Quality shall be set as follows: 0. (Not defined) 1. - 2. (b AND f / simple GNSS) 3. (c AND g / differential GNSS) 4. - 5. - 6. - 7. (Not defined).
eventType	This DF consists of a DE causeCode and subCauseCode.	Profiled	Fixed value. The causeCode is set to 97 (Collision Risk). The subCauseCode is set to 1 (Longitudinal Collision Risk).	causecode set to 97. subCauseCode set to 1.
eventHistory	This is a sequence of EventPoints, which together form a path from the eventPosition to the end of the road works or, if it exists, the eventPosition of the next related DENM (downstream). It therefore defines the (length of the) area for which the DENM is valid. Which DENMs are related is defined by the DF referenceDenms. The maximum number of points is 23.	Profiled	This DF is not used since this use case warns for a dangerous point rather than a dangerous stretch.	Not used.

DENM standard			Profile		
Field	Meaning		Status	Content	Value
location container			Profiled		
eventSpeed	This DF can be used to define the speed of the traffic inspectors vehicle.		Profiled	The Flister application currently does not provide this information. This DF is therefore not used.	Not used.
event-Position-Heading	The heading direction of the event.		Profiled	Not used because of a possible conflict with traces.	Not used.
traces	This DF consists of minimum 1, maximum 7 traces of type PathHistory. These traces consist of points describing the path towards the eventLocation. These are used by 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, the minimum number of points is 1.	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).
		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).

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 Network&Transport Layer

This section explains how the different message sets received from the Facilities Layer are handled by the Network&Transport (N&T) Layer, ('source' operations) and handed over via information on BTP destination port.

The protocols used by the Network&Transport layer are Basic Transport Protocol [BTP] and GeoNetworking [GN]. Other Network&Transport layer protocols like TCP/UDP/IP(v6) are not in scope of this document.

The data elements of the BTP and GN protocols used for DENM (CAM) and IVI message sets sent by the R-ITS-S (R-ITS-S as source) are described in this section. Other message sets are out of scope of the present document.

The deployment of the R-ITS-S networks as described in this section is based on the following:

1) All messages related to 'events' that are sent by a R-ITS-S are assumed to be relevant for V-ITS-S within communication range, and should be processed by the internal Facilities/Applications functions of the V-ITS-S. For this reason the destination area for GBC messages is set to a circle around the R-ITS-S with a radius larger than the max. communication range of the R-ITS-S (typical 400m @23 dBm) and set to 1.000 m around. In this way all V-ITS-S within communication range are automatically also in the destination area and will process the message in the Facilities/Application layer.
2) The geographical routing of events is controlled by a C-ITS-S (Central Unit, CU), so the most appropriate R-ITS-S for events is selected by a central C-ITS-S system. This approach is different from vehicles where 'events' are always related to the physical vehicle, and the physical location of the V-ITS-S. For a R-ITS-S network, with communication nodes that are directly connected to a (physical) information system along a highway, this approach is regarded as most efficient and simple.
3) The R-ITS-S does not request multi-hop operation, all messages are sent with a MHL=1 or via SHB. The advantage is that the initial deployment is simplified, and predictable. In a later phase this might change, e.g. at higher penetration rates (>5%).

The rest of this section explains the parameters used in the different message sets of the use cases of the ITS Corridor. This section gives references to the C2C Basic System Profile specification [C2C]. Although this C2C specification is not public and may not be available to all, it is considered highly relevant as a reference.

The table gives an overview of the main data elements used for the different messages at the N&T layer, where the R-ITS-S is the 'source' of the message. The GN forwarding operations of the R-ITS-S are explained in chapter 'Access Layer'.

4.1 Basic Transport Protocol

Basic Transport Protocol shall be applied as transport protocol according to the ETSI specification [BTP].

The protocol operations as specified in clause 9 of [BTP] are regarded as operations which may be handled outside the physical R-ITS-S system, e.g. in a central information system. This split in operation functions between R-ITS-S and CU is not in scope of this document.

Element	Content	Profile status	Value	Comment
Next Header (NH)	BTP-B for non-interactive packet transport.	Profiled	BTP-B (2)	
Destination port	Set to values as described in [BTP].	Profiled	CAM = (2001)	Not used. According to the standard all ITS-S shall send CAM messages. However, the R-ITS-S has no physical relevance, since the R-ITS-S does not participate in traffic and position, speed and heading are irrelevant for e.g. collision avoidance. The details for CAM by an R-ITS-S are not fully specified in [CAM]. CAM messages are therefore not used for R-ITS-S.
				This requirement is similar to RS_BSP_275 [C2C].
			DENM = (2002)	This requirement is similar to RS_BSP_276 [C2C].
			IVI = (2006)	Specific to R-ITS-S. Not included in [BTP].
Destination port info		Profiled	Set to value 0	This requirement is similar to RS_BSP_274 [C2C].

4.2 GeoNetworking

GeoNetworking (GN) shall be applied as networking protocol according to the ETSI specification [GN]. Default protocol constants of the GN protocol not overwritten in this profile shall be set as specified in Annex G of [GN]. The table underneath provides an overview of GN protocol constants for this R-ITS-S profile.

Element	Content	Profile status	Value	Comment
Basic Header				
Version				
Next Header (NH)	The Next Header field shall be set to Secured Packet for all packets.	Profiled	Secured Packet (2)	
LifeTime (LT)	The LifeTime (LT) field of all GBC packets shall be set to the minimum of validityDuration and repetitionInterval. The value of the LifeTime field shall not exceed the itsGnMaxPacket-Lifetime, specified in Annex G of [GN].	Profiled	Equal to min(validity-Duration, repetition-Interval).	This requirement is similar to RS_BSP_259 [C2C].
Common Header				
Next Header (NH)	BTP-B headers shall be employed for ITS messages where the R-ITS-S is the 'source' of the message sent towards V-ITS-S.	Profiled	BTP-B (2)	Section 7.3 from [BTP] requirement is similar to RS_BSP_273 [C2C]
Header Type (HT)		Profiled	Geobroadcast (4)	DENM and IVI are Geobroadcast (GBC) (CAM, MAP and SPAT are Singlehopbroad-cast (SHB)).
Header Sub Type (HST)	Circular area.	Profiled	Ceoanycast_Circle (0)	For DENM and IVI.

Element	Content	Profile status	Value	Comment
Traffic Class (TC): Store-Carry-Forward (SCF)	Store-carry-forward shall be disabled. Consequently, the SCF bit of the Traffic Class (TC) field of the Common Header of GBC packets shall be set to 0.	Profiled	Disabled (0)	This requirement differs from C2C RS_BSP_260. The GBC messages of a R-ITS-S (source) are sent with MHL=1 for DENM / IVI packets. An R-ITS-S will not request forwarding operations from the V-ITS-S, either direct or via 'stored-carry-forward'.
Traffic Class (TC): Channel Offload	Channel offload shall always be disabled for GN packets (for the DENM and IVI messages). Consequently, the channel offload bit of the TC field of the Common Header of all packets shall be set to 0.	Profiled	Disabled (0)	This requirement is similar to RS_BSP_262 [C2C].
Traffic Class (TC): TC ID	The DENM and IVI messages shall always be sent via the CCH-channel. A R-ITS-S shall use the mapping of Traffic Class ID (TC ID) to Access Categories, as specified in clause 8, table 5 of [GN].	Profiled	DENM = (1) or (3) IVI = (2) or (3)	The DENM priority is defined by the related use case as specified in [RHS], [ICRW] and [LCRW]. The traffic class is not included in the DENM message, but passed from the Applications and Facilities layer to the Network&Transport layer, as defined in [GN], Annex I. The Amsterdam Group [AG-FD] / [AG-MS] defines that the value for repetitionInterval shall be set in accordance with the applicable Decentralized Congestion Control (DCC) algorithm [DCC], implying that the value shall be in the range between 0.1 and 0.5 sec. Simultaneously the repetition interval (TTX) for Traffic Class (TC) 1 has been defined to be between 95ms and 250ms, depending on the

Element	Content	Profile status	Value	Comment
				channel load. It is assumed that both rules together imply that the value for repetitionInterval shall be between 0.1 and 0.25 sec. This profile assumes that although for DENM the TC value (1) and for IVI the TC value (2) is the optimal value for the long term, for 'day 1' the value (3), which implies a higher repetition interval and a lower broadcasting frequency, is more appropriate. For 'day 1' therefore a TC value of (3) and a broadcasting frequency of 1 Hz for both DENM and IVI may be used.
Flags	The Flags value shall be set to the GN protocol constant itsGnIsMobile.	Profiled	Equal to itsGnIsMobile	This parameter is Stationary (0) for R-ITS-S.
Max Hop Limit (MHL)	Maximum hop limit.	Profiled	DENM = (1) IVI = (1)	It is assumed that R-ITS-S are placed at selected pre-defined positions, so equipped vehicles (with V-ITS-S) will receive I2V messages in a consistent way without the need for multi-hop support by V-ITS-S.

Extended Header				
Source Position Vector: GN Address: Source Station Type (ST) (itsStationType)	Data element ST (Station Type) of the GN address in the Source Position Vector of the GBC header. The station type in the GN source address shall be identical to the station type in DENMs. For IVIs the station type shall be set to RoadSideUnit (15).	Profiled	RoadSideUnit (15)	

Element	Content	Profile status	Value	Comment
Source Position Vector: GN Address: ITS Country Code (SCC)	Country specific.	Profiled		
Source Position Vector: GN Address: Lat/Long	Position of the R-ITS-S	Profiled	Set by application.	
Source Position Vector: Position Accuracy Indicator (PAI)	A R-ITS-S shall send beacon messages, according to [GN], clause 9.2.3. A R-ITS-S may only send messages with the Position Accuracy Indicator (PAI) set to 1.	Profiled	(1)	This requirement is similar to RS_BSP_269 [C2C]. The position accuracy of a R-ITS-S shall be better than 40 m 2drms (twice distance root-mean-squared) in all 3 dimensions.
Source Position Vector: Speed (S)	Assuming stationary R-ITS-S.	Profiled	(0)	
Source Position Vector: Heading (H)	Assuming stationary R-ITS-S.	Profiled	(0)	
GeoAreaPos: Lat/Long	For DENM and IVI this shall be the position of the R-ITS-S.	Profiled	Position of the R-ITS-S	
Distance a	1000 m.	Profiled	(1000)	
Distance b	0 m.	Profiled	(0)	
Angle	0 degrees	Profiled	(0)	

Element	Content	Profile status	Value	Comment
Protocol constants				
itsGnLocalAddr-ConfMethod	The data elements of the GN address will be derived from the N&T layer management entity. The GN address configuration of a R-ITS-S shall not use 'Anonymous'.	Profiled	Managed (1)	
itsGnIsMobile	This parameter is used in the data element Flags of the GN Common Header.	Profiled	Stationary (0) for R-ITS-S	
itsGnIfType	GN shall only be used with itsGnIfType = ITS-G5 (1).	Profiled	ITS-G5 (1)	This requirement is similar to RS_BSP_414 [C2C].
itsGnSecurity	GN packets shall include security header and certificate formats, according to [SHC].	Profiled	Enables (1)	this requirement is similar to RS_BSP_251 [C2C].
itsGnMaxGeo-AreaSize	The maximum size of geographical areas in GBC or GBA shall be 80 km².	Profiled	(80)	This requirement is similar to RS_BSP_255 [C2C].
itsGnDefault-TrafficClass		Profiled	(0x03)	
itsGnGeo-Broadcast-Forwarding-Algoritm	A R-ITS-S shall not request GN forwarding operations from V-ITS-S, either direct or via Store-Carry-Forward. A R-ITS-S shall forward GN messages received from V-ITS-S's as specified in [GN]. The multi-hop operation mode (forwarding operation) shall be supported by implementing the forwarding algorithm specified in the Annex E.3 [GN]. Consequently, the GN protocol constant itsGnGeoBroadcastForwardingAlgoritm shall be set to the value 2 (Contention Based Forwarding, CBF).	Profiled	Contention Based Forwarding (CBF) (2)	This requirement is similar to RS_BSP_266 [C2C].

Element	Content	Profile status	Value	Comment
Duplicate packet detection				
Algorithm	Duplicate packet detection shall be used. Consequently, the algorithm specified in A.2 and A.3 of [GN] shall be used for detecting duplicate packets.	Profiled	As in A.2, A.3 of [GN]	This requirement is similar to RS_BSP_268 [C2C].

5 Access Layer

The following requirements with respect to the Access Layer apply.

Requirement	Comment
Radio Communication Equipment	
Equipment for radio communication shall be applied according to the specification [Radio].	This requirement is related to RS_BSP_222 [C2C].
The control channel G5-CCH shall be used by the R-ITS-S to send messages it generates (source operation) necessary for the use cases covered by this profile.	This requirement is similar to RS_BSP_225 [C2C]. The control channel G5-CCH operates at a central frequency of 5.900 MHz and a channel width of 10 MHz. The corresponding settings for OFDM transmission in Physical Layer and the Data Link Layer (MAC, LLC/SNAP) in [WLAN] shall be used to support this operation.
A R-ITS-S shall be future-proof with respect to Multi-Channel Operations, in the sense that it supplies the mechanisms to offload traffic (based on TC and transport type) to another channel (other than CCH).	Multi-Channel Operation via the other channels SSH1 and SSH2 in the ITS-G5A frequency band is officially not in scope in this document. Also the reception of messages in the channels SSH1 and SSH2 by R-ITS-S is not in scope of this document. A R-ITS-S should however be future-proof to include other channels.
RF output power of the R-ITS-S shall be adjustable.	It is not foreseen in the initial deployment that the output power shall be changed per message, e.g. to max. 33 dBm for high-priority DENM (TC=0) and max. 23 dBm for other messages.

Access Layer Specification	
ITS G5 access layer shall be applied according to the ETSI specification [AL].	This requirement is related to RS_BSP_227 [C2C].
An ITS-G5 station shall adhere to the physical (PHY) layer orthogonal frequency division multiplexing (OFDM) as defined in clause 18 of [WLAN].	This requirement is related to [AL].
An ITS-G5 station shall adhere to the medium access control (MAC) layer functionality as defined in [WLAN] by setting the MIB parameter dot11OCBActivated to true enabling communication outside the context of a basic service set (BSS).	This requirement is related to [AL].
An ITS-G5 station shall adhere to the logical link control (LLC) as defined in [LLC] and the mode of operation is set to Type 1 - unacknowledged connectionless mode.	This requirement is related to [AL].
An ITS-G5 station shall adhere to the subnetwork access protocol (SNAP) as defined in [LMAN]. An ITS-G5 station shall comply to the functionality defined in clause 5 ITS-G5 Access layer.	This requirement is related to [AL]. The SNAP provides the possibility to distinguish between different network protocols through EtherTypes.
An ITS-G5 station shall adhere to the Access Layer as specified in [AL] Clause 18 of [WLAN] with the PHY OFDM system with a 'half-clocked' operation using 10 MHz channel spacing with data communications capabilities of 3, 4.5, 6, 9, 12, 18, 24, and 27 Mb/s.	
An ITS-G5 station shall adhere to the Access Layer as specified in [AL] Clause 18 of [WLAN] with the support of transmitting and receiving at data rates of 3, 6, and 12 Mb/s set at mandatory when using 10 MHz channel spacing.	3, 6 and 12 Mb/s shall be supported by a R-ITS-S, but 6 Mb/s shall be used as default speed to transmit messages in the CCH channel. 3, 6 and 12 Mb/s shall be supported for reception of messages, since it is mandatory.
A transfer rate of 6 Mbit/s shall be used to transmit messages on the control channel G5-CCH.	This requirement is similar to RS_BSP_228 [C2C].
To be future-proof, the transfer rates 3 Mbit/s and 12 Mbit/s shall be supported on the control channel G5-CCH.	This requirement is similar to RS_BSP_397 [C2C].
GN frames shall use the EtherType value 0x8947 as listed by the IEEE Registration Authority [RA].	This requirement is similar to RS_BSP_270 [C2C]. This parameter is used in the MAC header.
The Ethernet broadcast mode shall be supported.	This requirement is similar to RS_BSP_398 [C2C].
All GN frames with packet header SHB and GBC shall be sent via MAC broadcast. The destination address of the 802.2 header shall be set to FF:FF:FF:FF for all transmitted messages.	

Mitigation Techniques for CEN DSRC	
Mitigation techniques shall be applied according to the ETSI document [DSRC].	This requirement is similar to RS_BSP_230 [C2C]. In the Netherlands CEN DSRC systems for tolling are not deployed today. The requirement might be relevant for future use.
At least the detect-and-avoid method according to [C2C] based on the tolling zone announcement messages shall be applied.	This requirement is similar to RS_BSP_232 [C2C].

5 GHz Channel Specification	
Channels in the 5 GHz frequency band shall be applied according to the ETSI document [Channel].	This requirement is similar to RS_BSP_233 [C2C].
The following DCC-Profiles defined inside [Channel] shall be supported: DP0, DP1, DP2 and DP3. These four DCC-Profiles shall use the following DCC-Profile Identification (DPID) values: • DP0: used only for DENMs with Traffic Class = (0) • DP1: used for DENMs with Traffic Class = (1) • DP2: used for CAMs with Traffic Class = (2), same DP2 is used for IVI with Traffic Class = (2) • DP3: used for forwarded DENMs and other low priority messages	This requirement is similar to RS_BSP_233 [C2C]. Traffic class is set by the Application, and needs to be transferred via Facilities to Network&Transport layer (GN). DCC is specified in [Channel] and [DCC].
A R-ITS-S shall be future-proof with respect to DCC operations, in the sense that it supplies the mechanisms to enforce per-channel and per-TC rate control (limiting the number of messages per second at the expense of BTP request drops) and to enforce per-channel and per-TC Transmit-Power Control.	

6 Management Entity

The Management Entity is not relevant for the messages sent over 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.

7 Security Entity

The requirements for the Security Entity will be added in later releases.

Annex A: Roadsign codes

For the Netherlands the following choices with respect to the roadsign codes have been made [RoadSigns]. No distinction is made between signs which are accompanied by flashers and which are not.

		Roadsign code								
Sign		**Service Category Code**		**Picto-gram code**	**Attr. ind. code**	**Attributes**				**Picto-gram**
Lane closed	Red cross	1	3	768	2					
Clear lane to left	White arrow pointing left	1	3	771	2					
Clear lane to right	White arrow pointing right	1	3	772	2					
End of all restrictions by electronic signs	End of restric-tions	1	3	773	2					
Maximum speed limited to the figure indicated	Speed limit 50	1	2	557	1	SPE	SPM	050	KPH	
Maximum speed limited to the figure indicated	Speed limit 70	1	2	557	1	SPE	SPM	070	KPH	
Maximum speed limited to the figure indicated	Speed limit 80	1	2	557	1	SPE	SPM	080	KPH	
Maximum speed limited to the figure indicated	Speed limit 90	1	2	557	1	SPE	SPM	090	KPH	
Lane free	Green arrow pointing down	1	3	769	2					

Annex B: Traces and Zones

This annex provides details on the use of traces (in DENM) and zones (in IVI) as well as on related issues such as relevance distance, etc.

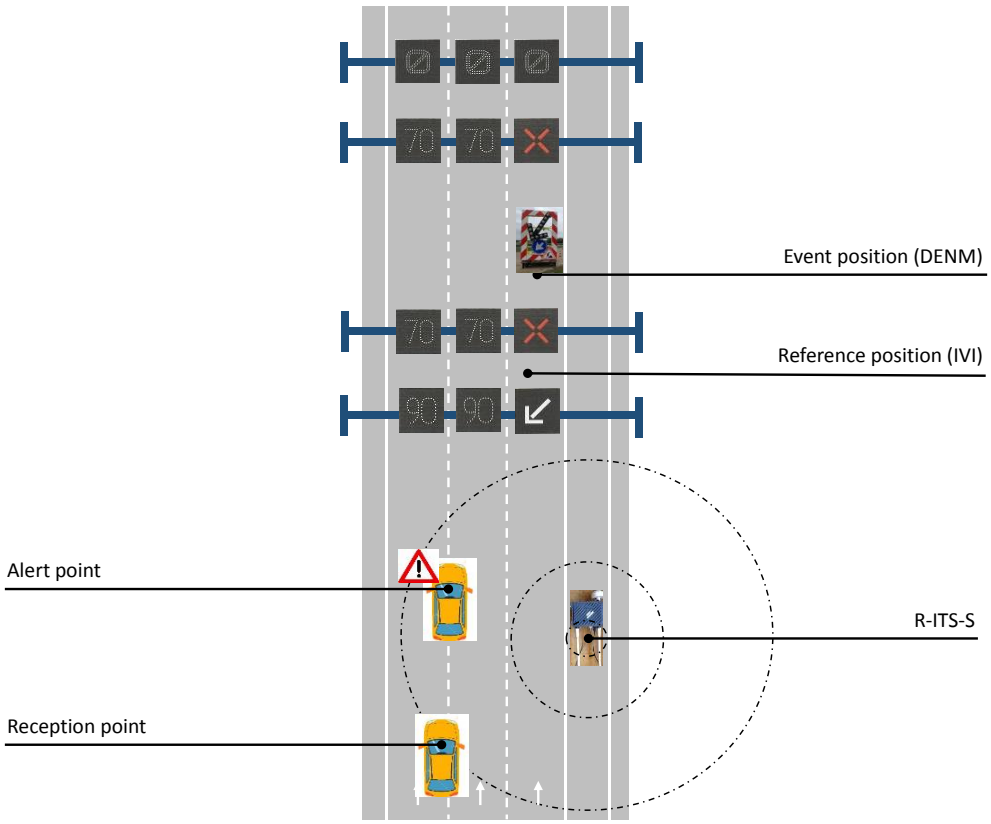
B.1 Definitions

The event position in DENM shall be the position of the obstacle, e.g. the trailer in RWW or the traffic inspectors vehicle in CRW.

The reference position in IVI can be any suitable point. It has no functional meaning itself.

The alert point is the point where the V-ITS-S informs the road user. This is the point where the human-machine interface should be started.

The reception point is the point where the V-ITS-S first receives the message. This point should be upstream of the alert point and preferably also upstream of the start of the zone or trace.



B.2 Traces (DENM)

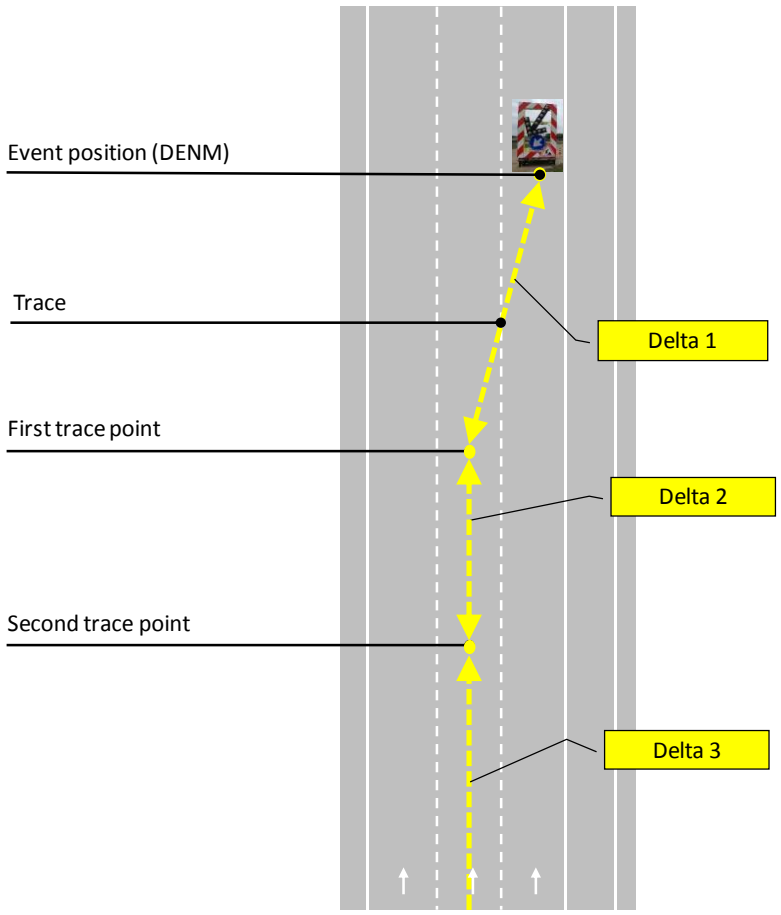
Traces are determined with respect to the event position. The trace defines the path leading to the event position.

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.

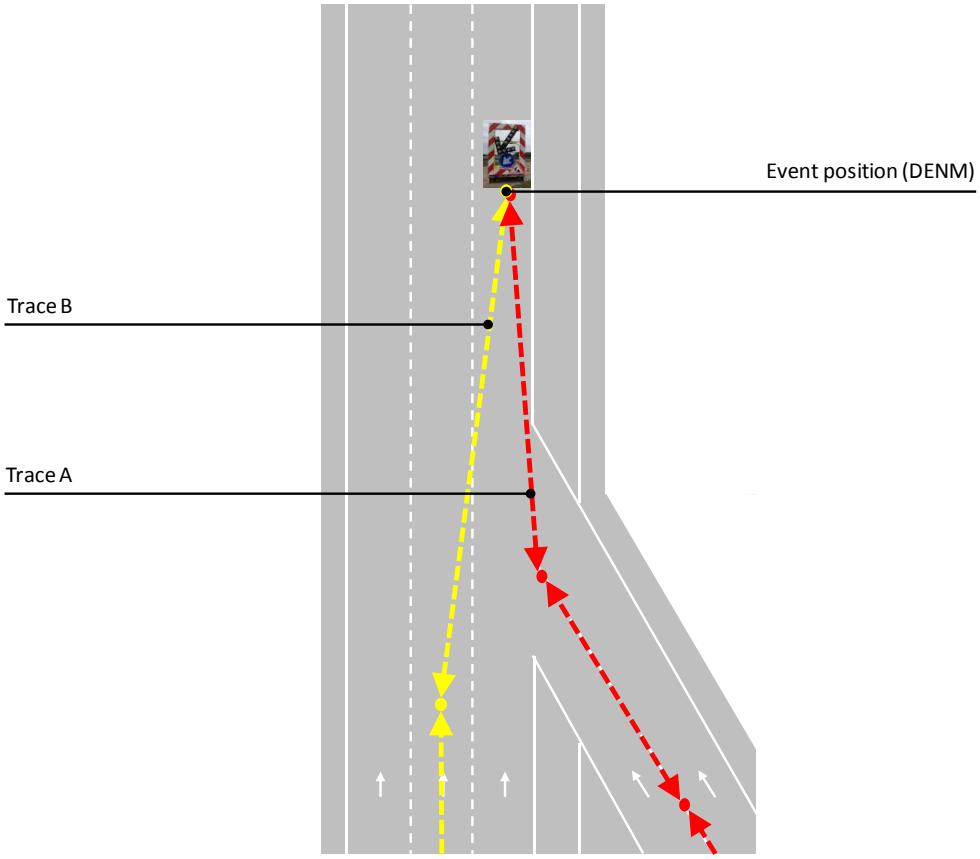
All trace points shall be positioned in the middle of the carriageway. The first trace point shall be positioned as far away as possible upstream from the event position (note that this is not shown in the figure).

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.

The trace thus also defines the heading of the event. The heading can be determined by following the trace points in reverse order, from last to first. The heading is given by the last trace point, to the next point, … , to the first trace point, up to the event position.



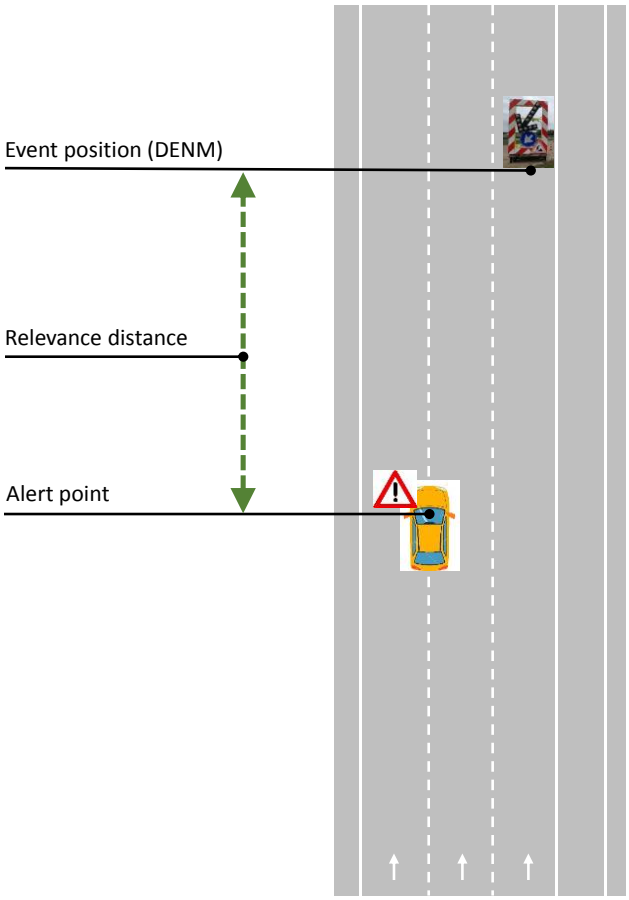
There may be multiple traces, i.e. there can be more than one path leading to the event position (e.g the main carriageway and a ramp).



B.3 Relevance distance

The relevance distance defines the alert point as perceived by the R-ITS-S. This is the point where, from the point of view of the R-ITS-S, the human-machine interface should be started. Note that the V-ITS-S, based on this data element but also based on other information it receives, may decide to alert the road user at another moment.

The start of the trace or detection zone shall be upstream of the alert point.



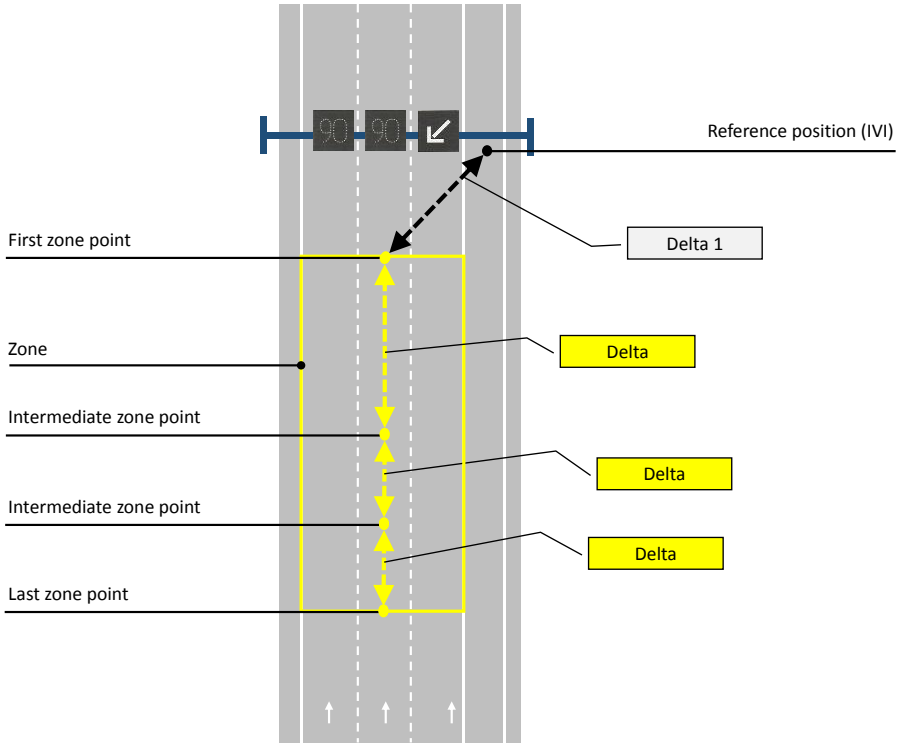
B.4 Zones (IVI)

There shall be at least one relevance zone (RZ). A zone can have more than one purpose, it can for instance serve as a detection zone (DZ) as well as a relevance zone (RZ).

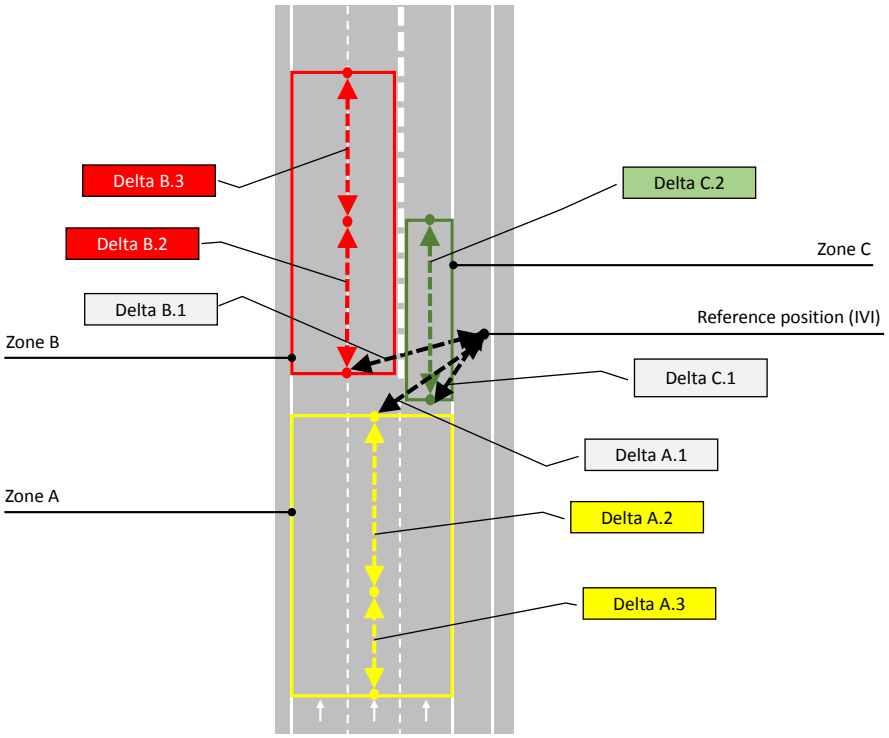
Zones are determined with respect to the reference position. A zone shall be defined by delta positions. The first zone point shall refer to the reference position. Additional zone points shall refer to the previous point in the list.

A zone shall consist of at least two zone points. Note that, contrary to traces, the first delta position is not part of the zone.

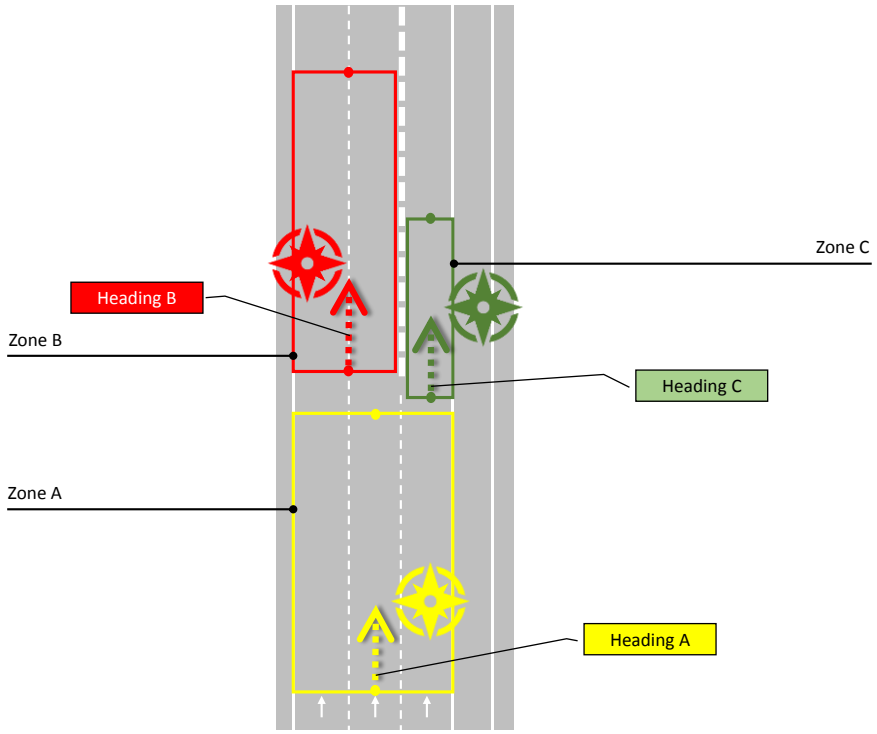
Zone points are not, contrary to traces, listed in a predefined order. It is left open whether zone points are listed in upstream or downstream order. This applies to all zones, independently of whether they are detection zones or relevance zones (or both). The heading of a zone can therefore not be determined from the order of the zone points.



There may be multiple zones. Zones are independent of each other, they have no relation other than that they all refer to the same reference position. The numbers of the zones (zoneId) do not have a specific meaning, they are merely used as reference.



A zone definition shall always include a zone heading, giving the orientation of the zone with regards to the North. The zone heading is defined in the downstream direction.



B.5 Determining trace and zone points

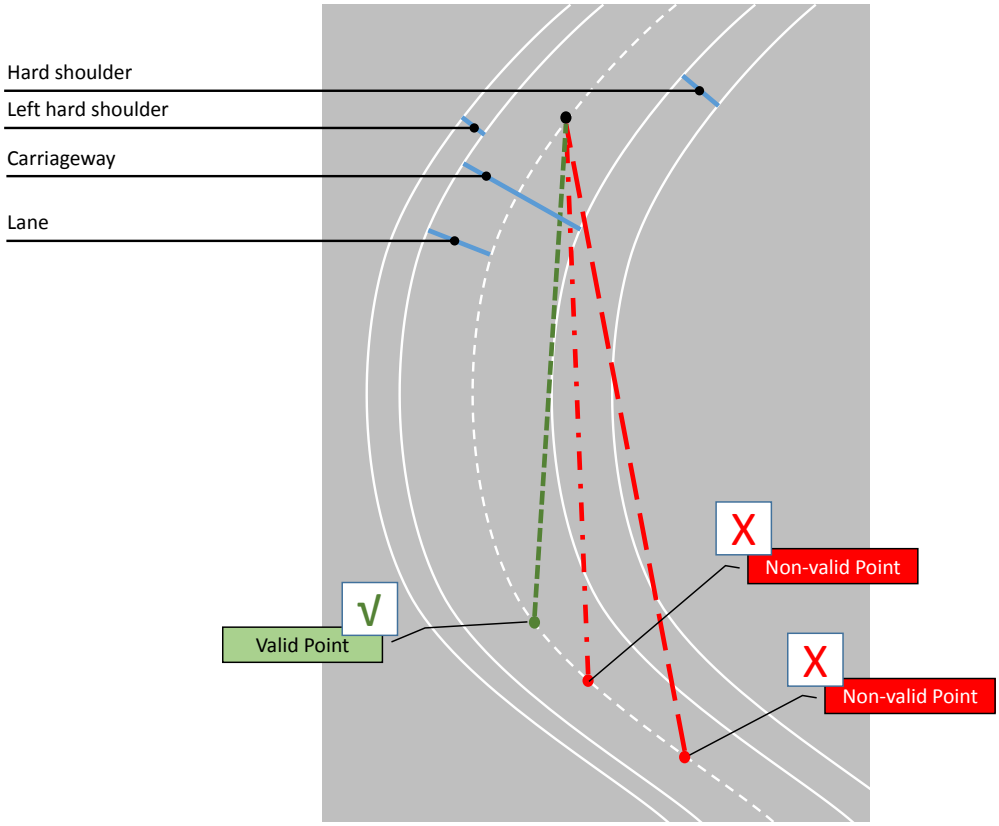
In case of a straight road, no intermediate trace or zone points are needed. An intermediate point shall be added when the line between two consecutive points falls outside of the carriageway or when the delta does not fit in the maximum value of the data element.

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 metres per degree depends on whether it refers to latitude or longitude and on the distance from the equator.

For the Netherlands this implies 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.

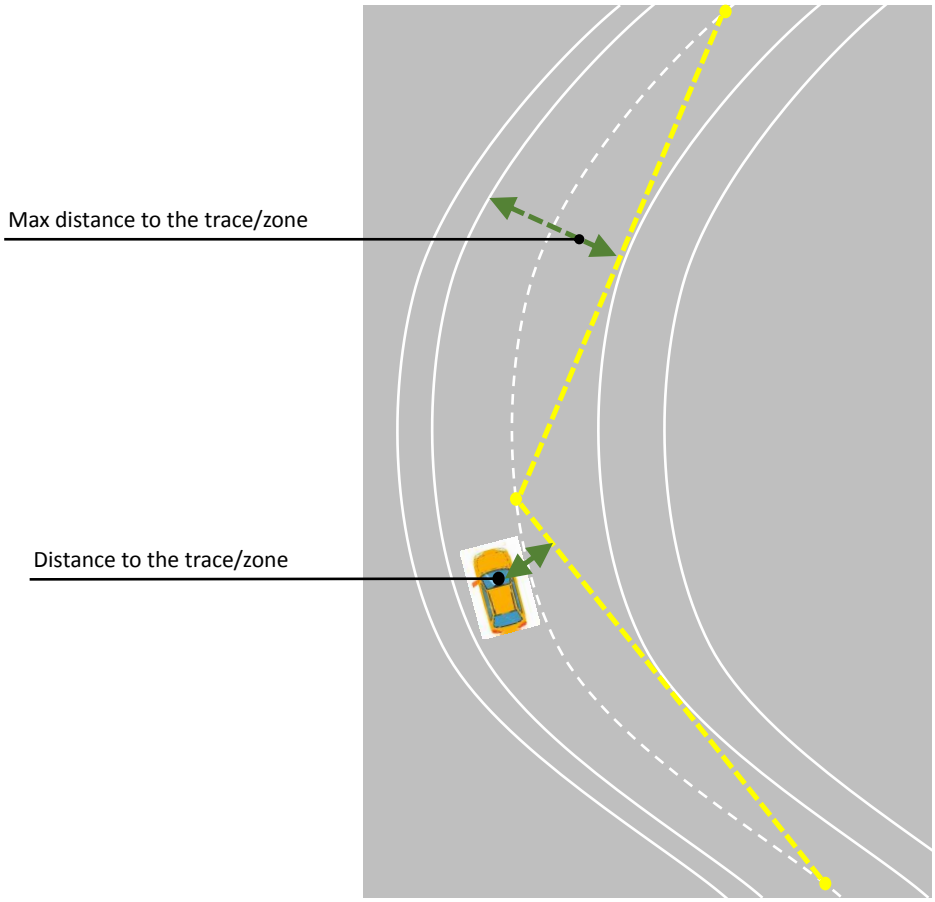


The V-ITS-S shall, based on its position with respect to the trace or zone, decide whether the DENM or IVI message is relevant or not.

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.

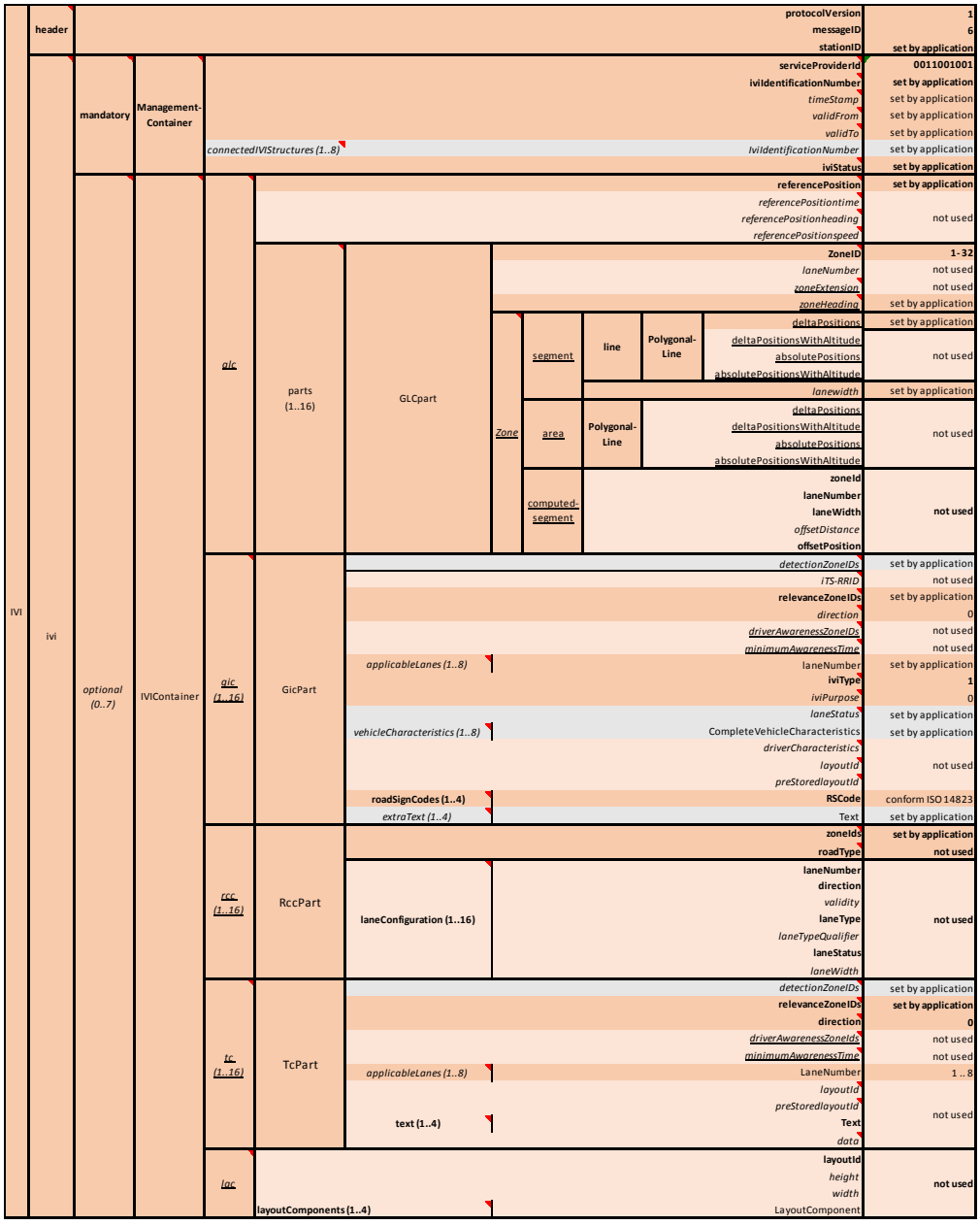
The V-ITS-S shall determine the distance to the trace/zone autonomously, based on all information it has available. Note that this may range from no information at all to additional information from other sources such as digital maps, MAP messages, etc.


Max distance to the trace/zone
Distance to the trace/zone

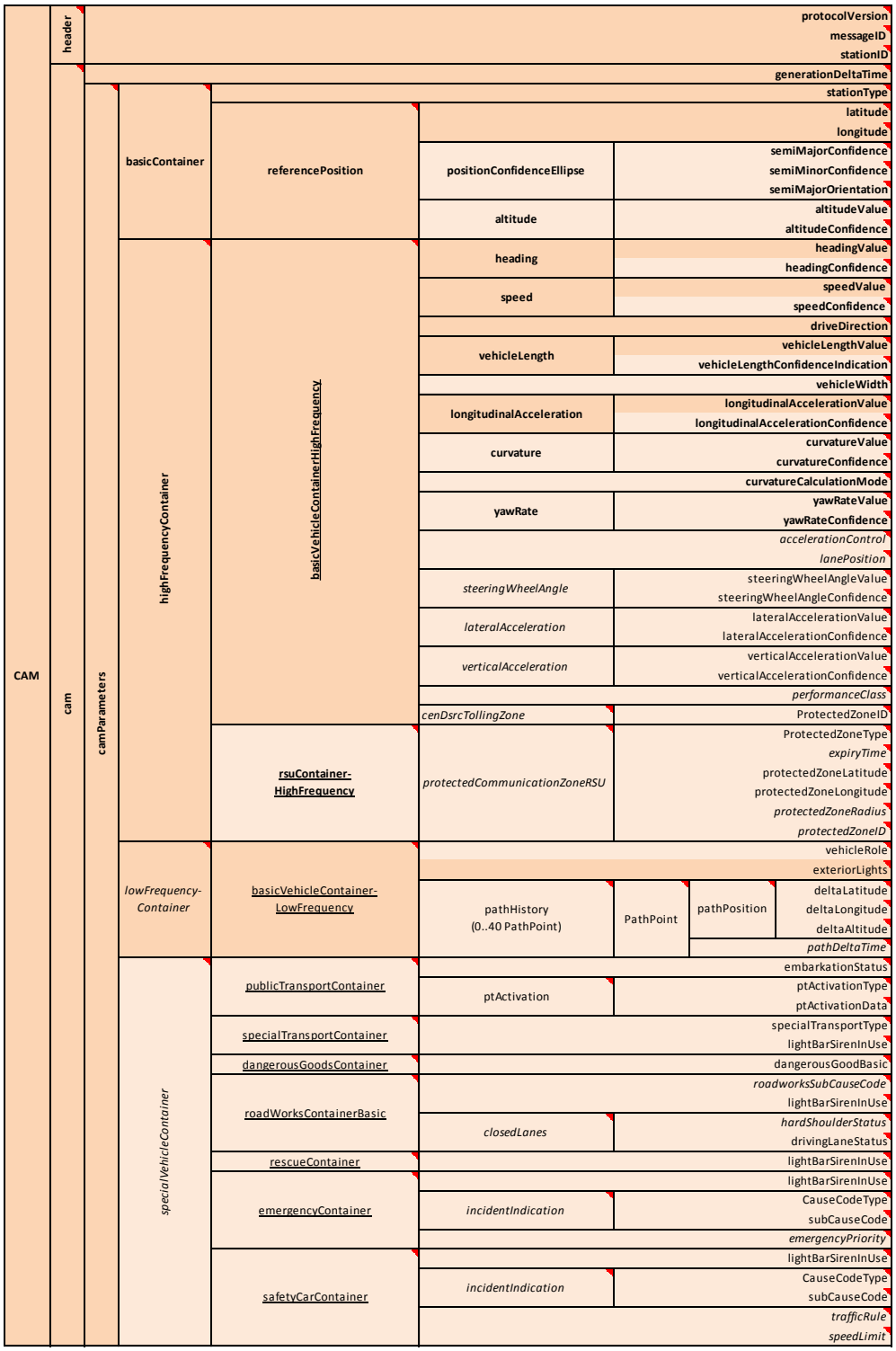
Annex C: RWW DENM Profile

DENM	header						protocolVersion		1
							messageID		1
							stationID		set by application
	denm	management	actionID				originatingStationID (stationID)		set by application
							sequenceNumber		set by application
							detectionTime		set by application
							referenceTime		set by application
							termination		set by application
			eventPosition				latitude		set by application
							longitude		set by application
				positionConfidenceEllipse			semiMajorConfidence		set by application
							semiMinorConfidence		set by application
							semiMajorOrientation		set by application
				altitude			altitudeValue		unavailable
							altitudeConfidence		
							relevanceDistance		4 or 5
							relevanceTrafficDirection		1
							validityDuration		720
							transmissionInterval		not used
							stationType		15
		situation					informationQuality		1-7
			eventType				causeCode		3
							subCauseCode / RoadworksSubCauseCode		3 or 4
			linkedCause				causeCode		not used
							subCauseCode		
			eventHistory (1..23 | 40 EventPoint)	EventPoint	eventPosition		deltaLatitude		not used
							deltaLongitude		
							deltaAltitude		
							eventDeltaTime		
							informationQuality		
		location	*eventSpeed*				speedValue		not used
							speedConfidence		
			eventPositionHeading				headingValue		not used
							headingConfidence		
			traces (1..7 PathHistory)	PathHistory (0..40 PathPoint)	PathPoint	pathPosition	deltaLatitude		set by application
							deltaLongitude		set by application
							deltaAltitude		set by application
							pathDeltaTime		not used
							roadType		not used
		alacarte					*lanePosition*		set by application
			impactReduction				heightLonCarrLeft		not used
							heightLonCarrRight		
							posLonCarrLeft		
							posLonCarrRight		
							positionOfPillars		
							posCentMass		
							wheelBaseVehicle		
							turningRadius		
							posFrontAx		
							positionOfOccupants		
							vehicleMass		
							requestResponseIndication		
							externalTemperature		not used
			roadWorks				*lightBarSirenInUse*		not used
				closedLanes			*hardShoulderStatus*		set by application
							drivingLaneStatus		set by application
				restriction (.. StationType)			StationType		not used
							speedLimit		set by application
				incidentIndication			causeCode		not used
							subCauseCode		
				recommendedPath	ItineraryPath (1..40 ReferencePosition)	ReferencePosition	latitude		not used
							longitude		
						positionConfidenceEllipse	semiMajorConfidence		
							semiMinorConfidence		
							semiMajorOrientation		
						altitude	altitudeValue		
							altitudeConfidence		
				startingPointSpeedLimit			deltaLatitude		set by application
							deltaLongitude		set by application
							deltaAltitude		set by application
							trafficFlowRule		2 or 3
				referenceDenms (0..8 ActionID)	ActionID		originatorStationID (stationID)		set by application
							sequenceNumber		set by application
							positioningSolution		not used
			stationaryVehicle				*stationarySince*		not used
							stationaryCause		
				carryingDangerousGoods			dangerousGoodsType		
							unNumber		
							elevatedTemperature		
							tunnelsRestricted		
							limitedQuantity		
							emergencyActionCode		
							phoneNumber		
							companyName		
							numberOfOccupants		
				vehicleIdentification			*wMInumber*		
							vDS		
							energyStorageType		

Annex D: IVS IVI Profile



Annex E: bPVD CAM Profile



Annex F: CRW DENM Profile