



Common set of functional and technical specifications for SCOOP

Deliverable 2.4.1

Activity 2: Studies

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- **R** corresponds to the release number: it is upgraded each time SC Studies validates the diffusion of a new release,
- **X** is the major version number: it is upgraded each time SC Studies validates the deliverable,
- **Y** is the minor version number: it is upgraded each time a contributor changes anything.

Once the deliverable is approved, its version number is upgraded from vR.XY to vR.(X+1)0

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As illustration:

0.03 > Work in progress version

0.10 > Del. Approved by SC Studies but not released

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2.05 > Del. Updated - in progress version

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1. Document presentation

1.1 Introduction

The general objective of the SCOOP project is to test the implementation conditions for the cooperative systems. The stakes of the project are as follows:

- Improve road safety
- Optimise the management and impact of traffic and road information
- Help reduce environmental pressures, especially greenhouse gas emissions
- Optimise the costs of managing the infrastructure and develop new services, including intermodal
- Help prepare the vehicles of tomorrow

It has been agreed to focus on use cases for which there is a body of standards that the consortium has deemed mature.

The specification needs for the SCOOP project result from this approach.

The first objective of this deliverable is to identify and present the specification needs of the SCOOP project. The detailed specifications for the SCOOP project will be presented in several deliverables.

This deliverable presents the specifications common to all specification deliverables that the other deliverables must refer to, and specifies the connection between the different specification deliverables.

1.2 Document objectives and summary

The objective of the document is to present the architecture of the SCOOP project's functional specifications. Based on key definitions described in the reference documents or standard documents, it involves:

- presenting the connections between the different SCOOP documents that deal with the specifications;
- presenting the SCOOP system by explaining the generic cases of data and information transmission used to characterise where the intelligence functions are located in the SCOOP chain, which amounts either to qualifying the information upon transmission (qualifying upon transmission or processing to requalify upon retransmission) or arbitration or prioritisation functions upon reception;
- proposing the specifications identified as reference (e.g., those that are inherent to the criteria and the rules for filling in the "containers" when messages are transmitted, including the definition of the default values (based on the state of the art, these default values may be subject later to more in-depth work);
- proposing common rules for prioritising the use cases displayed.

This document aims, with the other specification documents (concerning the prioritisation of services, the list of applicable standards for specifications and development, the R-

ITSS specifications, the SCOOP platform and the V-ITS-S) to make it possible for SCOOP to be developed based on the interoperability objectives.

This document presents in particular the consensuses that have emerged on the subjects covered in chapters 2 to 6:

- Chapter 2 presents a summary of the entire SCOOP system. It lists the use cases that will be allowed, the system components and their functions, the different types of messages and the architecture principles for the information flows.
- Chapter 3 covers the CAM (Cooperative Awareness Message) and DENM (Decentralized Environmental Notification Message) specifications. It addresses the nomenclature based on the transmitters and use cases, and explains the mandatory fields that have to be filled in and the optional ones.
- Chapter 4 addresses the message transmission conditions.
- Chapter 5 covers the major prioritisation principles for the display.
- Chapter 6 list the communication profiles.
- Chapter 7 presents Network and transport layer specifications.
- Chapter 8 deals with security questions.
- Chapter 9 presents the connection between specifications given in this deliverable and in those expected in other deliverables.

1.3 Document status

This deliverable may be subject to several successive versions validated based on Steering Committee decisions.

- An appendix of this deliverable will subsequently define:
 - the R-ITS-S service announcement messages, the methods of exchanging certificates for the PKI, the methods of reporting U-logs and T-logs data collection from C-ITS-S for evaluation or validation, as well as all detailed communication channels associated with these mechanisms.
 - the values of SCOOP DENM parameters that are not shown in this version of the deliverable
 - how the V-ITS-S U-logs and T-logs are reported will be specified in the appendix of this deliverable

2. Definition of the SCOOP system

2.1 List of SCOOP use cases

The purpose of the cooperative systems implemented in the SCOOP project is to enable communications between vehicles and a road infrastructure in order to produce the SCOOP use cases defined in the deliverable 2.2 General description of services in its version 0 of 17 December 2014 (Table 1).

Table 1: Use Cases list managed by Road Operators Platform

A1	Traffic data (position, speed, direction)	
A2	Collected Data from Road Hazard Signaling (crashes, etc.) Note: A2 translates the reported information by automatic triggering	A2-D1: warning - temporary slippery road A2-D4a: stationary vehicle A2-D4b: vehicle breakdown A2-D5: vehicle in accident A2-D6: reduced visibility A2-D10: warning - emergency brake A2-D11: warning - end of queue A2-E6: extreme weather conditions
A3	Collected Data from Road Hazard Signaling Note: A3 translates the information reported manually	A3-D2a: animal on the road A3-D2b: people on the road A3-D3: obstacle on the road A3-D5: accident A3-D8: unmanaged blockage of a road

Table 2: Use Cases list managed only by Road Operator

B1	Roadwork Warning - planned roadwork (stationary and mobile plus salting zone)	
B2	Roadwork Warning – road operator intervention	
B3	Roadwork Warning - winter maintenance	

Table 3: Use Cases list managed (reception and emission) by all Scoop@F C-ITS-S

D1	Road hazard Signalling - temporary slippery road	
D2	Road hazard Signalling - animal, people on the road	D2a: animal on the road D2b: pedestrian on the road
D3	Road hazard Signalling - obstacle on the road	

D4	Road hazard Signalling - stationary vehicles, breakdown	D4a: stationary vehicle D4b: vehicle breakdown
D5	Road hazard Signalling - unprotected accident area	
D6	Road hazard Signalling - reduced visibility	
D8	Road hazard Signalling - unmanaged blockage of a road	
D10	Road hazard Signalling - emergency brake	
D11	Road hazard Signalling - end of queue	
E6	Road hazard Signalling - exceptional weather conditions	

- These use cases are specified based on the body of standards presented in the deliverable L2.4.1.bis.

2.2 List of SCOOP system components

SCOOP system components shall designate all physical components that enable users to produce or exchange the messages necessary to produce the SCOOP use cases. They are listed in the table below with the SCOOP nomenclature.

The components underpinning the cooperative systems are the ITS stations as defined in the standard ETSI EN 302 665.

Table 4: SCOOP system components and SCOOP nomenclature

API	Application Programming Interface
C-ITS	Cooperative Intelligent Transport System "By cooperative systems, we mean (definition adopted by the EC, unit C.5 - ICT for "ICT for Transport and the Environment"): "Road operators, infrastructure, vehicles, their drivers and other road users will co-operate to deliver the most efficient, safe, secure and comfortable journeys"
C-ITS-S	Cooperative ITS Station
CAM	Cooperative Awareness Message provide information about the presence, positions and basic status of vehicles and road side units to the surrounding area
CAN bus	Controller Area Network BUS: Cabling inside a vehicle transmitting electronic data.
DATEX	Data Exchange A data exchange protocol, structured in a set of technical annexes, containing also a database of road traffic related events, standardized by the CEN under the number 16157.
DENM	Decentralized Environmental Notification Message, transmitted by a vehicle when it detects an event (see DENM standard)
GNSS	: Global navigation satellite system, system used for positioning and road segment identification
GPS	Global Positioning System : American GNSS
HMI	Human-Machine Interface: a front-end user interface.
ICPU	name for the basic part of a Vro-ITS-S
PF	French Interface Platform
PFro	Road Operator's Platform
PKI	Public Key Infrastructure
R-ITS-S	Roadside ITS Station: ITS station implemented in the road infrastructure
TLOGS	Records related to Technical data
ULOGS	Records related to User data
Vro-ITS-S	Road Operator Vehicle ITS station: It is, in SCOOP, an after-market Vru-ITS-S specialized for traffic operator.
Vru-ITS-S	an embedded ITS Station in a road user vehicle

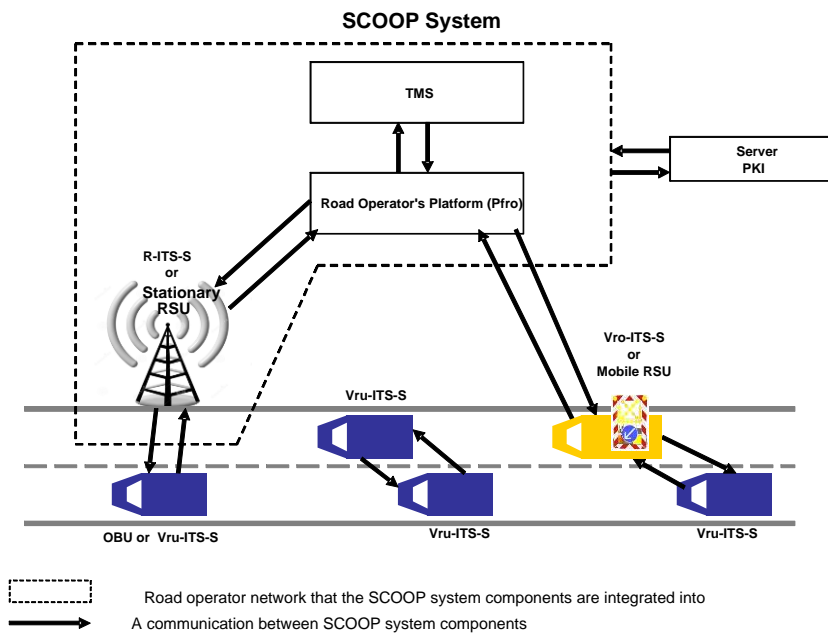


Figure 1: Diagram of the SCOOP system with the PKI

Roles of system components (excluding PKI)

The Road Operator's Platform, or PFro receives and processes information received from the management terminal or the road operator's traffic management system. It sends information to the operator's cooperative equipment (roadside stations or stations in the operators' vehicles), but does not communicate directly with the users' vehicles. It processes information received from the roadside stations and makes it available to the operator.

- The functional specifications for the SCOOP platform, PFro, are set out in the specification 2.4.3.2 (detailed specifications) deliverables.

The roadside stations, R-ITS-S, receive the information from the **PFro**, and broadcast them locally to user vehicles. They receive information and queries transmitted by vehicles, which are then processed (for storage, routing or sending). They send the event-based messages (i.e., all SCOOP use cases except A1) in a non-consolidated form to the PFro. They send the traffic information (A1 cases) to the platform after consolidating the data. They broadcast service announcement messages (see 2.4.3) through CAM-I (Cooperative Awareness Message -Infrastructure) message specified in 2.4.1.1.

- The R-ITS-Ss' technical specifications are described in the deliverable 2.4.2.1.

The vehicle embedded units, V-ITS-S are the ITS stations installed in users' vehicles (**Vru-ITS-S** or user **V-ITS-S**) or operators' vehicles (**Vro-ITS-S** or operator **V-ITS-S**), which are equipped with a human-machine interface (HMI). They are able to broadcast automatically and manually, via HMI, messages to other ITS stations. They receive information sent by other vehicles or roadside stations, process information for potential display to the driver via his HMI.

Vru-ITS-S cannot communicate (send and receive messages) directly with the **PFro** whereas the **Vro-ITS-S** can. The **Vro-ITS-S** include all the functionalities of the **Vru-ITS-S** plus the functionalities specific to the road operator ("operator" mode).

"mobile R-ITS-S" function designates an operator V-ITS-S function that sends to the platform the event-based messages (i.e., all SCOOP use cases except A1) transmitted by the users' vehicles or created by the operator V-ITS-S itself, like the R-ITS-S. On the other hand, the mobile R-ITS-S function does not send traffic information (A1 cases)

- The technical specifications concerning the **Vro-ITS-S** operation are described in the deliverable 2.4.2.2.
- **Human-machine interfaces (HMI)** connected to the V-ITS-S are used to display warning messages or to inform drivers. The **Vru-ITS-S** HMI are specific to each automobile manufacturer. They will be described in two SCOOP deliverables (2.4.2.3 Renault and 2.4.2.3 PSA) on HMI components developed by each manufacturer but they won't be considered as specification. The common display principles are nevertheless addressed further in this document.

View of the possible functional communication paths in the SCOOP system (without representing the PKI)

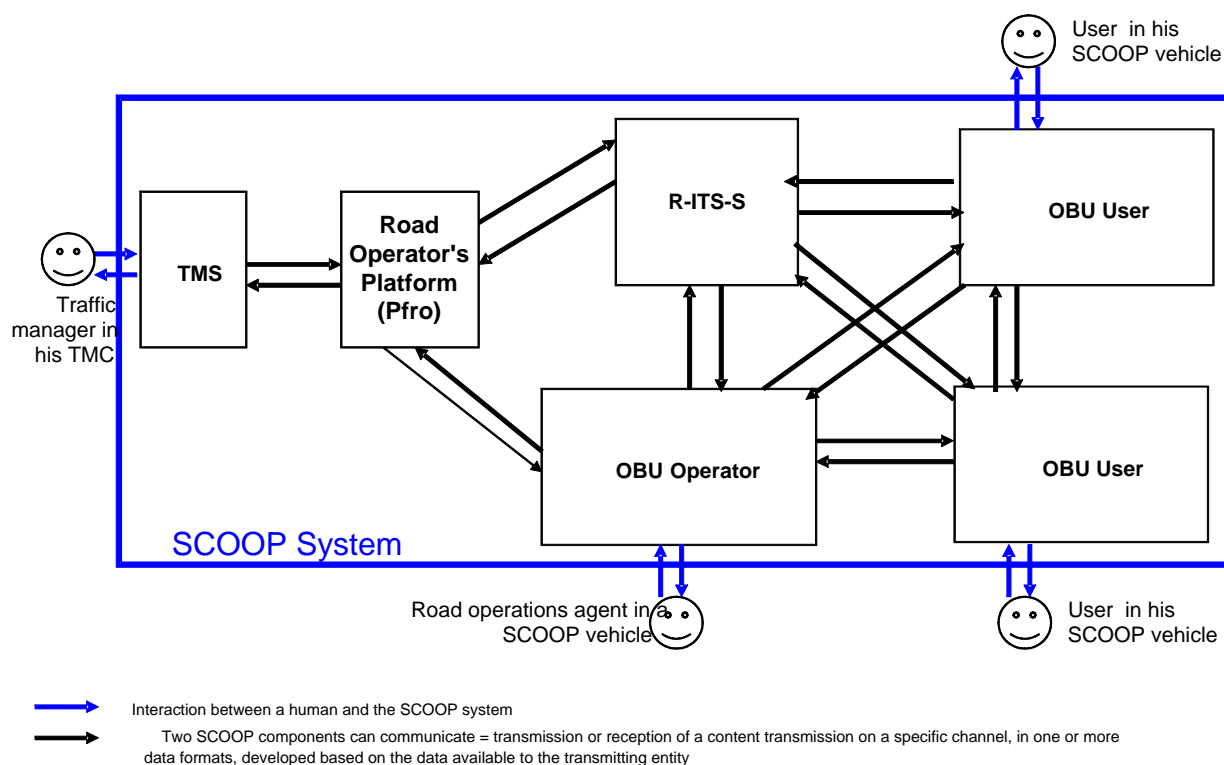


Figure 2: View of the functional communication channels for the SCOOP system (excluding PKI)

2.3 General architecture of an ITS station and list of related standards

The SCOOP ITS stations are based on an architecture defined by the European standardisation organisation, ETSI (European Telecommunications Standards Institute) in the standard EN 302 665. They include different layers.

- These different layers and technical aspects are described in the deliverables 2.4.2.1, 2.4.2.2 and 2.4.2.3.
- The application layer will only be addressed here and from a functional point of view.
- In the context of SCOOP, the standards considered as a minimal reference group to implement the V-ITS-S, R-ITS-S and PFro are described in the deliverable 2.4.1_bis.
- This deliverable specifies the choices related to the implementation of CAM and DENM considering the following version: **EN 302 637-2 v1.3.2. (2014-11)** and **EN 302 637-3 v1.2.2. (2014-11)**.

2.4 Types of messages exchanged in SCOOP

2.4.1 CAM (Cooperative awareness message) and DENM (decentralized environmental notification message)

The messages sent from V-ITS-S to the R-ITS-S or V-ITS-S are **CAM** and **DENM**. The messages sent from the R-ITS-S to V-ITS-S are **CAM-I** and **DENM**.

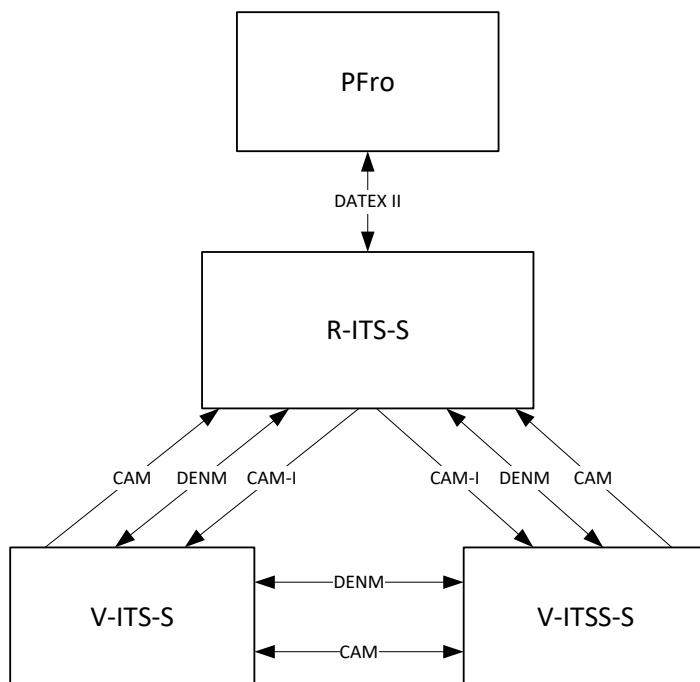


Figure 3: View of the types of messages exchanged in SCOOP

- The CAM messages sent by the R-ITSSs are called CAM-I messages and are detailed in the deliverable 2.4.1.1. Nevertheless, it should be noted that this message make it possible to use the following fields of the CAM standard:

Field name in the CAM standard	Additional description of the CAM standard	Mandatory field? (see definition § 3.2)	SCOOP choices	comments and
B.50 ProtectedCommunicationZonesRSU	Information about the position of a toll using the 5.8 GhZ frequency band. This information, broadcast by an R-ITSS, should make it possible for vehicles to adopt the toll's neighbourhood mitigation techniques.	O= <i>optional</i> in the standard and mandatory in SCOOP	CAMs transmitted by the R-ITSSs will use this field.	The filling for the R-ITSSs is left up to the discretion of each road operator and the V-ITSSs must be ready to interpret it in order to implement the reception mitigation techniques.

2.4.2 Messages related to scoop experimentation

Other **messages related to SCOOP experimentation** for assessment, supervision and validation needs are sent by the V-ITS-S and R-ITS-S: these are the U-logs and T-logs (data for users' evaluation and data for technical evaluation).

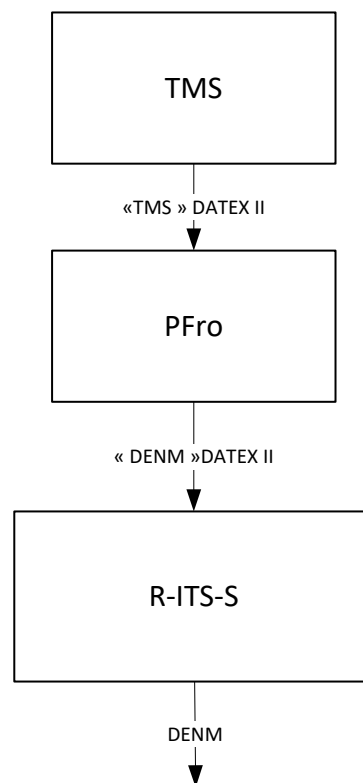
The specifications of U-Logs and T-Logs are defined in deliverable 2.4.1.3. They result from studies related to their different uses:

- The use of the **U-logs and T-logs for evaluation needs** is covered in the deliverable 2.3.1.1.
- The use of **system component supervision needs** is covered in the deliverables for the 2.4.2.1 components for the R-ITS-S, 2.4.2.2 for the operator V-ITS-S, 2.4.2.3 Renault and PSA for the user V-ITS-S.
- The use of the **U-logs and T-logs for validation needs** is covered in the deliverable 2.6.1.
- How the V-ITS-S U-logs and T-logs are reported will be specified in the deliverable 2.4.1.1.

2.4.3 DATEX II V2.3 messages

The messages transmitted by the Road Operator's Platform (PFro) to the R-ITS-S are sent thanks to DATEX II V2.3. The R-ITS-S translate the DATEX II V2.3 messages into DENM to broadcast them to the V-ITS-S. The DENM translation to DATEX II V2.3 is not translated field by field in the DENM. Moreover, it should be verified that chosen container can be translated into DATEX II V2.3.

The PFro receive the DATEX II message from the TMS, in order to not modify the existing DATEX II message send by the TMS, the PFro have to adapte it.



- A DATEX II V2.3 – CAM DENM dictionary is specified in the deliverable 2.4.1.4 based on the CAM and DENM defined in this deliverable.

2.5 Principles for the system architecture

2.5.1 Transmission, reception, processing and relay

The cooperative message broadcast logic distinguishes 3 steps:

- Transmission of a message;
- Reception of a message;
- How to process a message received.

Once received, cooperative messages can be forwarded.

2.5.2 Definition principles for scoop

The architecture principles for SCOOP can be stated as follows:

- Transmitters are responsible for qualifying the information upon transmission.
- Transmitter qualifies the information independently of the processes that will then be performed by the receiving entities.
- Rules for qualifying the information are shared between all SCOOP partners at a level that enables the same level of understanding.
- Major principles regarding the prioritisation between displayed uses cases have been established between the partners.
- Each receiving entity is responsible for processing and displaying the information.

2.5.3 Communication principles between system components

Two types of transmitted messages will be differentiated:

- Transmitted messages are intended to be broadcast in a relevant geographic zone and do not identify the receiver in advance (every ITS station travelling in the geographic zone is likely to be a receiver of the message). This is the broadcast mode that can be assigned to a precise or undefined geographic zone.
- Transmitted messages are addressed to a pre-identified recipient. This is the "unicast" mode (point-to-point).
- The table specifies the message transmission modes by transmitter-receiver pair.

Table 3: Transmission mode for messages

RECEIVER TRANSMITTER	R-ITS-S	Operator V-ITSS (operator mode and user mode)	Renault user V-ITSS	PSA user V-ITSS	PFro	TMS	PKI servers
R-ITS-S	/	D_denm D_cam-i	D_denm D_cam-i	D_denm D_cam-i	A	/	A (via operator network)
Vro-ITSS	D_denm D_cam	D_denm D_cam	D_denm D_cam	D_denm D_cam	A	/	A (via operator network)
Vru-ITS-S	D_denm D_cam	D_denm D_cam	D_denm D_cam	D_denm D_cam	/	/	A
PFro	A	A			/	A	
TMS	/	/	/	/	A	/	/
PKI servers	A	A (via operator network)	A	A	/		

[A]=Addressing: transmitted messages that are addressed to one or more pre-identified receiver

[D_denm] = Geographic broadcasting: transmitted messages are broadcast in a relevant geographic zone and do not identify the receiver in advance (DENM logic)

[D_cam] = General broadcasting: transmitted message is intended to be received by every ITS station in the ad-hoc network (CAM logic)

- This table is valid for use cases covered in this document and does not foresee any changes made necessary by the inclusion of other use cases.

2.5.4 Transmission

2.5.4.1 CAM and DENM information flows related to scoop use cases

The information flow transmission is defined for SCOOP use cases. There are 3 message creation logics :

- 1. **Creation and broadcast logic for a DENM or CAM = message created by an Vru-ITS-S** (automatically ou manually); message broadcasted; message received by an V-ITS-S or an R-ITS-S; and message processed by the V-ITS-S or R-ITS-S

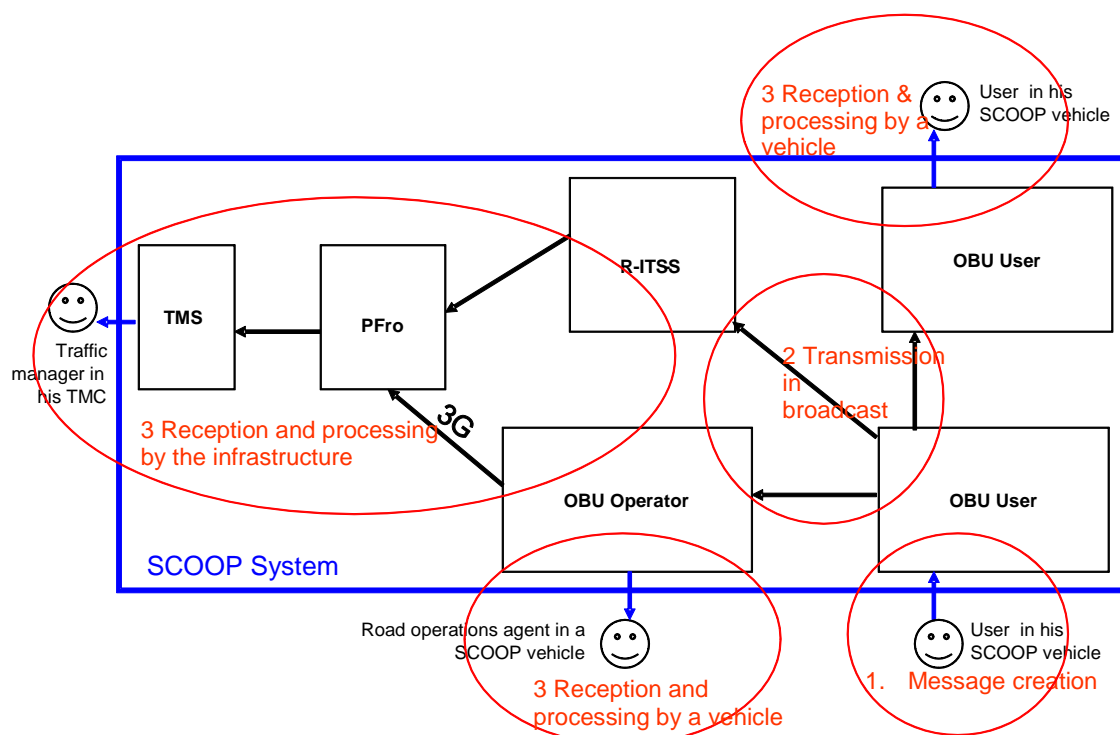


Figure 4: Creation of a message by a Vru-ITS-S

NOTE: same logic for a message transmitted by a Vro-ITS-S in "user" mode

- 2. **Creation of Vro-ITS-S message**, broadcast and reception by V-ITS-S or R-ITS-S. Messages are processed by the V-ITS-S or R-ITS-S.

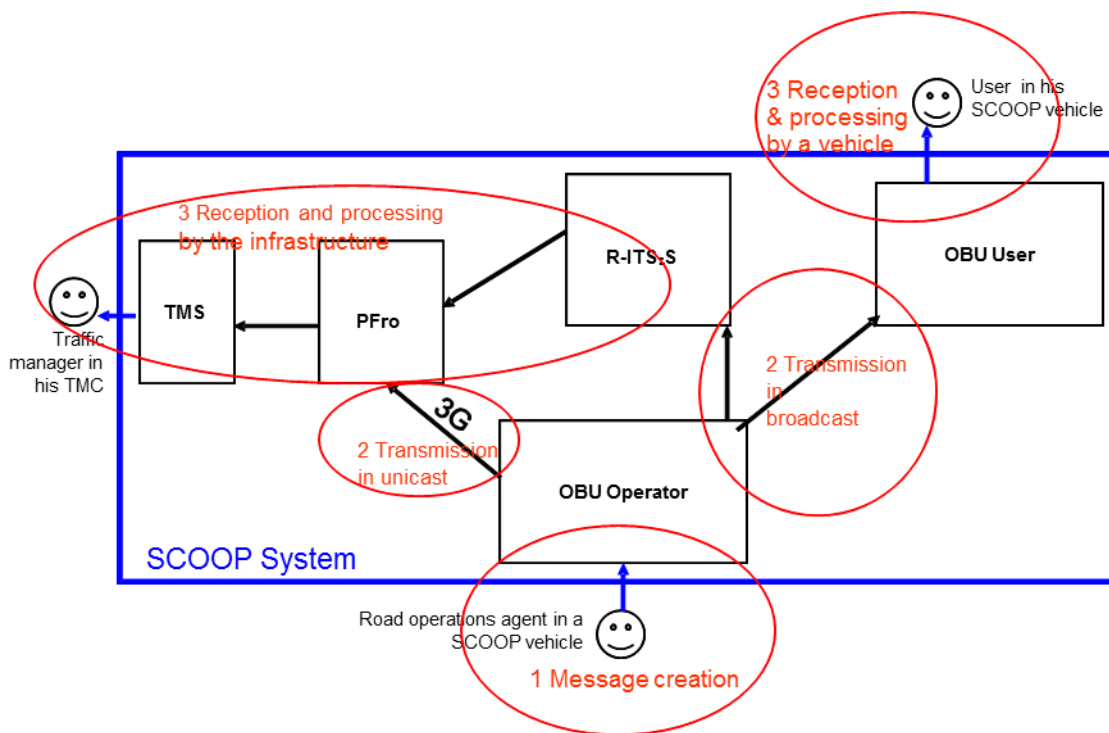


Figure 5: Creation of a message by a Vro-ITS-S

NOTE: same logic for a message transmitted by Vro-ITS-S in "operator" mode

- **3. Message created by the operator via itsTMS:** the TMS transmits the message to the SCOOP platform; the platform identifies the relevant R-ITS-Ss and transmits the message for broadcasting; the R-ITS-S broadcast the message; message received by a V-ITS-S; message processed by the V-ITS-S (broadcast logic for a DENM from theTMS).

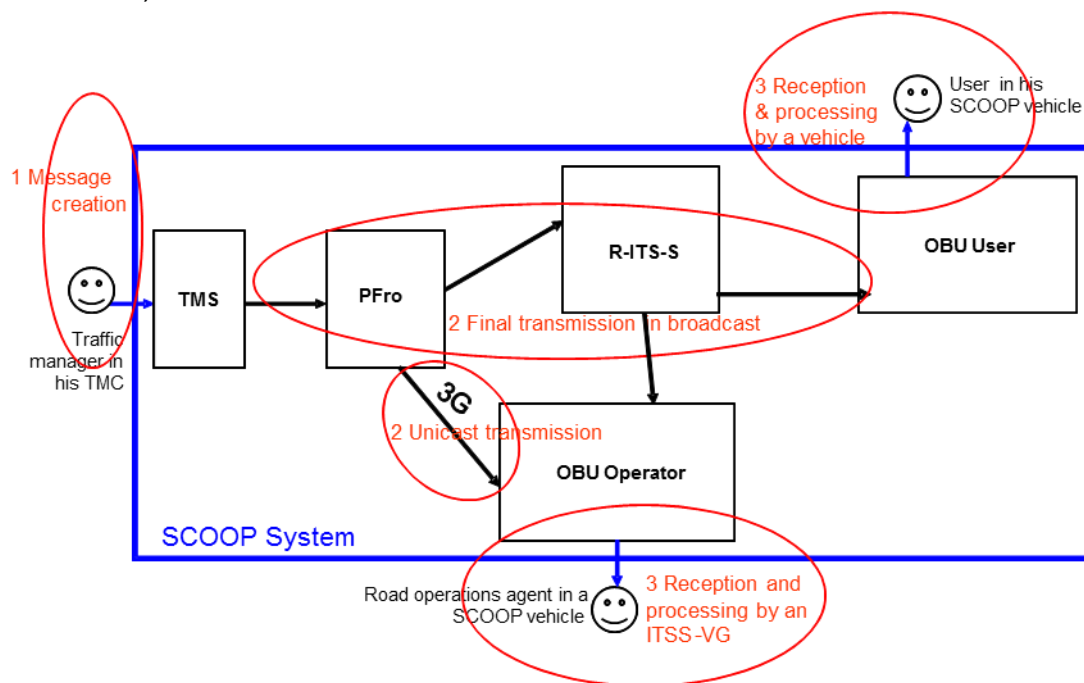


Figure 6: Creation of a message by the road operator via the TMS

2.5.5 Broadcast for service announcements by a R-ITS-S

Service announcement by a R-ITS-S allows to initiate routing actions or to announce tolls.

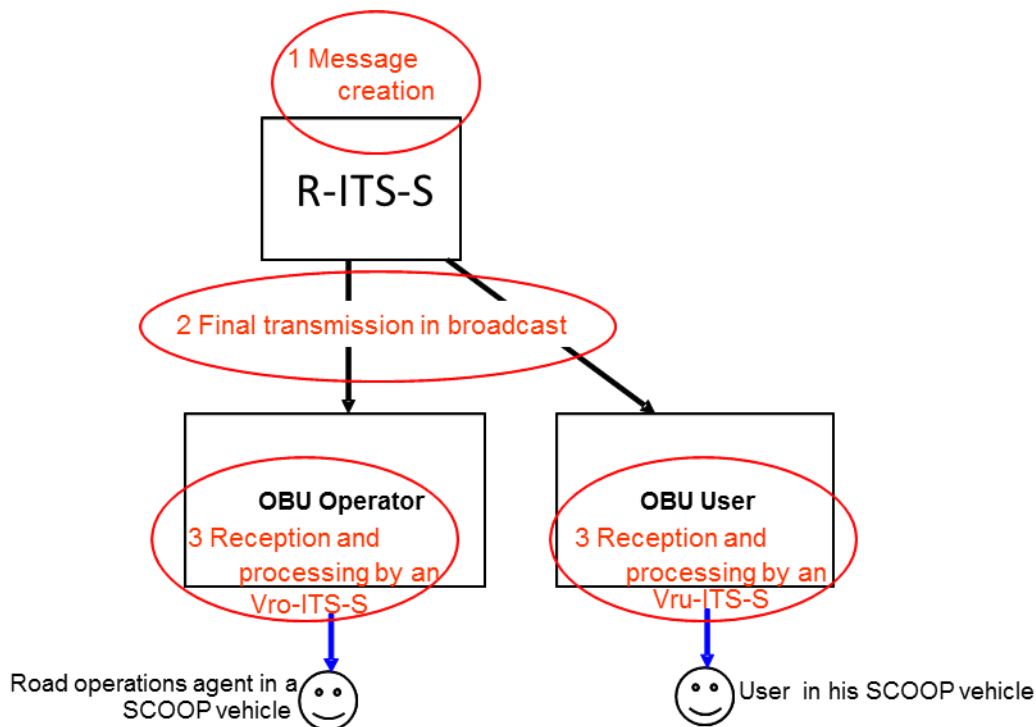


Figure 7: Service Announcement by a R-ITS-S

- This subject is detailed in the deliverable 2.4.1.1.

2.5.6 Routing and downloading process by an R-ITS-S: LOG and PKI request

- This subject is detailed in the deliverable 2.4.1.1.

2.6 General SCOOP technical choices

- DENMs can be sent by manual or automatic triggering. Initially, it had been planned to allow the user to use an "ATTENTION" (= warning) button to report events the user considers dangerous that aren't considered as SCOOP manually triggered use cases. The information will then be qualified by the road operator. This option was abandoned in light of the following harmful and undesired effects:
 - The users could use this option to report the presence of police or radar,
 - This simplification button could be used intensively to report a range of events, by ease/economy.
- The U-logs and T-logs are sent to the R-ITS-S which forward them in appropriate repositories for storage based on methods that can be configured by each road operator.
- The R-ITS-S transmit general broadcast messages in order to announce the available services (routing capability)
- The SCOOP use cases are not based on the communications between R-ITS-S.
- The SCOOP platform receives and sends messages in DATEX II V2.3.
- The SCOOP project doesn't impose cartography in the Vru-ITS-S nor in the R-ITS-S.
- The SCOOP wave 1 does not consider hybridation, even if the operator is equipped with cellular and G5. The messages sent by the operator vehicles to the platform do not go through the R-ITS-S, but are sent directly via cellular (operator vehicle's position message, PKI requests, U-Log and T-log). The Vro-ITS-S in "mobile R-ITS-S" function send messages in DATEX II V2.3 via cellular to the Road Operator's Platform. On the other hand, CAM and DENM messages are sent via ITS G5. User vehicles do not have cellular; therefore, messages sent to the PKI or log servers will go through R-ITS-S (in real time routing for the PKI and in batch mode for U-logs and T-logs).
- Messages are sent in IPv6 when it is technically possible:
 - Messages sent by the V-ITS-S in G5 are in IPv6.
 - Messages sent by the R-ITS-S in G5 are in IPv6.
 - Messages sent by the Vro-ITS-S via cellular are in IPV4 for the SCOOP wave 1 and will be in IPv6 for wave 2.

This implies that the SCOOP components must be able to support IPv6, potentially encapsulated in IPv4.

3. CAM and DENM

3.1 General concept of CAM and DENM

Two main types of cooperative messages are used to realize SCOOP use cases: the CAM (Cooperative Awareness Message) and DENM (Decentralized Environmental Notification Message). They are explained by standards defined in §2.3.

CAM are intended to activate the cooperative awareness (i.e., locate in real time the vehicles or cooperative infrastructure and signal the position and state of the vehicles). CAM are transmitted regularly by the V-ITS-S and all of the C-ITS-S within range can receive and process them.

DENM are warning messages intended to be broadcast in a geographic zone. They are only transmitted during an unexpected event. They are triggered automatically (involving different sensors on the vehicle) or can result from a (driver's or operator's) manual action via a HMI embedded in the vehicle.

These messages can also be transmitted by the R-ITS-Ss to broadcast information from the operator, generally coming from a TMS.

CAM architecture is described in Figure 8 and Figure 9. It is composed by mandatory data (ITS PDU header, Basic container containing in particular the ID and the last geographic positions of the ITS station as well as the High Frequency (HF) container containing the vehicle's fast-changing data) and conditional data, which should be specified based on the message's sender.

A header followed by a set of containers including different sets of unitary fields to be filled defines DENM (Figure 10).

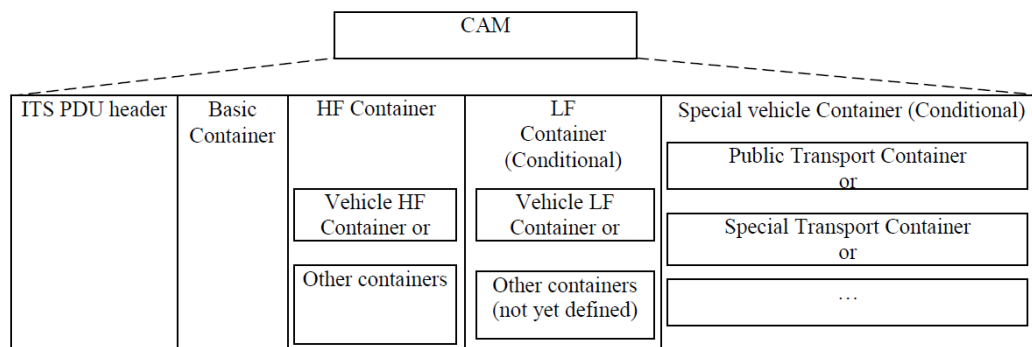


Figure 8: structure of a CAM

The structure of secure messages (Figure 9) sent in SCOOP is presented in the deliverable 2.4.4.6_bis.

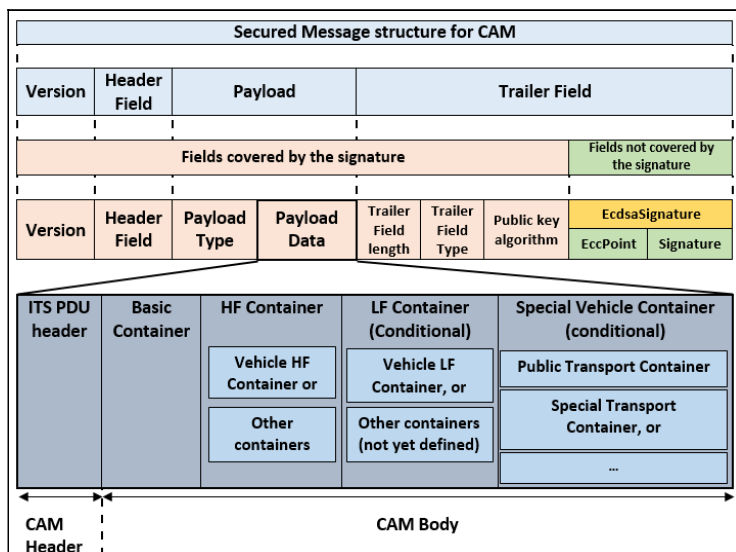


Figure 9: Secure CAM

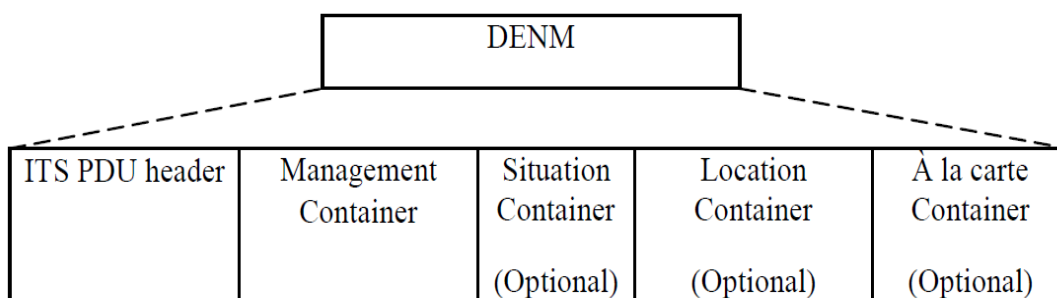


Figure 10: Structure of a DENM

3.1.1 Processing of CAM and DENM for data collection

The V-ITSS regularly transmit CAM data. The R-ITS-S consolidate CAM messages to construct the traffic data (e.g., average speed), which are then sent in DATEX II V2.3 to the SCOP platform.

The R-ITS-S do not consolidate the DENM. There is no prioritisation between the DENMs to be processed by an R-ITS-S: all DENMs are translated individually in DATEX II V2.3 and sent to the PFro, which consolidates them and makes them available to the TMS.

The DENM messages transmitted by a Vro-ITS-S in "mobile R-ITS-S" mode, which are broadcasted to the V-ITS-S, are systematically translated in DATEX II V2.3 and sent individually to the SCOP platform.

3.1.2 Communication profile for CAMs and DENMS

Table 5: Communication profile

Sender: V-ITS-S, R-ITS-S Addressing mode: Geographic broadcast	Receiver: Any ITS station in the defined geographic zone	Content transmitted DENM messages created or relayed	Access layer G5= 802.11p Channel CCH	Application protocol DENM No. of related port Port 2002	Network transport BTP Geonet
Sender: V-ITS-S Addressing mode: General broadcast	Receiver: Any ITS station in the ad-hoc local network	Content transmitted CAM messages created	Access layer G5= 802.11p Channel CCH	Application protocol CAM No. of related port Port 2001	Network transport BTP Geonet
Sender: Vro-ITS-S in operator mode Addressing mode: Addressing without routing by an R-ITS-S	Receiver: platform	Content transmitted Position of the road operator vehicle and DENM messages created	Access layer cellular 3G/4G Channel 3G/4G	Application protocol DatexIIv2 in HTTP	Network transport TCP/IPv4

- The other communication channels specific to the PKI, to the R-ITSs' service announcement messages and to the U-log and T-log exchanges will be covered later in the deliverable 2.4.1.1.
- The communication profiles between the R-ITS-S and the platform, which only require a consensus between operators, will be covered on other deliverables.

3.2 Specification needs related to the CAM and DENM architecture

3.2.1 Choice of fields to fill in and how to fill them in

The fields defined in the CAM and DENM standards are either:

- *mandatory* (i.e., mandatory fields that the transmitting entity must fill in)
- *optional* (i.e. fields that don't have to be filled in)

The non-mandatory character concerns the existence of the field in the messages to transmit.

It has been decided to define the notion of "mandatory" field for SCOOP based on the written definition of *mandatory* in the CAM standard:

A *mandatory* field is a field that must absolutely exist in a message transmitted with a value other than (0) (i.e., *unavailable*) when the information exists and is available.

- All of the *mandatory* fields in CAM and DENM standards are considered as mandatory for SCOOP and this deliverable may specify how to fill them in.
- All of the *optional* fields in the CAM and DENM standards listed in this deliverable (see §3.2.2 and § 3.2.3) have to be filled in if the information exists and this deliverable may specify how to fill them in. These fields are essential for the SCOOP project. In terms of ASN.1 specification, these fields are always listed as optional as specified in the standard.
- All of the *optional* fields in the CAM and DENM standards that are not listed in this deliverable (see §3.2.2 and § 3.2.3) remain non-mandatory for SCOOP.

If the information is not available, an essential field for SCOOP (that might be optional in the standard) can be filled in with "unavailable" if the value "unavailable" exist in the standard, but the field can also not be encoded in the ASN-1.

NOTE: The fields of the CAM or DENM standards, which specifically concern the information presented on the CAN bus of vehicles cannot be supplied by the ITS stations not connected to the vehicle's CAN bus.

Consequently, the components concerning the transmission of messages subject to a SCOOP choice are relative to:

- The choice of the fields to report among the non-mandatory fields to realize the use cases
- Potentially, the precise definition of the content of each field.

Nota: Timestamps

As a reminder, here how the timestamp_{ITS} should be computed within the ITS stations:

$$\text{Timestamp}_{ITS} = \text{UTC_Time_system} - \text{UTC_Time_startof2004} + \text{leap_seconds_since2004}$$

The UTC_Time_system and the way to update the leap seconds (GNSS update, manual configuration, etc.) are under the provider responsibility.

However, since some systems cannot update the leap seconds during the project, if a control is implemented on the timestamps for the received messages, it is required to have a 3'' tolerance for CAM messages and a 60'' tolerance for DENM messages.

As a reminder, the timestamps of Datex II messages do not take into account the computation of leap seconds. Hence, when receiving a Datex II from the SCOOP platform, ITSS-R (and mobile ITSS-R) must ensure the conversion between the timestamps as well (see deliverables 2.4.1.4 and 2.4.2.1).

Table 6: CAM definition: ITS PDU Header

ITS PDU HEADER			
Field No. and name (as in the annex of the CAM standard)	Description (See complete definition in appendix annex B of the standard)	Mandatory (M) Optional (O) in the standard ¹	SCOOOP comments and choices
B.1 Header	CAM header that includes the following information: <ul style="list-style-type: none"> the version of the communication protocol the type of message (CAM), the ID of the CAM transmitter (station ID) 	M	For all CAM messages transmitted (Vru-ITS-S and Vro-ITS-S): protocolVersion = (1) messageID = (2) stationID= INTEGER (0.4294967295) <ul style="list-style-type: none"> stationID is computed from the pseudonym certificate, see Deliverable L2.4.4.8
B.3 GenerationDeltaTime	Generation time of the CAM	M	

Table 7: CAM definition: Basic container

BASIC CONTAINER			
Field No. and name (as in the annex of the CAM standard)	Description (See complete definition in annex B of the standard)	Mandatory (M) Optional (O) in the standard ²	SCOOOP comments and choices
B.18 StationType	Type of station NOTE: According to ETSI TS 102 894-2: unknown (0), pedestrian (1), cyclist (2), moped (3), motorcycle (4), passengerCar (5), bus (6), lightTruck (7), heavyTruck (8), trailer (9), specialVehicles (10), tram (11), roadSideUnit (15)	M	The Vru-ITS-S should use the code (5). The Vro-ITS-S should use: code (5) in user mode; in operator mode: (9) if FLR and (10) for all other operator vehicles
B.19 Reference Position	Vehicle's position and related precision. This measurement is made on the temporal basis of B.3 GenerationDeltaTime The position is the position of the front central point of the front bumper. The precision, obtained based on a PositionEllipse Confidence, should be 95% Failing this, it is declared unavailable. It is defined based on two ellipse axes: * a North-South axis * an East-West axis	M	

¹ Optional but to fill in for SCOOOP if the data exist.

² Optional but to fill in for SCOOOP if the data exist.

Table 8: CAM definition: High frequency container

HIGH FREQUENCY CONTAINER				
Field No. and name (as in the annex of the CAM standard)	Description (See complete definition in annex B of the standard)	Mandatory (M) Optional (O) in the standard ³	SCOOP choices	comments and
B.21 Heading	Vehicle's orientation vis-à-vis North and precision of the orientation value provided. This precision should be reliable at 95%. Failing this, the precision is declared unavailable.	M		
B.22 Speed	Vehicle's speed and precision of the speed value. This precision should be reliable at 95%. Failing this, the precision is declared unavailable.	M	This information will be aggregated by the R-ITS-S	
B.25 DriveDirection	Vehicle's direction of motion: frontwards or backwards	M		
B.35 VehicleLength	Length of the vehicle and related precision: * the length of the vehicle includes the accessories like a trailer * the precision covers the detection of an accessory like a trailer and the knowledge of its length	M	This information will be aggregated by the R-ITS-S. The Vro-ITS-S will indicate the maximum possible for length. This information can be tuned if it's possible to detect accessories like trailer.	
B.36 Vehicle Width	Vehicle's overall width (including the side view mirrors)	M	This information will be consolidated by the R-ITS-S. The Vro-ITS-S will indicate the maximum possible for width.	
B.26 Longitudinal Acceleration	Vehicle's longitudinal acceleration at the vehicle's centre of gravity when empty. This data also includes the precision of the acceleration value, which should be reliable at 95%. Failing this, it is declared unavailable.	M	This information is not necessarily available for all Vro-ITS-S (without connection to the CAN bus)	
B.31 Curvature	Curvature followed by the vehicle and direction of this curvature (left/right) This data also includes the precision of the curvature value, which should be reliable at 95%.	M	This information is not necessarily available for all Vro-ITS-S (without connection to the CAN bus)	
B.32 CurvatureCalculationMode	Precision of the consideration of the yawrate in the curvature calculation. Failing this, the precision is declared unavailable.	M	This information is not necessarily available for all Vro-ITS-S (without connection to the CAN bus)	
B.33 YawRate	Yawrate: characterises the vehicle's speed of rotation around its centre of gravity when empty: • negative value if rotation is clockwise (as seen from above) • positive value if rotation is counter clockwise (as seen from above) This data also includes the precision of the yawrate, which should be reliable at 95%. Failing this, the precision is declared unavailable.	M	This information is not necessarily available for all Vro-ITS-S (without connection to the CAN bus)	

³ Optional but to fill in for SCOOP if the data exist.

LOW FREQUENCY CONTAINER			
Field No. and name (as in the annex of the CAM standard)	Description (See complete definition in annex B of the standard)	Mandatory (M) Optional (O) in the standard ⁴	SCOOP comments and choices
B.23 VehicleRole	<p>Role of the vehicle transmitting the CAM message. This field is numbered. NOTE: According to ETSI TS 894 V2 V1.2.1:</p> <ul style="list-style-type: none"> • default(0), • publicTransport(1), • specialTransport(2), • dangerousGoods(3), • roadWork(4), • rescue(5), • emergency(6), • safetyCar(7), • agriculture(8), • commercial(9), • military(10), • roadOperator(11), • taxi(12), • reserved for future usage (13,14,15) <p>The use of codes (1) to (7) requires the use of mandatory fields that have to be filled in.</p>	O	<p>The Vru-ITS-S should use by default the value (0). The Vro-ITS-S should use the values (0) in user mode and (11) in operator mode.</p>
B.37 ExteriorLights	Activation status of the main exterior lights	O	<p>This will enable operators to refine the reasons for a warning (e.g., reduced visibility). In the context of an impact study, this will make it possible to determine which driver behaviour the warning message provokes (see deliverable L231). This information is not necessarily available for all Vro-ITS-S (without connection to the CAN bus)</p>
B.38 PathHistory	History of the latest movements over a given time or distance. This history involves a list of points (up to 23 points), whose generation/coding should comply with the standard SAE J2735.	O	<p>Exchanges with the ITS corridor:</p> <ul style="list-style-type: none"> • The manufacturers rely on a maximum of 40 tracking points with a distance of 22.5 m between the points • After a pseudonym change, path history has to be deleted. • The operators can use different variables • Path History implementation is based on the Design Method One specified in CAMP 811492B - Vehicle Safety Communications – Applications (VSC-A), Final Report: annex Volume 1 - System Design and Objective Test, September 2011, annex B-2, while taking into account the following parameters: $K_PHALLOWABLEERROR_M = 0.47 \text{ m}$, where $PH_ActualError < K_PHALLOWABLEERROR_M$ <ul style="list-style-type: none"> • Maximum distance between concise path points, $K_PH_CHORDLENGTHTHRESHOLD = 22.5 \text{ m}$ • $K_PH_MAXESTIMATEDRADIUS = REarthMeridian$ • $K_PHSMALLDELTA_PHI_R = 1 \text{ degree}$ • $REarthMeridian = 6378.137 \text{ km}$

⁴ Optional but to fill in for SCOOP if the data exist.

3.2.2 Denm fields for SCOOP

All of the fields listed in this table are essential for SCOOP project and must be filled in if the information exists by the Vru-ITS-S, the Vro-ITS-S and the R-ITS-S.

Table 9: DENM definition : Header

LOW FREQUENCY CONTAINER			
Field No. and name (as in the annex of the DENM standard)	Description (See complete definition in annex B of the standard)	Mandatory (M) Optional (O) in the standard ⁵	SCOOP comments and choices
B.1 Header	DENM header that includes the following information: <ul style="list-style-type: none"> the version of the communication protocol the type of message (DENM), the ID of the DENM transmitter (station ID) 	M	protocolVersion = (1) messageID = (1) stationID = computed from the pseudonym certificate, see Deliverable L2.4.4.8

Table 10: DENM definition : Management container

MANAGEMENT CONTAINER			
Field No. and name (as in the annex of the DENM standard)	Description (See complete definition in annex B of the standard)	Mandatory (M) Optional (O) in the standard ⁶	SCOOP comments and choices
B.7 ActionID	ActionID is given by : <ul style="list-style-type: none"> The identifier of the transmitting ITS station (whole number between 0 and 4294967295), sequential number attributed by the transmitting station (whole number between 0 and 65535) Each terminal (V-ITSS, R-ITSS, C-ITSS) increments each new event it detects. Once the maximum number of events is reached (65535) or at a new start-up of the station, the event numbering starts over at a random value different from 0. When sending an update of an already reported event, the DENM sent takes the same ActionID number as the actionID of the initial DENM report for the event. The new reported DENM is then considered as an update of the DENM initially sent and carries the same Action ID. When cancelling or deleting an already reported event, the DENM sent takes the same ActionID number as the actionID of the initial DENM report for the event. Then the new DENM reports that the event reported initially is terminated.	M	For R-ITS-S, the actionID is computed using the identifier of the SCOOP platform. See L.2.4.1.4.

⁵ Optional but to fill in for SCOOP if the data exist.

⁶ Optional but to fill in for SCOOP if the data exist.

B.11 DetectionTime	<p>Instant when the reported event in the DENM:</p> <ul style="list-style-type: none"> • is detected, in the case of a new event, • is updated for V-ITS-S • is terminated, in the case of the end of an event. <p>* in the case of a repeated message, this time remains the same as the time included in the first message (detection)</p>	M	<p>There is no required way in the standard to fill in <i>detectionTime</i>. The ITS stations' application fills in this field. Consequently, it has to be specified for SCOOP.</p> <p>The detectionTime field is different than the time when a message is transmitted/generated (<i>referenceTime</i>).</p> <p>For SCOOP, it is proposed by default that the detectionTime corresponds to:</p> <ul style="list-style-type: none"> • when the triggering conditions are fulfilled for automatic or automated triggering, • when the user activates a manually triggered report via the embedded HMI, • the beginning of the event estimated by the TMC when the DENM is from the TMC
B.37 ReferenceTime	<p>Instant when a new message, updated message or termination message is transmitted/generated.</p>	M	<p>Different from detectionTime.</p>
B.50 Termination	<p>The message indicates that it is "Cancelation" or "Negation" of a previously sent message (the message carries the same ActionID as the message it terminates).</p> <p>NOTE :</p> <ul style="list-style-type: none"> • This information is optional • This message should be kept in memory by the transmitter 	O	<p>The Vru-ITS-S, Vro-ITS-S, C-ITSS or R-ITS-S can fill it in with a value other than (0) depending on the use cases.</p> <p>Depending on the use cases, a vehicle (or an R-ITS-S) can cancel a DENM that it has transmitted itself.</p> <ul style="list-style-type: none"> • <i>It has been decided in SCOOP that the SCOOP ITS stations do not have the right to negate the DENMs transmitted by another ITS station.</i> <p>The termination message is sent with the same Interval repetition, repetition duration until the validityduration as the message it terminates.</p> <p>Triggering conditions are described in 2412.</p>
B.14 EventPosition	<p>Event's geographic position</p> <p>The DENM standard specifies that when the event's position corresponds to a position of the vehicle transmitting the DENM message, then eventPosition corresponds to the vehicle's position when the event is detected and entered in the mandatory detectionTime field.</p>	M	<p>For the DENMs that are activated manually, it is considered that the eventPosition corresponds by default to the vehicle's position when the user activates the function via the HMI</p> <ul style="list-style-type: none"> • It has been decided that initially there won't be any algorithms designed to recalculate the event position reported manually by a user in SCOOP wave 1.
B.39 Relevance- TrafficDirection	<p>Traffic direction where event information is relevant for the receiver</p> <p>This field is numbered:</p> <ul style="list-style-type: none"> • allTrafficDirections(0), • upstreamTraffic(1), • downstreamTraffic(2), • oppositeTraffic(3) 	O	<p>Filling in this field for SCOOP is detailed by use case.</p> <p>See chapter 3.2.6 for details.</p>
B.55 ValidityDuration	<p>Estimation of the event's validity duration</p> <p>If the event lasts beyond the duration initially estimated, the original transmitter transmits the message again while</p>	O	<p>The filling in of this field for SCOOP is detailed by use case, otherwise the default value is DefaultValidity (see DENM field defined in B.10).</p>

	<p>updating the estimate of the remaining duration.</p> <p>If the validity duration of the event cannot be estimated, a default value shall be entered.</p> <p>If not entered, the default validity duration of a DENM message is DefaultValidity.</p>		When an update is sent, the remaining time to validity duration is reset.
B.49 StationType	<p>Type of transmitting station</p> <p>NOTE: According to ETSI TS 102 894-2: unknown (0), pedestrian (1), cyclist (2), moped (3), motorcycle (4), passengerCar (5), bus (6), lightTruck (7), heavyTruck (8), trailer (9), specialVehicles (10), tram (11), roadSideUnit (15)</p>	O	The Vru-ITS-S use (5); the Vro-ITS-S use (5) in user mode, (10) in "operator" mode (potentially (9)) or (15) in "operator" mode and "mobile R-ITS-S" function; the R-ITS-S use (15)

Table 11: DENM definition : Situation container

Situation container			
Field No. and name (as in the annex of the DENM standard)	See definition in annex B of the corresponding standard	Mandatory (M) Optional (O) in the standard ⁷	SCOOP comments and choices
B.23 InformationQuality	SCOOP uses a different definition than the definition of the Amsterdam group. This involves the quality level of the information transmitted taking into account the probability that the event exists in the location indicated.	M	<ul style="list-style-type: none"> The definition for this field for SCOOP is detailed specifically in § 3.2.5 Filling in this field for SCOOP is detailed by use case. (See InformationQuality)
B.17 EventType	Description of the type of event, including the "cause code" and the "sub-cause code".	M	The choice of cause codes and sub-cause codes, as well as the related transmission conditions, are detailed by use case.
B.13 EventHistory	History of positions based on the eventPosition.	O	<p>This field is used to signal an event spread over a linear zone.</p> <p>Event linked to the road operator work (sent by Vro-ITS-S) is a punctual event (no event history).</p> <p>Event emitted by R-ITS-S can contain an event history defined from the DATEX message of the PFro.</p> <p>V-ITS-S can emit a DENM with an eventHistory for use cases D1, D6 and E6. This field is used by the Eco-AT project. It is also used in the UC D6 (reduced visibility), E6 (precipitation) and D1 (slippery road) in the C2C specifications.</p> <p>If the event is linear and static (events from R-ITS-S), the event position remains identical at each update along with the event history points.</p> <p>However, the standard is unclear on how to implement the event history for dynamic</p>

⁷ Optional but to fill in for SCOOP if the data exist.

			<p>events (essentially for Vru-ITS-S). Both solutions are still under discussions:</p> <p>1 – The event position changes at each update and the previous event position become point of the eventhistory. Trace and eventhistory overlap.</p> <p>2 – The event position remains identical at each update and new event history points are added along with each update.</p> <p>The way to encode it is as follows : $EP = CP + \text{delta}$ with $EP = \text{EventPoint}$ (new eventhistory point) and $CP = \text{CurrentPoint}$ (or eventposition for the first one)</p>
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Table 12: DENM definition : Location container

Situation container			
Field No. and name (as in the annex of the DENM standard)	See definition in annex B of the corresponding standard	Mandatory (M) Optional (O) in the standard ⁸	SCOOP comments and choices
B.16 EventSpeed	Event's speed. If the event is associated with an ITS vehicle, the speed is the vehicle's one. This information is associated with a confidence level. If there is no confidence level, the confidence level will be considered as equal to 95%. However, it should be noted that an ITS application may require a specific confidence level.	O	In practice, this field will be filled in by the V-ITS-S: <ul style="list-style-type: none"> for the B1 (mobile roadwork), B2 (approaching vehicle) and B3 (winter road maintenance vehicle) cases for the Vro-ITS-S; by the non-stationary transmitting vehicles for the relevant use cases for the Vru-ITS-S
B.15 EventPositionHeading	Direction or orientation of the event on the road. This information is associated with a confidence level. If there is no confidence level, the confidence level will be considered as equal to 95%. However, it should be noted that an ITS application may require a specific confidence level.	O	Must be filled in for the Vru-ITS-S, the Vro-ITS-S or the R-ITS-S if available. Must be filled in for all event linked to the ego vehicle and its move where the value is available. Must be filled in even if the vehicle becomes stationary thanks to its path history. This information is built with information from GNSS or Can bus.
B.51 Traces	Groups of traces: each trace is defined by a set of points determining a path leading to the event. Several traces or paths can lead to the event; up to 7 traces should be able to be integrated in the message.	M	All SCOOP transmitters will fill in this field. Consequently, the PFro should know how to fill in this field for the R-ITS-S. The way to encode it is as follows: PP = CP + delta with PP = PathPoint (new pathpoint of the trace) and CP = CurrentPoint (or eventposition for the first one) See chapter 3.2.6 for details of traces for messages from the TMC according to the relevancetrafficdirection of the event. Depending of the emitter the traces could have been generated differently. For the Vro-ITS-S, the algorithm for generate the traces is described in the 2.4.2.2 Bis. The traces generation is implemented in order to manage the highway ramp or Vro-ITS-S in a reverse maneuver.
B.42 RoadType	Type of road where the event is located.	O	It should be possible to have a map to provide this information. In practice, this information will be available for the operator (R-ITS-S and Vro-ITS-S), but not necessarily for the Vru-ITS-S.

Table 13: DENM definition : A la carte container

⁸ Optional but to fill in for SCOOP if the data exist.

A LA CARTE CONTAINER			
Field No. and name (as in the annex of the DENM standard)	See definition in annex B of the corresponding standard	Mandatory (M) Optional (O) in the standard ⁹	SCOOP comments and choices
B.24 LanePosition	In the case of a road with several lanes, lane on which the event is positioned. NOTE : • This data should be supplied with a minimum confidence level of 95%.	O	In practice, the information will only be filled in relevantly by the R-ITS-S because the GPS precision is insufficient to fill in this field for the V-ITS-S (even if they would have a map)
B.18 ExternalTemperature	Outside temperature where the event is reported	O	In practice, this information is easy for the Vru-ITS-S to report. This data is interesting for road operator.
B.9 ClosedLanes	Specifies whether the work involves one or more closed traffic lanes. This additional information also specifies whether the emergency traffic lane is closed to traffic or whether it can be used for specific needs (e.g., for the closing)	O	This field is rendered mandatory in SCOOP to the extent that the operators who so wish will potentially fill it in, but its use is not required to produce the SCOOP use cases.
B.44 SpeedLimit	Speed limit authorised in the work zone	O	The operator should provide this information (via the R-ITS-S) when it is available.
B.52 TrafficFlowRule	Side of the work zone that the traffic should be on (right side or left side)	O	The Amsterdam Group recommends using this field but its use is not required to produce the SCOOP use cases.
B.30 PositioningSolution	Specifies the technical position used by the transmitter to estimate the position of the event.	O	
B.47 StationarySince	Elapsed time of the stationary vehicle.	O	It shall be present when the information is required by the ITS application and when the information is available. Must be filled in for all use cases D when a vehicle is stationary.
B.56 VehicleIdentification	Characteristics of the stationary vehicle: • Brand (ETSI TS 101 539-1) • Model (ISO 3779)	Not used in SCOOP part 1	

Table 14: Other parameters for DENM

Other parameters			
Field No. and name (as in the annex of the DENM standard)	See definition in annex B of the corresponding standard	Mandatory (M) Optional (O) in the standard ¹⁰	SCOOP comments and choices
B.10 DefaultValidity	Default value for the duration of validity of a DENM	M	This a default value set at 600s as recommended.

⁹ Optional but to fill in for SCOOP if the data exist.

¹⁰ Optional but to fill in for SCOOP if the data exist.

3.2.3 EventType - definition of the messages transmitted by use case

Table 15 to Table 27 list the cause codes and sub-cause codes used for SCOOP by use case. Cause code and sub-causecode emitted by C-ITS-S are detailed in deliverable 2412. But all C-ITS-S have to understand cause code and sub-causecode listed below.

Table 15: Cause codes and sub-cause codes for Temporary slippery road

D1 – Temporary slippery road				
SCOOP nomenclature	Cause code	Sub-cause code	Type transmission of	Comments on the choice of codes
A2-D1 Temporary slippery road	6: adverse weather condition - adhesion	0: unavailable	Automatic transmission by an V-ITS-S	
D1 Temporary slippery road	6: adverse weather condition - adhesion	0: unavailable	Transmission from the TMC	
D1 Temporary slippery road- persistent frost	6: adverse weather condition - adhesion	1: heavy frost on road	Transmission from the TMC	If used, this case can be displayed the same way as 6/0 because the HMI may not report such a level of granularity.
D1 Temporary slippery road- diesel fuel	6: adverse weather condition - adhesion	2: fuel on road	Transmission from the TMC	
D1 Temporary slippery road- mud	6: adverse weather condition - adhesion	3: mud on road	Transmission from the TMC	
D1 Temporary slippery road- snow	6: adverse weather condition - adhesion	4: snow on road	Transmission from the TMC	
D1 Temporary slippery road- ice	6: adverse weather condition - adhesion	5: ice	Transmission from the TMC	The cause codes 6/1, 6/5, 6/6, 6/9 signal different types of ice or black ice that it is interesting to differentiate for drivers used to these different indications.
D1 Temporary slippery road- black ice	6: adverse weather condition - adhesion	6: black ice	Transmission from the TMC	
D1 Temporary slippery road- oil	6: adverse weather condition - adhesion	7: oil on the road	Transmission from the TMC	
D1 Temporary slippery road- gravel	6: adverse weather condition - adhesion	8: LooseChippings	Transmission from the TMC	
D1 Temporary slippery road- instant black ice	6: adverse weather condition - adhesion	9: instantBlackIce	Transmission from the TMC	In SCOOP, it is recommended that the operators only use the code 6/6 to signal black ice and not 6/1, 6/5 or 6/9.
D1 Temporary slippery road- roads salted	6: adverse weather condition - adhesion	10: roadsSalted	Transmission from the TMC	

Table 16: Cause codes and sub-cause codes for Warning - animal, people on the road

Warning - animal, people on the road				
SCOOP nomenclature	Cause code	Sub-cause code	Type transmission of	Comments on the choice of codes
A3-D2a animal on the road	11: hazardous animal – animal on the road	0: unavailable	Report triggered manually by a user	To the question of distinguishing between a small and big animal, it was decided to stay with a unique "Animal on the road" triggered report.
D2a Animal on the road	11: hazardous animal – animal on the road	0: unavailable	Transmission from the TMC	
D2a Animal on the	11: hazardous	1: wild animal	Transmission	If used, this case can be

road - wild	location – animal on the road		from the TMC	displayed the same way as 11/0 because the HMI may not report such a level of granularity.
D2a Animal on the road - herd	11: hazardous location – animal on the road	2: herd of animals	Transmission from the TMC	
D2a Animal on the road - small animal	11: hazardous location – animal on the road	3: small animal	Transmission from the TMC	
D2a Animal on the road - big animal	11: hazardous location – animal on the road	4: big animal	Transmission from the TMC	
A3-D2b person on the road	12: human presence on the road	0: unavailable	Report triggered manually by a user	See box hereafter [Comment on the choice of codes for A3-D2b]

[Comment on the choice of codes for A3-D2b]

The detection will not be automatic. The driver of the SCOOP vehicle who sees a person on the road will make the detection.

NOTE: Based on the RHS standard, the manually triggered reports from a vehicle should only concern the vehicle's occupants:

FRUC1002: Event triggering condition:

- Automatic triggering by the V-ITS-S detecting that one of its occupants is leaving the vehicle.
- Manually triggered by one of the passenger of the vehicle signalling its departure from the vehicle.
- Manually triggered by the human himself using a nomadic device."

D2b person on the road	12: human presence on the road	0: unavailable	Transmission from the TMC	
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Table 17: Cause codes and sub-cause codes for obstacle on the road

D3 - obstacle on the road				
<i>SCOOP nomenclature</i>	<i>Cause code</i>	<i>Sub-cause code</i>	<i>Type transmission of</i>	<i>Comments on the choice of codes</i>
A3-D3 Obstacle on the road	10: hazardous – obstacle on the road	0: unavailable	Report triggered manually by a user.	See box hereafter [Comment on the choice of codes for A3-D3]

[Comment on the choice of codes for A3-D3]

To the question of distinguishing between a small and big obstacle, it was deemed difficult to implement and would require an additional choice in the HMI. Therefore it was decided to stay with a unique "Obstacle on the road" report.

D3 Obstacle on the road	10: hazardous – obstacle on the road	0: unavailable	Transmission from the TMC	It seems difficult to provide additional clarifications about the objects using the sub-cause code (for the record: 1- shedload, 2- parts of vehicles, 3- tyres, 4- big objects, etc.)
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Table 18: Cause codes and sub-cause codes for Warning stationary vehicles,

breakdown

D4 - Warning stationary vehicles, breakdown				
SCOOP nomenclature	Cause code	Sub-cause code	Type of transmission	Comments on the choice of codes
A2-D4a - Warning stationary vehicle	94: stationary vehicle	0: unavailable	Automatic transmission by a V-ITS-S	
D4 vehicle stationary/breakdown	94: stationary vehicle	0: unavailable	Transmission from the TMS	Some operators only handle breakdowns and will only broadcast the code 94/2 and not 94/0.
A2-D4b Warning EGO vehicle breakdown	94: stationary vehicle	2: vehicle breakdown	Automatic transmission by an V-ITS-S	See box hereafter [Comment on the choice of codes for A2-D4b]
[Comment on the choice of codes for A2-D4b]				
The operators would like to use the Cause Code 91, with the breakdown details, for the following reasons:				
*They don't service all breakdowns, like an air conditioning breakdown				
*They want to be able to manage the priority of service calls, in case of simultaneous breakdowns, towards long-term breakdowns (e.g., priority for an engine breakdown (sub-cause code 3) rather than a flat tyre (sub-cause code 8).				
D4 vehicle stationary/breakdown	94: stationary vehicle	2: vehicle breakdown	Transmission from the TMC	Some operators only handle breakdowns and will only broadcast the code 94/2 and not 94/0.

Table 19: Cause codes and sub-cause codes for Warning stationary vehicles, breakdown

D5 - Warning stationary vehicles, breakdown				
SCOOP nomenclature	Cause code	Sub-cause code	Type of transmission	Comments on the choice of codes
A2-D5 Warning accident zone – EGO vehicle in accident	94: stationary vehicle	3: post crash	Automatic transmission by an V-ITS-S	
A3-D5 Warning accident zone	2: accident	0: unavailable	Report triggered manually by a user	See hereafter [Comment on the choice of codes for A3-D5]

[Comment on the choice of codes for A3-D5]

Manually triggered reports are deemed useful for the following reasons:

- Enable SCOOP vehicles to report this type of event for another vehicle, SCOOP or not, due to the deemed low probability of an accident with a SCOOP vehicle.
- In case of a low impact crash (e.g., a repeatable impact at 15km/h) no passive safety component is triggered and the Crash information is not transmitted. Consequently, such a crash could not be covered by a DENM;
- In case of a more severe crash, the battery connection could be lost. In this case as well, a DENM could not be transmitted.

NOTE: due to a lower position precision than in the case of an automatic transmission by the vehicle in the accident, a 2 / 0 transmission will have a lower quality level than a 94 / 3.

NOTE: The cause code 2 is provided in the DENM, but not in the RHS standard

D5 Warning accident zone	2: accident	0: unavailable	Transmission from the TMC	See box hereafter [Comment on the choice of codes for D5]
<p>[Comment on the choice of codes for D5]</p> <p>It has been decided to take the Cause Code and sub-cause code 2 / 0 to differentiate it from the automatically triggered report (94 / 3).</p> <p>The operator will be able to specify the type of accident: (1-multiple vehicles, 2-major rescue means, 3-lorry, 4-Bus, etc.).</p> <p>NOTE: The HMI may not report to the driver such a level of detail due to clarification reasons.</p>				
D5 Warning - unprotected accident area	2: accident	7: unsecured Accident	Transmission from the TMC	See box [Comment on the choice of codes for D5]
D5 Unprotected accident area - multiple vehicles	2: accident	1: multi vehicle accident	Transmission from the TMC	If used, this case can be displayed the same way as 2/0 because the HMI may not report such a level of granularity
D5 Unprotected accident area - major rescue means	2: accident	2: heavy accident	Transmission from the TMC	
D5 Unprotected accident area - lorry	2: accident	3: accident involving lorry	Transmission from the TMC	
D5 Unprotected accident area - Bus	2: accident	4: accident involving bus	Transmission from the TMC	
D5 Unprotected accident area - hazardous materials	2: accident	5: accident involving hazardous materials	Transmission from the TMC	
D5 Unprotected accident area - accident on opposite lanes	2: accident	6: accident on opposite lanes	Transmission from the TMC	

The operators are not interested by the stationary Vehicle event but by the Vehicle breakdown information, with the cause of the stop, if possible, to decide and define the service priorities. To the extent that it will be difficult to report this level of detail manually, this Use Case is abandoned in the "manual reporting" mode.

Table 20: Cause codes and sub-cause codes for Warning reduced visibility

D6 - Warning reduced visibility				
<i>SCOOP nomenclature</i>	<i>Cause code</i>	<i>Sub-cause code</i>	<i>Type transmission of</i>	<i>Comments on the choice of codes</i>
A2-D6 Warning reduced visibility	18: Adverse weather condition - visibility	0: unavailable	Automatic transmission by an V-ITSS	
A2-D6 Warning reduced visibility	18: Adverse weather condition - visibility	0: unavailable	Transmission by the TMC	For this type of warning some operators will prefer to transmit the IVS messages deployed in phase 2 (e.g., "FOG RISK")
D6 warning reduced visibility - fog	18: adverse weather condition - visibility	1: fog	Transmission from the TMC	The operators plan to be able to transmit these cause codes.
D6 warning - reduced visibility - smoke	18: adverse weather condition	2: smoke	Transmission from the TMC	The manufacturers should be able to display this use case if

D6 warning - reduced visibility - snow	- visibility 18: adverse weather condition - visibility	3: heavySnowfall	Transmission from the TMC	possible (if the calendar and the technical implementation allow it). If used, this case can be displayed the same way as 18/0 because the HMI may not report such a level of granularity
D6 warning - reduced visibility - rain	18: adverse weather condition - visibility	4: heavy Rain	Transmission from the TMC	
D6 warning - reduced visibility - hail	18: adverse weather condition - visibility	5: heavy Hail	Transmission from the TMC	

Table 21: Cause codes and sub-cause codes for unmanaged blockage of a road

D8 - unmanaged blockage of a road				
<i>SCOOP nomenclature</i>	<i>Cause code</i>	<i>Sub-cause code</i>	<i>Type of transmission</i>	<i>Comments on the choice of codes</i>
A3-D8: unmanaged blockage of a road (road with blocked traffic)	9: hazardous location – surface condition	0: unavailable	Report triggered manually by a user	The standard doesn't appear to manage this use case. SCOOP chooses to use this cause code to allow the use of the sub-cause codes provided by diverting the use to signal obstacles on the road that cause an unmanaged obstacle or blocked traffic.
D8: unmanaged blockage of a road (road with blocked traffic) - rock falls	9: hazardous location – surface condition	1: rock falls	Transmission from the TMC	The operators plan to be able to transmit these cause codes. The manufacturers should be able to display this use case if possible (if the calendar and the technical implementation allow it). If used, this case can be displayed the same way as 9/0 because the HMI may not report such a level of granularity
D8: unmanaged blockage of a road (road with blocked traffic) - subsidence	9: hazardous location – surface condition	4: subsidence	Transmission from the TMC	
D8: unmanaged blockage of a road (road with blocked traffic) - avalanche	9: hazardous location – surface condition	5: snow drifts	Transmission from the TMC	
D8: unmanaged blockage of a road (road with blocked traffic) - burst pipe	9: hazardous location – surface condition	7: burst pipe	Transmission from the TMC	

Table 22: Cause codes and sub-cause codes for emergency brake warning

D10 - emergency brake warning				
<i>SCOOP nomenclature</i>	<i>Cause code</i>	<i>Sub-cause code</i>	<i>Type of transmission</i>	<i>Comments on the choice of codes</i>
A2-D10 warning emergency brake	99: Dangerous situation	1: Emergency electronic Brake lights	Automatic transmission by an V-ITS-S	

Table 23: Cause codes and sub-cause codes for end of queue warning

D11 - end of queue warning				
<i>SCOOP nomenclature</i>	<i>Cause code</i>	<i>Sub-cause code</i>	<i>Type of transmission</i>	<i>Comments on the choice of codes</i>
A2-D11 warning end of queue	27: Dangerous end of queue	0: unavailable	Automatic transmission by an V-ITS-S	NOTE: This cause code (and its meaning) is provided in the DENM, but not in the RHS standard (but recommended in the C2C)

Table 24: Cause codes and sub-cause codes for exceptional weather conditions warning

E6 - exceptional weather conditions warning				
<i>SCOOP nomenclature</i>	<i>Cause code</i>	<i>Sub-cause code</i>	<i>Type of transmission</i>	<i>Comments on the choice of codes</i>
A2-E6 Warning exceptional weather conditions	19: Adverse weather condition - precipitation	0: unavailable	Automatic transmission by an V-ITS-S	See hereafter [Comment on the choice of codes for A2-E6]
A2-E6 Warning exceptional weather conditions	19: Adverse weather condition - precipitation	1: heavy rain	Transmission from the TMC	
A2-E6 Warning exceptional weather conditions	19: Adverse weather condition - precipitation	2: heavy snowfall	Transmission from the TMC	
[Comment on the choice of codes for A2-E6]				
<p>The cause code 19/0 is recommended by the C2C and is centred on the "heavy rain" use case because it is the only feasible one in V2V. Hence the choice to use 19/0 and not 17/0.</p> <ul style="list-style-type: none"> Nevertheless, SCOOP makes provision to flow information downwards in I2V. This way, operators that have other types of information can use other codes: For wave 1, these codes are specified in this deliverable for the use case Eg (e.g., 17/1, 17/4); For wave 2, other codes can be added in a subsequent version of this deliverable 				
E6 - Warning exceptional weather conditions - strong winds	17: Adverse weather condition — extreme weather condition	1: strong winds	Transmission from the TMC	<p>The operators plan to be able to transmit these cause codes. The manufacturers should be able to display this use case if possible (if the calendar and the technical implementation allow it).</p> <p>If used, this case can be displayed the same way as 19/0 because the HMI may not report such a level of granularity.</p>

Table 25: Cause codes and sub-cause codes for planned roadwork warning

B1 - Planned roadwork warning				
SCOOP nomenclature	Cause code	Sub-cause code	Type of transmission	Comments on the choice of codes
B1 warning scheduled roadwork - stationary	3: Roadwork	0: unavailable	Transmission from the TMC	The TMC indicates the traffic-rerouting zone in the case of stationary roadwork and the roadwork zone in case of mobile roadwork (linear location).
B1 warning scheduled roadwork - stationary	3: Roadwork	3: Slow moving Road Maintenance	Transmission from an operator vehicle (automatic or manual case)	The operator vehicle that transmits is the one that is in the roadwork protection zone.
B1 warning scheduled roadwork - stationary	3: Roadwork	3: Slow moving Road Maintenance	Transmission from the TMC	The information sent concerns a pre-scheduled zone in which the user risks coming upon mobile roadwork.

Table 26: Cause codes and sub-cause codes for road operator intervention warning

B2 - road operator intervention warning				
SCOOP nomenclature	Cause code	Sub-cause code	Type of transmission	Comments on the choice of codes
B2 warning road operator intervention - the operator vehicle on patrol	26: Slow Vehicle	1: maintenance Vehicle	Transmission from an operator vehicle (automatic or manual case)	The operator vehicle that transmits is the one that is on patrol
B2 warning road operator intervention - operator vehicle out on service call	95: Emergency vehicle approaching	0: unavailable	Transmission from an operator vehicle (automatic or manual case)	See hereafter <i>[Comment on the choice of codes for B2 on 95/0]</i>
<p>See box hereafter <i>[Comment on the choice of codes for B2 on 95/0]</i></p> <p>Code 95 does not comply with C2C because it is identified as only being attributable to authorised vehicles as defined in the highway code.</p> <p>The manufacturers stress the display difficulties.</p> <p>The use of the cause code 95 will be detailed later in the annex of this deliverable.</p>				
B2 warning road operator intervention - operator vehicle stopped in a protected mode	15: Rescue and recovery work in progress	0: unavailable	Transmission from an operator vehicle (automatic or manual case)	<p>This code is transmitted when the operator vehicle stops in a protected mode</p> <p>This code is provided in the DENM, but not in the RHS standard.</p>

Table 27: Cause codes and sub-cause codes for winter maintenance warning

B3 - winter maintenance warning				
SCOOP nomenclature	Cause code	Sub-cause code	Type of transmission	Comments on the choice of codes
B3 - Warning winter maintenance - winter road maintenance vehicle on road	3: Roadwork	6: winter Service	Transmission from an operator vehicle (automatic or manual case)	Transmission conditions: blade raised and no salting. This code is used when the winter service vehicle does not have priority because it is not clearing snow nor salting (amber flashing lights).
B3 - Warning winter maintenance - winter road maintenance vehicle clearing snow	26: slow vehicle	6: snow plough	Transmission from an operator vehicle (automatic or manual case)	Transmission conditions: blade lowered. This code is used when the winter road maintenance vehicle is clearing snow.
B3 - Warning winter maintenance - winter road maintenance vehicle is salting	26: slow vehicle	8: salting vehicle	Transmission from an operator vehicle (automatic or manual case)	This code is used when the winter road maintenance vehicle is only salting.

3.2.4 InformationQuality – definition of the quality index

It has been decided that the quality index for SCOOP is the level of probability that the event or situation signalled by the message is true, from the point of view of the message transmitter. Consequently, it is a qualitative notion that involves the transmitter's responsibility.

The quality of SCOOP information does not take into account the event's positioning error, which is intrinsic to the system. If a transmitter transmits with a maximum quality level, this should mean that it provides information that it undertakes to consider as proven.

It has been decided to consider three quality levels for SCOOP, as defined in the three-level quality scale of DATEX II V2.

A SCOOP DENM message can therefore be transmitted with 3 quality levels:

- Q1 = Risk
- Q2 = Probable
- Q3 = Certain

It should be noted that there is no unavailable field. The default value is Q1.

The InformationQuality field in the DENM standard is a list that takes the values (0) unavailable, (1) lowest, (2), (3), (4), (5), (6) and (7) highest.

The quality levels for SCOOP are harmonised by the manufacturers to transcribe the C2C recommendations by use case.

From the R-ITS-S point of view (and the V-ITS-S of the road operator in a R-ITS-S mode):

- Tables 27 and 28 specify how to translate the information quality of the DENM to DATEX (messages received to the platform)
- Tables 29 and 30 specify how to translate the information quality of DATEX to DENM (from the platform to the messages issued by the R-ITS-S)

3.2.4.1 Quality levels for messages transmitted by the user vehicles

- We then designate by "messages transmitted by user vehicles," the messages transmitted by the following SCOOP components: Vru-ITS-S; Vro-ITS-S in "user" mode.

Here is a translation table of the quality levels (i.e., the values of the informationQuality field) into quality levels for SCOOP (3 levels: Q1, Q2 or Q3) for the messages transmitted by the Vru-ITS-Ss in SCOOP.

Table 28: Quality levels - Messages transmitted by the Vru-ITS-S in automatic mode

Messages transmitted by the Vru-ITS-S in automatic mode				
Use case	Codes	Q1 = risk	Q2 = Probable	Q3 = Certain
A2-D1 warning - temporary slippery road	6/0	(0), (1), (5)	(2), (3)	(4), (6), (7)
<i>Note: Quality levels A2-D1 translates the probability that the EGO vehicle has slip because the road is slippery</i>				
A2-D4a warning - EGO vehicle stationary	94/0	(0)	(1), (2)	(3)
<i>Note: Quality levels A2-D4a translates the probability that the EGO vehicle not involved in an accident would be stationary without being in a traffic jam</i>				
A2-D4a warning - EGO vehicle stationary	94/0	(0)	(1), (2)	(3)
<i>Note: Quality levels A2-D4a translates the probability that the EGO vehicle not involved in an accident would be stationary without being in a traffic jam</i>				
A2-D4b Warning EGO vehicle breakdown	94/2	(0)	(1), (2)	(3)
A2-D4a warning - EGO vehicle stationary	94/0	(0)	(1), (2)	(3)
<i>Note: Quality levels A2-D4a translates the probability that the EGO vehicle not involved in an accident would be stationary without being in a traffic jam</i>				
A2-D4b Warning EGO vehicle breakdown	94/2	(0)	(1), (2)	(3)
<i>Note: Quality levels A2-D4b translates the probability that the EGO vehicle is in a stationary breakdown</i>				
A2-D5 Warning accident zone – EGO vehicle in accident	94/3	(0)	(1), (2)	(3)
<i>Note: Quality levels A2-D5 translates the probability that the EGO vehicle is stationary because it has been in an accident</i>				
A2-D6 warning - reduced visibility	18/0	(0)	(1), (2)	(3), (4)
<i>Note: Quality levels A2-D6 translates the probability that the EGO vehicle has turned on its fog lights because the visibility is low</i>				
A2-D10 warning -	99/1	(0)	Not used	(1)

emergency brake				
<i>Note: Quality levels A2-D10 translates the probability that the EGO vehicle has braked in an emergency</i>				
A2-D11 warning - end of queue	27/0	(0)	(1), (2)	(3)
<i>Note: Quality levels A2-D11 translates the probability that the EGO vehicle has slowed down because it is in a traffic jam</i>				
A2-E6 warning - exceptional weather conditions	19/0	(0)	(1), (2)	(3), (4)
<i>Note: Quality levels A2-E6 translates the probability that the EGO vehicle is crossing a heavy rain zone</i>				

Table 29: Quality levels - Messages transmitted by the Vru-ITS-Ss in manual mode

Messages transmitted by the Vru-ITS-S in manuel mode				
Use case	codes	Q1 = risk	Q2 = Probable	Q3 = Certain
A3-D2a animal on the road	11/0	(0)	Not used	Not used
<i>Note: Quality levels A3-D2a translates the probability that an animal is on the road when and where the user reports having seen an animal</i>				
A3-D2b person on the road	12/0	(0)	Not used	Not used
<i>Note: Quality levels A3-D2b translates the probability that a person is on the road when and where the user reports having seen a person</i>				
A3-D3 obstacle on the road	10/0	(0)	Not used	Not used
<i>Note: Quality levels A3-A3-D3 translates the probability that an obstacle is on the road when and where the user reports having seen an obstacle on the road</i>				
A3-D5 unprotected accident area	2/0	(0)	Not used	Not used
<i>Note: Quality levels A3-A3-D5 translates the probability that an accident happened on the road when and where the user reports having seen an accident</i>				
A3-D8 unmanaged blockage of a road	9/0	(0)	Not used	Not used
<i>Note: Quality levels A3-D5 translates the probability that an unmanaged obstacle is on the road when and where the user reports having seen an unmanaged blockage of a road</i>				

- The details of the transmission conditions for each quality level for the messages transmitted by the Vru-ITS-S for each use case are covered in §.4.1 of this document.

3.2.4.2 Quality levels for messages transmitted by the operator

- We then designate by "messages transmitted by the operator," the messages transmitted by the following SCOOP components: TMS or TG; Road Operator's platform; R-ITS-S; Vro-ITS-S in "operator" mode.

In order to establish coherency between the DENM messages transmitted with the same cause codes, it is proposed that the quality be filled in with arbitrary values that respect the C2C relation when the operator transmits the messages. Arbitrarily, the value used is the largest among those used by the C2C for the same quality level. If no value is used by the C2C, it is proposed to use (0) for risk, (4) for probable and (7) for certain for the messages transmitted by the operator.

Table 30: Quality levels - Messages transmitted by the operator

Messages transmitted by the operator using the same cause codes as the messages transmitted by the Vru-ITS-Ss (manually or automatically triggered)

Use case	Codes	Q1 = risk	Q2 = Probable	Q3 = Certain
D1 warning - temporary slippery road	6/0	(1) if used	(3) if used	(7)
D2a warning - animal on the road	11/0	(0)	(4) if used	(7) if used
D2b warning - person on the road	12/0	(0)	(4) if used	(7) if used
D3 obstacle on the road	10/0	(0)	(4) if used	(7) if used
D4 stationary vehicle, breakdown - stationary vehicle	94/0	(0) if used	(2) if used	(3)
D4 stationary vehicle, breakdown - vehicle breakdown	94/2	(0) if used	(2) if used	(3)
D5 Warning accident zone	2/0	(0) if used	(4) if used	(7)
D6 Warning reduced visibility	18/0	(0) if used	(4) if used	(7)
D11 warning - end of queue	27/0	(0) if used	(2) if used	(3)

For the other messages transmitted by the TMS, it is proposed to use the quality scale proposed previously: (0) for Q1 = risk, (4) for Q2 = probable and (7) for Q3 = certain.

In practice, the policy of filling in the quality is as follows for the operators: the transmitted messages are necessarily proven information, therefore the messages cited are in principle transmitted with a quality level Q3.

Messages transmitted by the operator with the codes not used by the Vru-ITS-Ss

Use case	codes	Q1 = risk	Q2 = Probable	Q3 = Certain
B1 warning - scheduled roadwork	3/0 3/3 3/6	(0) if used	(4) if used	(7)
B2 - warning - work on lane	26/1 95/0 15/0	(0) if used	(4) if used	(7)
B3 - Warning winter maintenance - winter road maintenance vehicle on road	3/6 26/6 26/8	(0) if used	(4) if used	(7)
D1 warning - temporary slippery road	6/1 6/2 6/3 6/4 6/5 6/6 6/7 6/8 6/9 6/10	(0) if used	(4) if used	(7)
D2a warning - animal on the road	11/1 11/2 11/3 11/4	(0) if used	(4) if used	(7)
D5 - warning - accident zone	2/1 2/2 2/3 2/4 2/5 2/6	(0) if used	(4) if used	(7)

	2/7			
D6 - warning - reduced visibility	18/1 18/2 18/3 18/4 18/5	(0) if used	(4) if used	(7)
E6 warning - exceptional weather conditions - strong winds	17/1 17/4	(0) if used	(4) if used	(7)
D8 unmanaged blockage of a road	9/1 9/4 9/5 9/7	(0) if used	(4) if used	(7)

3.2.5 ValidityDuration

ValidityDuration represents both the duration of validity of the signalled event and the duration of validity of the message so it is processed. This parameter is defined use case by use case in the deliverable SCOOP_2.4.1.2_SpecificationOfDENM.xlsx.

This duration is not an absolute duration, it is increased at each DENM update to validityDuration of the previously transmitted DENM.

For SCOOP, it is considered that the duration of validity is defined independently of the message's quality level and depends in principle on the type of transmitter, the type of transmission and the type of event.

3.2.6 relevanceTrafficDirection and traces

The way to build the relevanceTrafficDirection and traces for vehicle messages and infrastructure messages is different. They also depend on the type of road that they are on. Consequently, they will depend on the presence of mapping systems within the vehicle/infrastructure.

As a reminder, the relevanceTrafficDirection is the direction in which an event should be taken into account and displayed.

Vehicles (including road operator vehicles)

Since vehicles only have one direction, they only send one trace.

Logics for default values of relevanceTrafficDirection, for vehicles are:

- "AllTrafficDirections" on a road that does not have divided carriageways;
- "UpStreamTraffic" for some stationary events, via automatically signalling, on a divided carriageway if the mapping is available;
- for manually triggered reports, by default "AllTrafficDirection"
- "DownStreamTraffic" for the priority vehicle warning case (message sent by operator vehicles only)

Vehicles always send punctual messages, except for the following use cases, where an eventHistory can be sent if the triggering conditions are still active: D1, D6, E6.

Infrastructure (from the TMS)

Messages from the TMS sent by R-ITS-S reporting **linear events** will only be sent with upstream notifications for this field. Indeed, if the linear events concern both directions (for example, slippery roads), two DENMs will be sent, one for each direction, with `relevancetrafficdirection = upstream`.

However, for messages from the TMC sent by R-ITS-S reporting **punctual events**, only one DENM message will be sent.

For punctual events concerning both directions, this field will be sent with an `alltrafficdirection` notification for all messages; there will be at least one trace in each direction (1st trace: direction of the event; 2nd trace: opposed direction – by projection on the opposite side of the road for divided carriage-ways).

For punctual events concerning only upstream direction, there will be only a trace in the direction of the event.

Datex messages that come from the TMC are then transformed within the SCOOP platform to perform the necessary operations (see deliverables 2.4.1.4 and 2.4.3.2 for more details).

Here how they are coded depending if they are punctual or linear:

In the case of **point locations** (e.g. there is no eventHistory in DENM message) :

If there is no trace

Use **<GroupOfLocations>** of type "point"

- `pointByCoordinates (= "eventPosition")`

If there is 1 trace:

Use **<GroupOfLocations>** of type "point"

• **<PointAlongLinearElement>** (= "Trace") :

- 1 `StartPointOfLinearElement`
- n `intermediatePointOfLinearElement`
- 1 `endPointOfLinearElement`
- `pointByCoordinates (= "eventPosition")`

If there are 2 traces or more:

Use **<GroupOfLocations>** of type "NonOrderedLocationByList"

containing "Point" :

point 1 ==> Trace 1

- `pointAlongLinearElement (= trace)`
 - 1 `StartPointOfLinearElement`
 - n `intermediatePointOfLinearElement`
 - 1 `endPointOfLinearElement`

• `pointByCoordinates (= eventPosition)`

point 2 ==> Trace 2

- `pointAlongLinearElement (= the trace)`
 - 1 `StartPointOfLinearElement`
 - n `intermediatePointOfLinearElement`
 - 1 `endPointOfLinearElement`

• Optionally: `pointByCoordinates (= eventPosition)`

point 3 ==> Trace 3

- `pointAlongLinearElement (= the trace)`
 - 1 `StartPointOfLinearElement`
 - n `intermediatePointOfLinearElement`
 - 1 `endPointOfLinearElement`

• Optionally: `pointByCoordinates (= eventPosition)`

Etc.

In the case of **linear locations** (EventHistory present in DENM message) :

If there is 1 trace or more

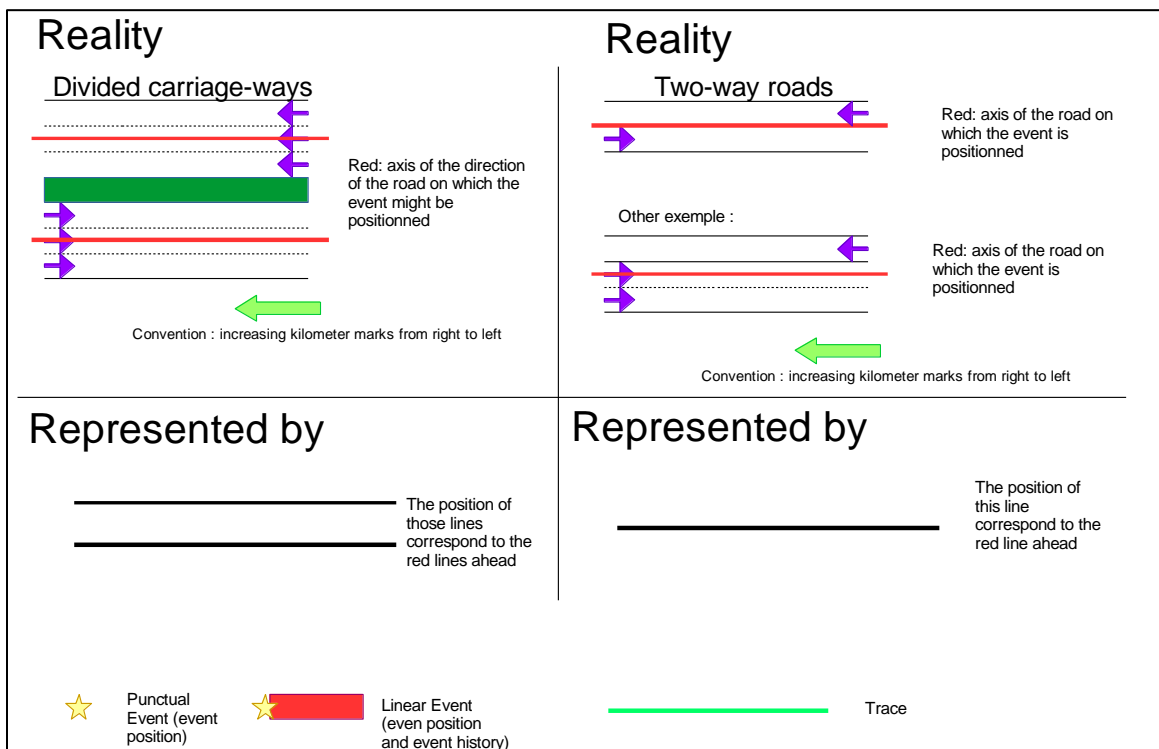
<GroupOfLocations> of type "NonOrderedLocationGroupByList" containing "Linear"

- `linearWithinLinearElement : index = 1 (EventHistory)`
 - `"PointCoordinates" with the relation "locationForDisplay" (= eventPosition)`
 - 1 `StartPointOfLinearElement`
 - n `intermediatePointOfLinearElement`
 - 1 `endPointOfLinearElement`
- `linearWithinLinearElement : index = 2 (Trace 1)`
 - `"PointCoordinates" with the relation "locationForDisplay" (= eventPosition)`
 - 1 `StartPointOfLinearElement`
 - n `intermediatePointOfLinearElement`
 - 1 `endPointOfLinearElement`
- `linearWithinLinearElement : index = 3 (Trace 2)`
 - `"PointCoordinates" with the relation "locationForDisplay" (= eventPosition)`
 - 1 `StartPointOfLinearElement`
 - n `intermediatePointOfLinearElement`
 - 1 `endPointOfLinearElement`
- etc.

The following schematics illustrate the previous sentences and show the way the infrastructure builds the traces.

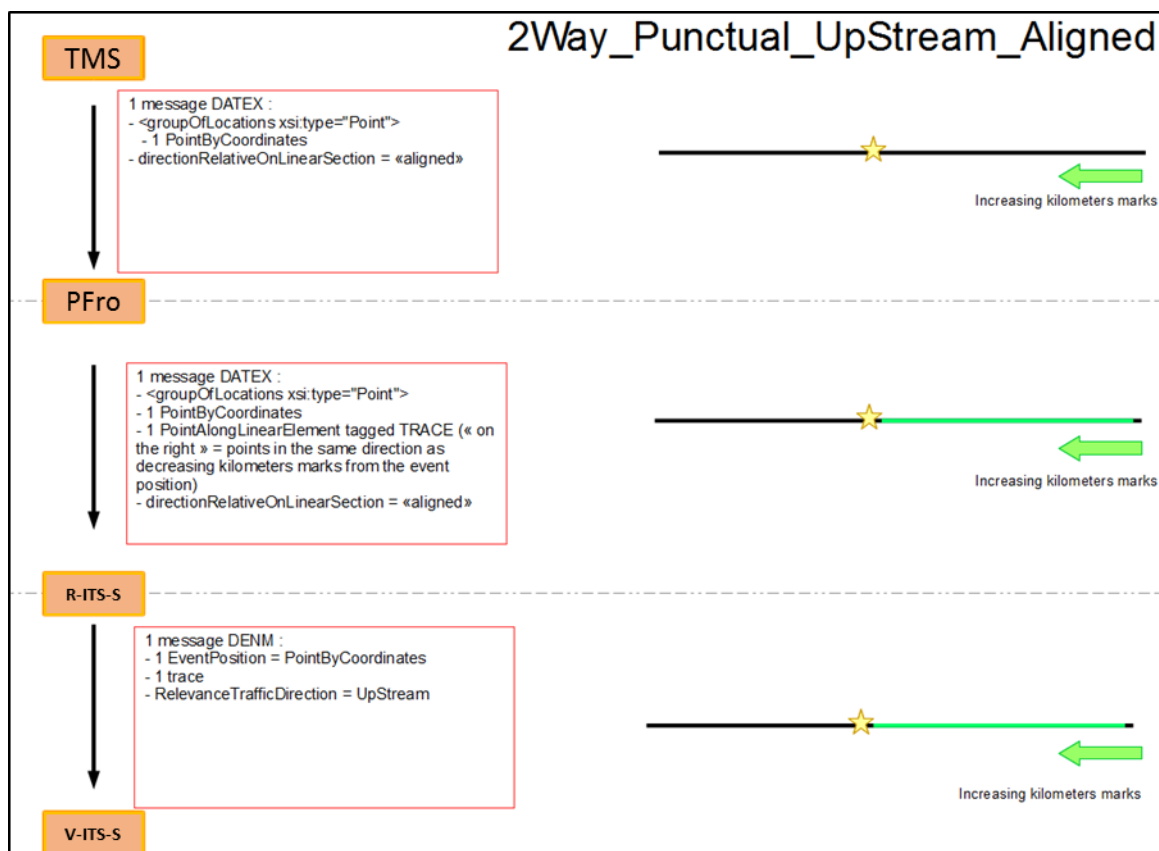
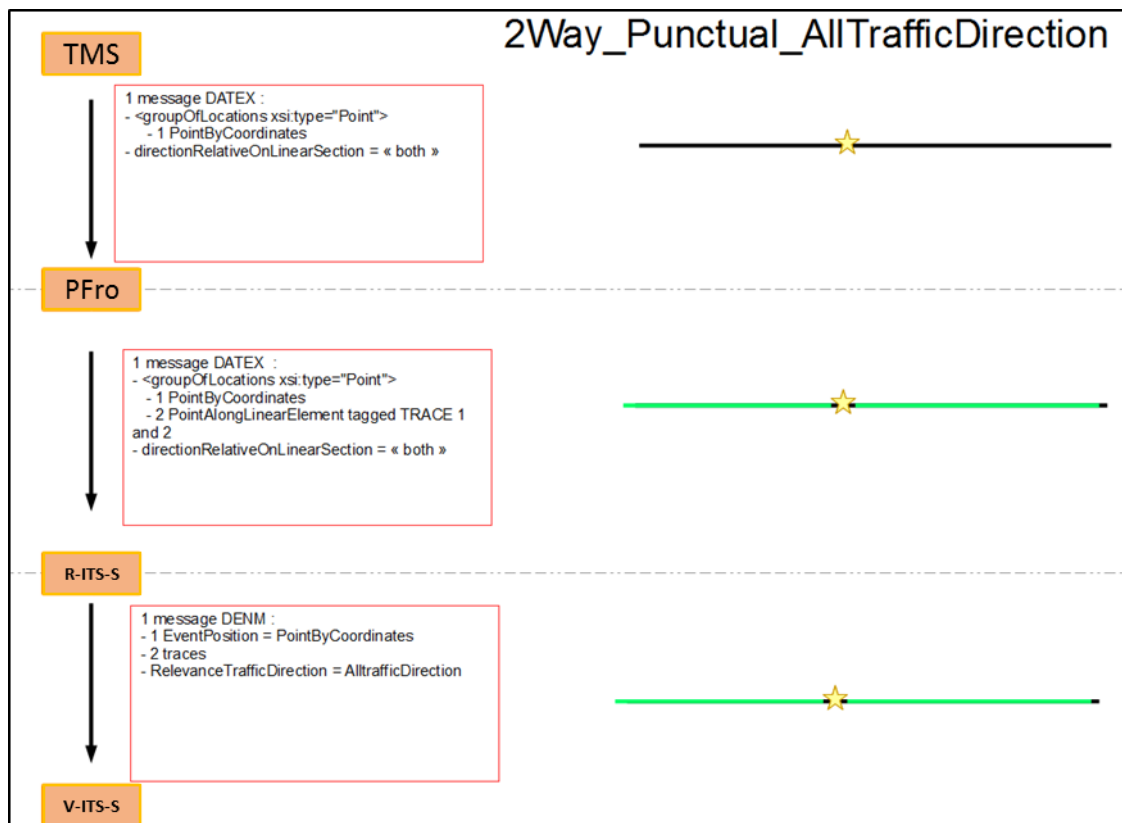
Here is the representation of the roads (legend for schematics below):

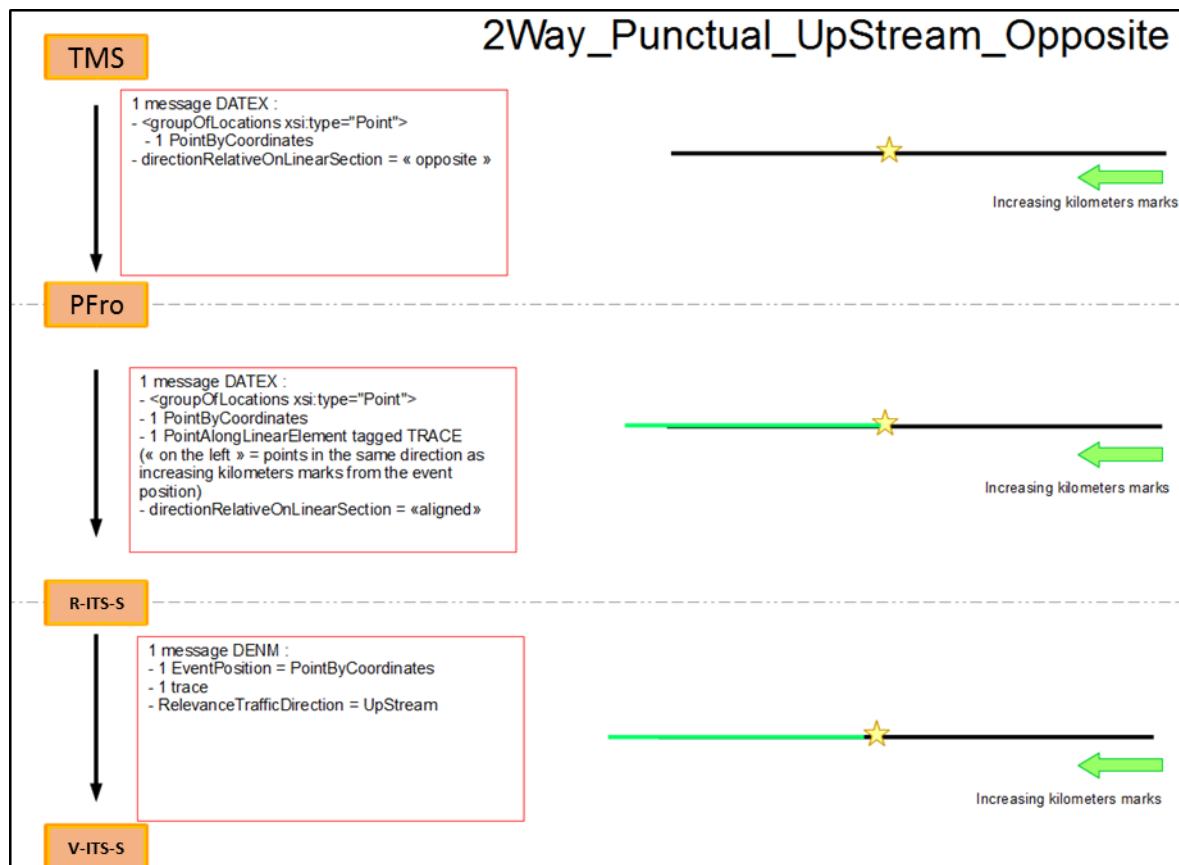
Figures 11: Messages sent from the TMC – complete chain



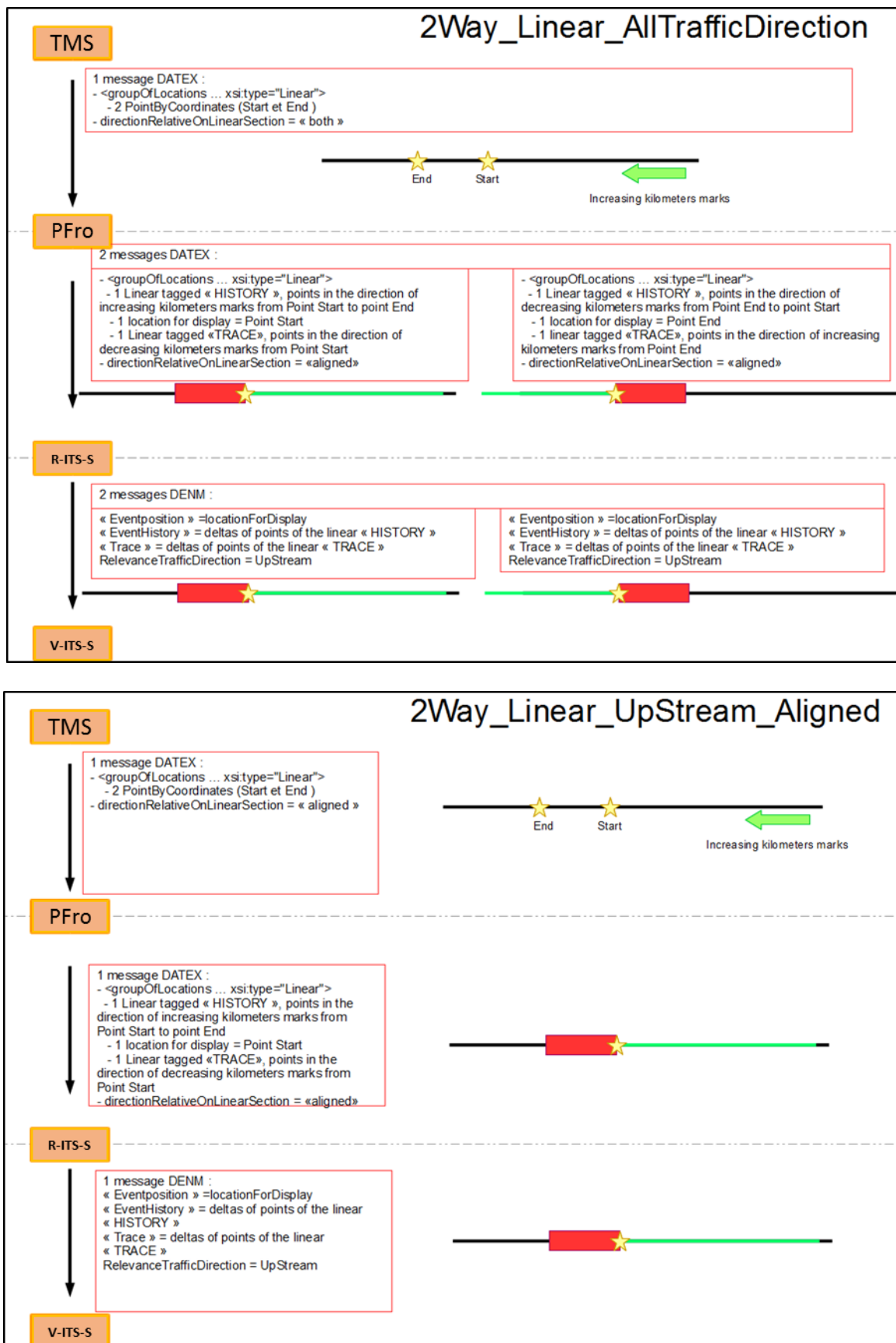
The entire chain from the TMS to the V-ITS-S is represented below, depending on the type of event, type of road and direction of event:

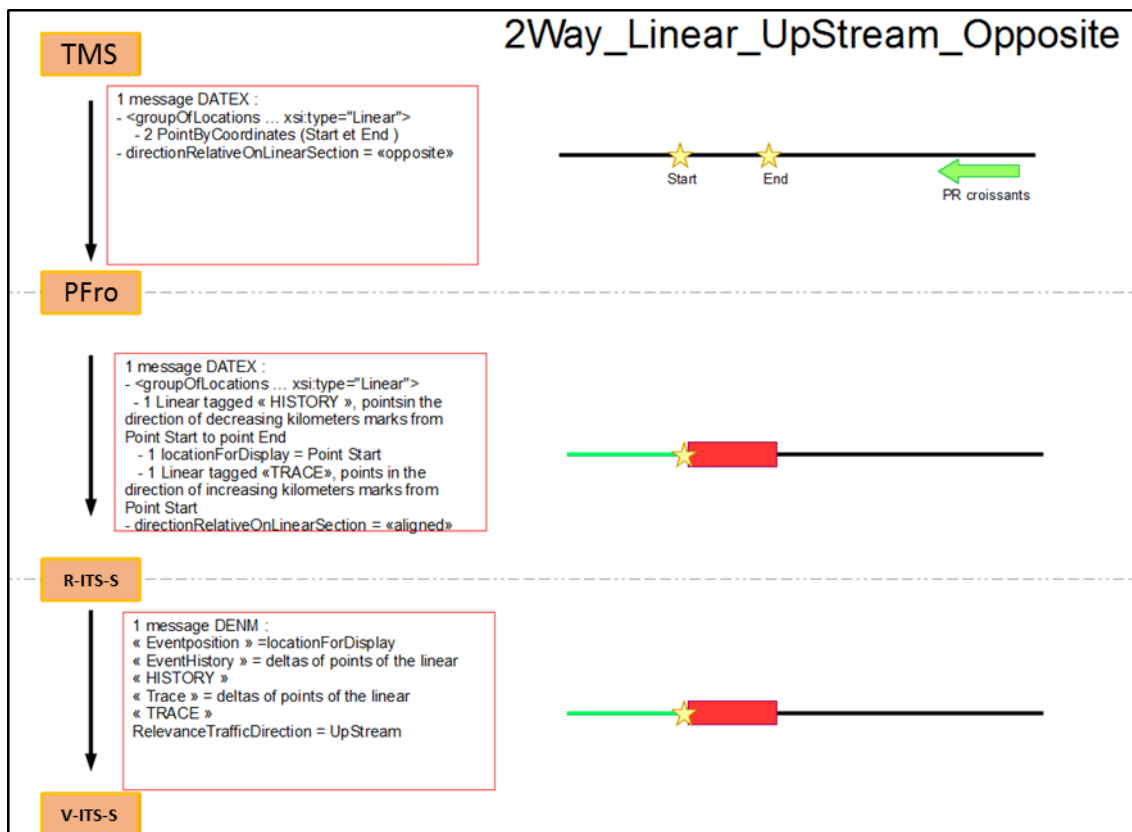
Punctual events on two-way roads:



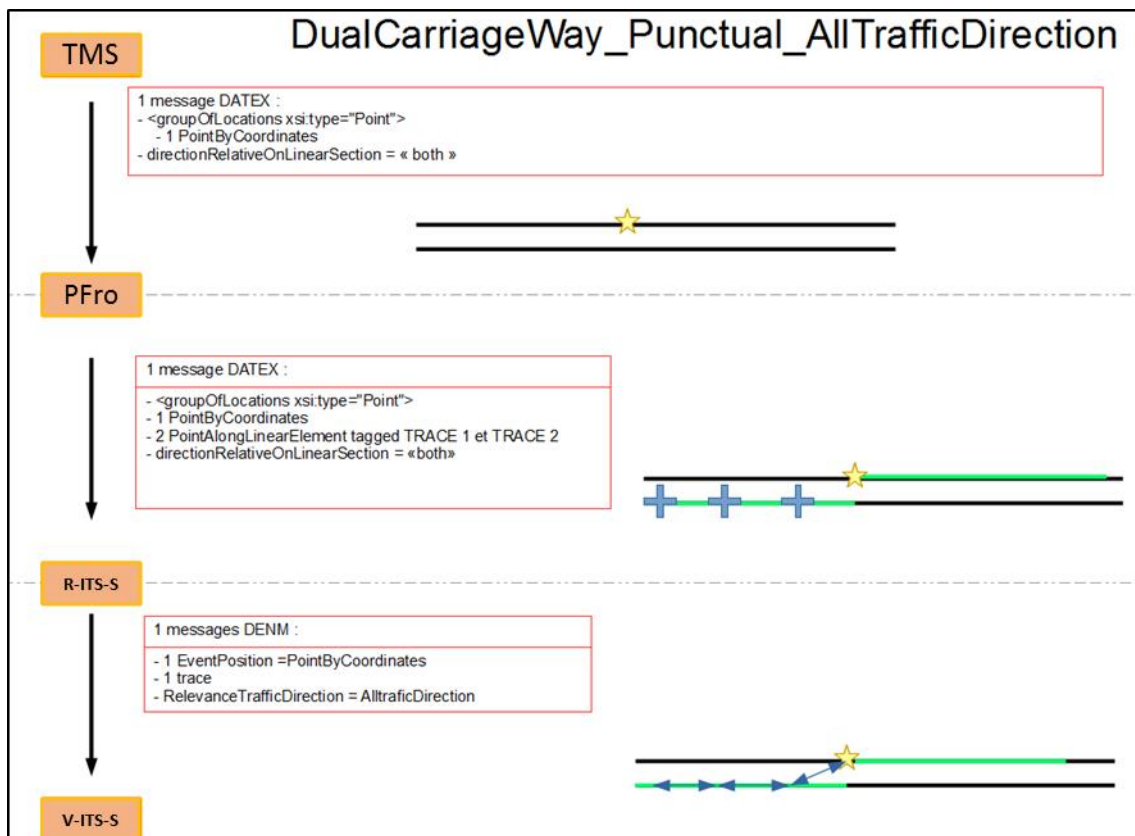


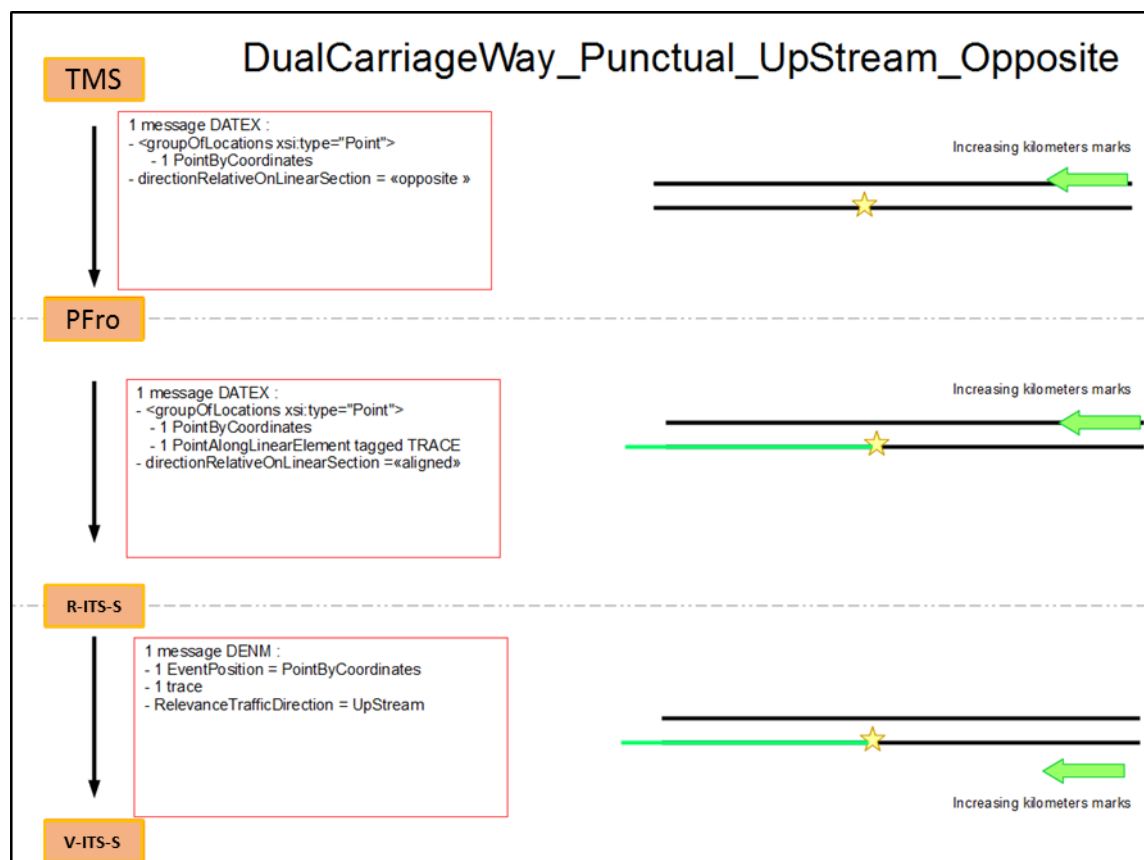
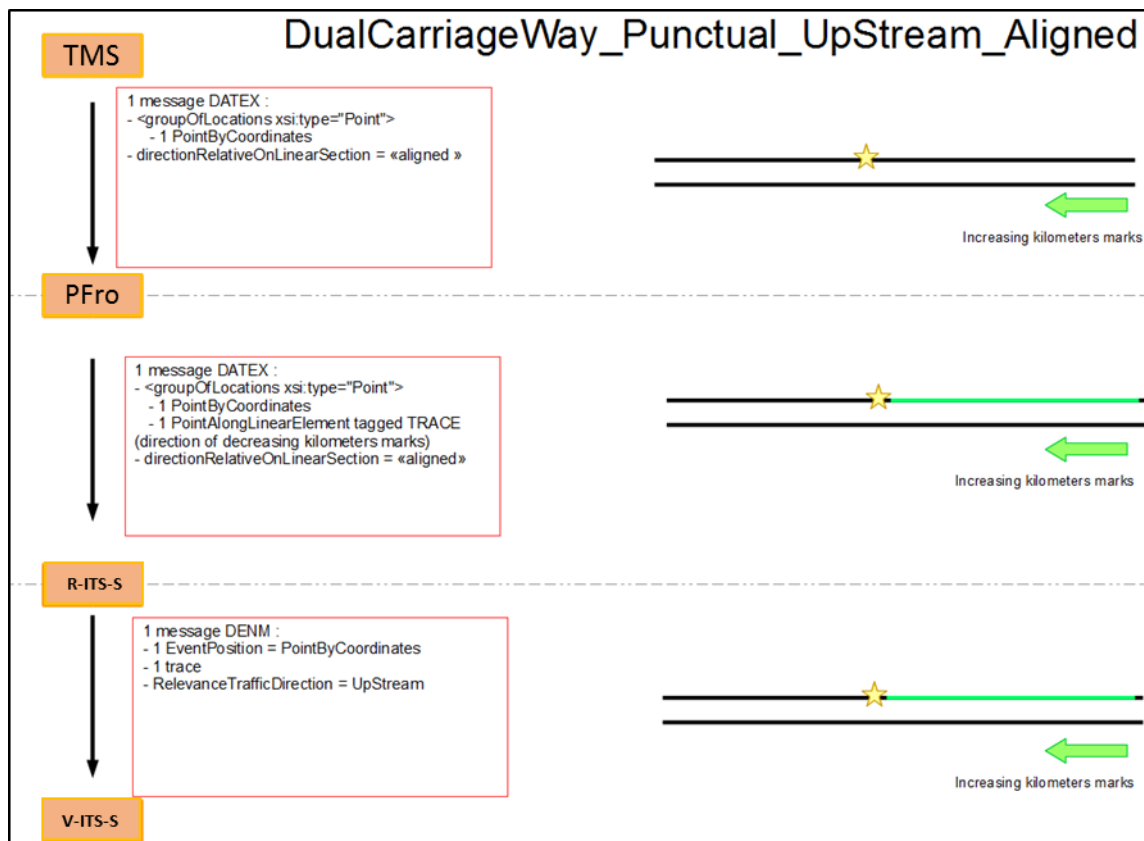
Linear events on two-way roads:



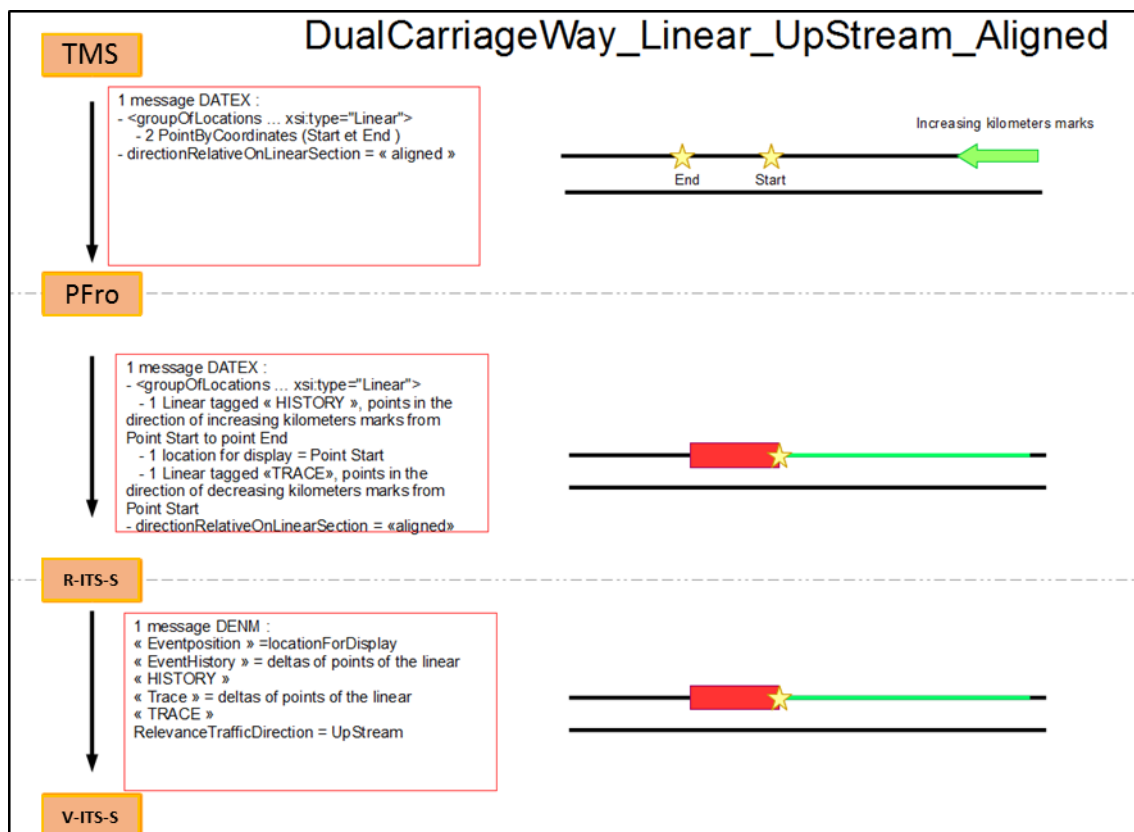
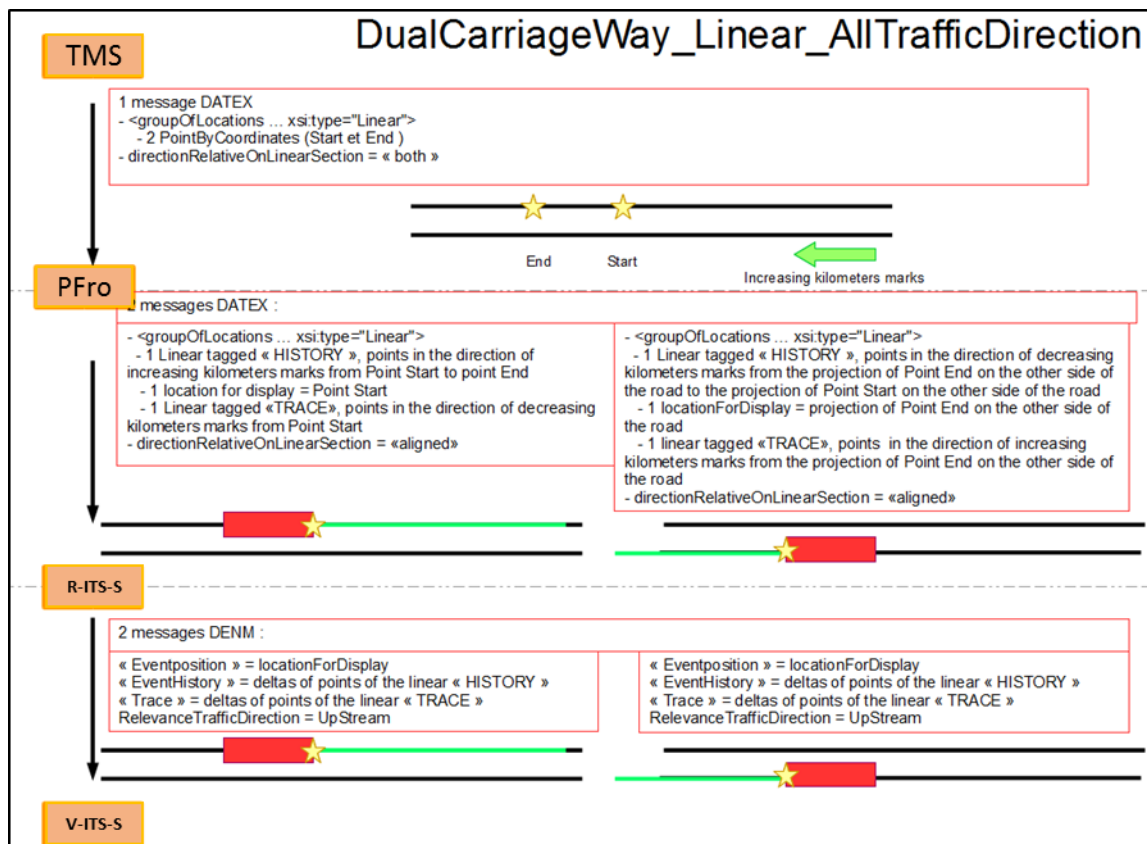


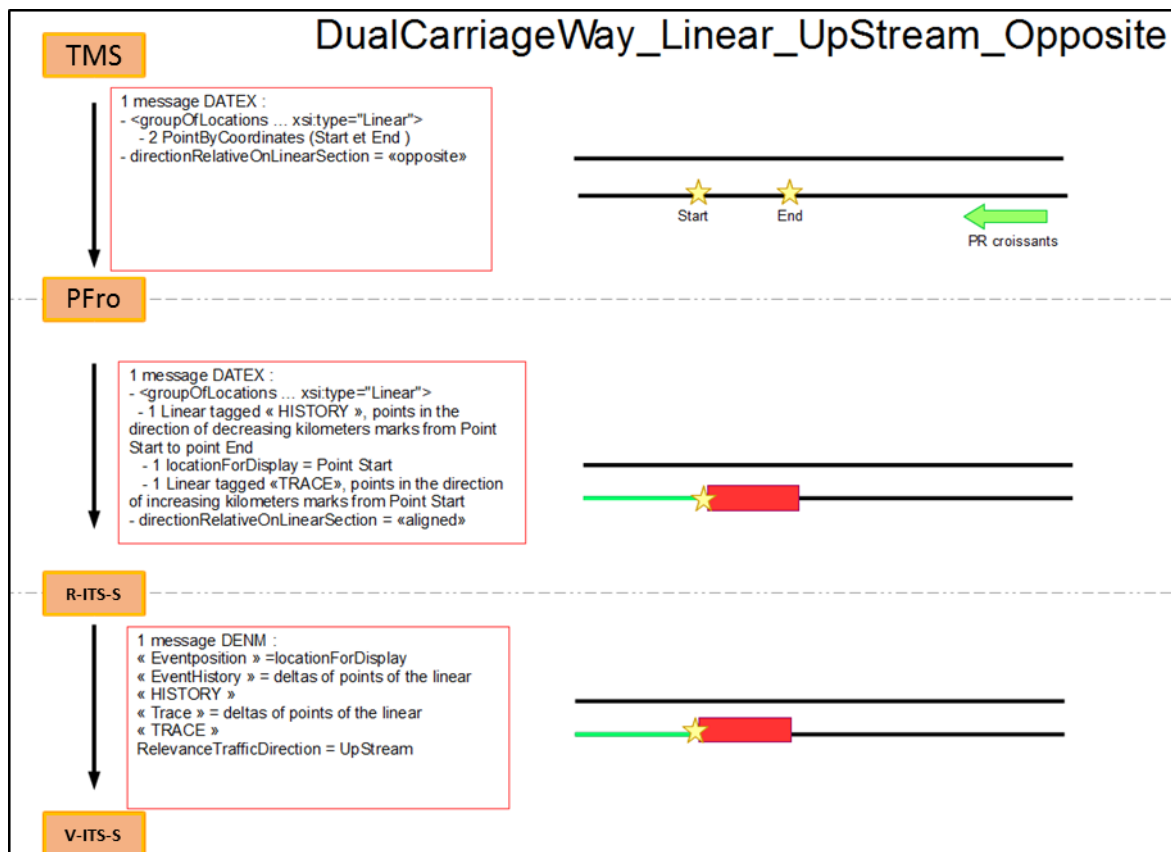
Punctual events on divided carriage-ways:





Linear events on divided carriage-ways:





Here a summary of the way the use-cases can be implemented based on the classification ahead:

Table 31: Use-cases sent from the TMS according to types of road, event and relevancetrafficdirection

Type of Road_Event	RelevanceTraffic Direction	3/0	3/3	6/x	11/x	12/0	10/0	94/x	2/x	18/x	9/x	17/x
2Way_Punctual	AllTrafficDirection	X	X	X	X	X	X	X	X		X	X
	Upstream_Aligned	X	X	X	X	X	X	X	X		X	
	Upstream_Opposite	X	X	X	X	X	X	X	X		X	
2Way_Linear	AllTrafficDirection	X	X	X	X	X	X		X	X	X	X
	Upstream_Aligned	X	X	X	X	X						
	Upstream_Opposite	X	X	X	X	X						
DualCarriageWay_Punctual	AllTrafficDirection	X	X	X	X	X	X	X	X		X	
	Upstream_Aligned	X	X	X	X	X	X	X	X		X	
	Upstream_Opposite	X	X	X	X	X	X	X	X		X	
DualCarriageWay_Linear	AllTrafficDirection	X	X	X	X	X				X		X
	Upstream_Aligned	X	X	X	X	X	X				X	
	Upstream_Opposite	X	X	X	X	X	X				X	

3.3 Other notions to specify outside of the CAM and DENM fields

3.3.1 Notion of zones

The notion of zone is covered by several definitions for the SCOOP project:

- the advance notice distance, marked D, is the distance between the eventPosition and the place where we want the user to be informed, which can be configured by the automobile manufacturers
- the destinationArea, marked D', is the area where the information is broadcast in.

The applications provide this information to the DENM service, which then transmits it to the networking & transport layer (see the DENM standard, §6.1.3.3)

It has been decided to consider the destination area as follows:

- Default = 10 km radius. The dissemination zone is a circle of radius of 10km; this corresponds to a itsGnMaxGeoAreaSize = 315 km²
- For user vehicle transmissions (Vru-ITS-S): the objective of the choice of default values is to enable a transmitted message to reach an R-ITS-S (via rebounds).
- For operator transmissions (R-ITS-S, Vro-ITS-S): each operator can configure this value according to the R-ITSS density in its network.

The relevance distance is not used in the scoop project.

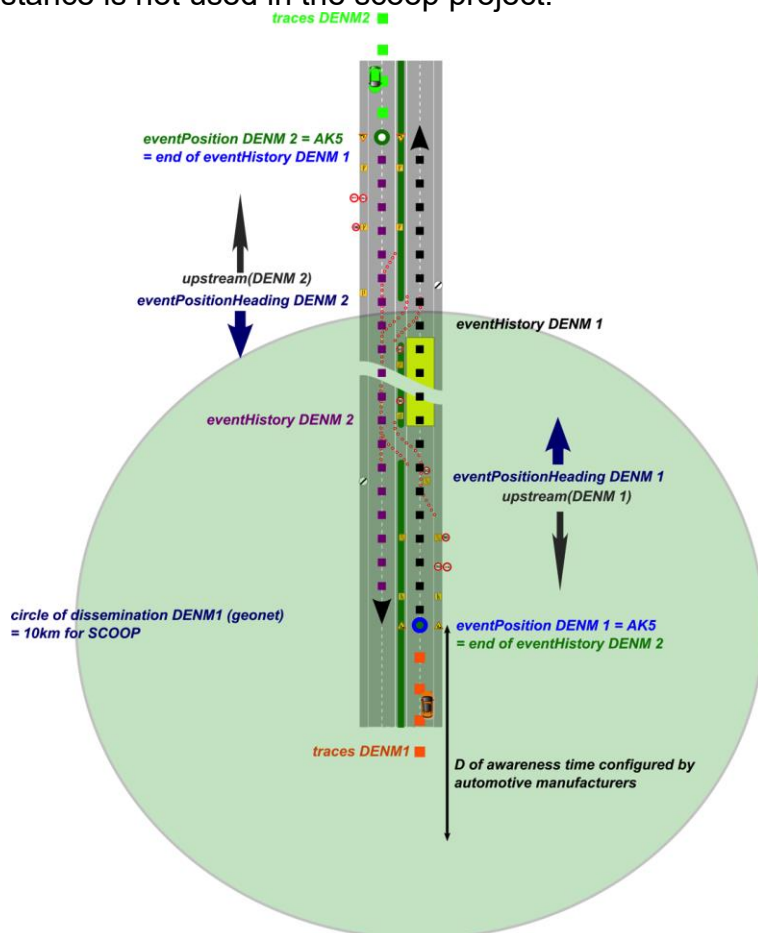


Figure 12: Illustration of a use case – Warning stationary roadwork

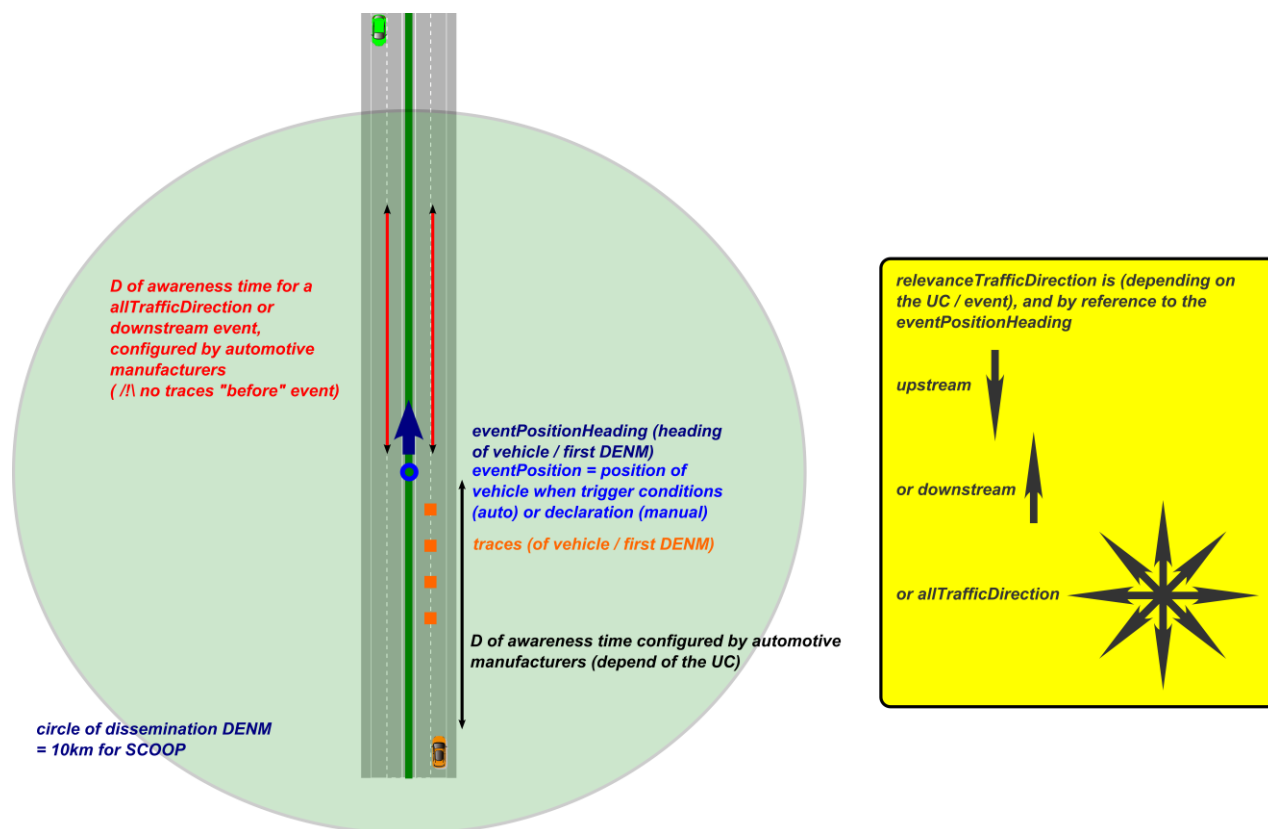


Figure 13: Illustration of punctual event

3.3.2 DENM forward

Two types of relays for DENM messages exist: a KAF (Keep Alive Forwarding) on application layer and a forward at the network and transport layer level. The SCOOP project chooses not to implement the KAF forwarding.

4. Message triggering conditions

4.1 Automatic transmissions by the Vru-ITS-S

4.1.1 A1: Data from the vehicle

The V-ITS-S generates CAM messages indicating the vehicle's status and position, which are received by all stations (V-ITS-S and R-ITS-S) within range of the vehicle.

The R-ITS-S that receives the CAMs from vehicles can perform different types of processing on these data before transmitting them to the Road Operator's Platform (calculate average speed, calculate traffic, average length, other consolidation of CAMs, etc.)

4.1.2 A2-D1: Temporary slippery road

Transmission conditions: Estimated loss of adhesion based on trigger information from the ABS/ASR, the travel of the pedals and the vehicle's acceleration and speed.

Use case	Information Quality defined for SCOOP	Trigger conditions	Comments
A2-D1 Warning temporary slippery road	0	[ASR request > 200 ms + accelerator pressure < 40%] or [ABS action > 200 ms + brake pressure < 50% of max]	
	1	[ASR request > 200 ms + accelerator pressure > 30% of max + acceleration < 40% of max] OR +[ABS action > 200 ms + brake pressure > 20% of max + deceleration < 50% of max] NOTE: values defined in reference to an equivalent situation with 0.85 asphalt	
	2	ASR request > 200 ms + accelerator pressure > 30% of max + [acceleration < 20% of max] NOTE: values defined in reference to an equivalent situation with 0.85 asphalt	
	3	[ASR request > 200 ms + accelerator pressure > 30% of max + acceleration < 10% of max] OR [ABS action > 200 ms + brake pressure > 20% of max + deceleration < 25% of max] NOTE: values defined in reference to an equivalent situation with 0.85 asphalt	
	4	ABS action > 200 ms + brake pressure > 20% of max + [deceleration < 10% of max] NOTE: values defined in reference to an equivalent situation with 0.85 asphalt	
	5	[ASR request > 200 ms + accelerator pressure < 30% of max during activation of the ASR] OR [ABS action + brake pressure < 20% of max]	
	6	Friction coefficient < 0.3 during at least 5s	
	7	Friction coefficient < 0.2 during at least 5s	

4.1.3 A2-D4a Stationary vehicle

Transmission conditions: Warnings activated and speed null during 30 seconds (Tempo reduced based on the position of the gearbox, the parking brake, the state of the doors, the seat belts and the ignition switch)

Use case	Information Quality defined for SCOOP	Trigger conditions	Comments
A2-D4a Warning stationary vehicle	1	Warning + V=0 since 30s	Risk of traffic jam without data on the vehicle's position (lane or shoulder)
	2	Warning + V=0 since 30s (can be reduced to 20s if enough triggering conditions) + [Neutral OR parking brake OR seat belt unbuckled]	Risk of traffic jam without data on the vehicle's position (lane or shoulder), for the case of the vehicle in neutral
	3	Warning + V=0 since 30s (can be reduced to 0 s if enough triggering conditions) + [door open during at least 3s OR -APC]	

4.1.4 A2-D4b Vehicle in breakdown

Transmission conditions: Service indicator light activated on the instrument panel + Warnings activated and speed null during 30 seconds (Tempo reduced based on the position of the gearbox, the parking brake, the state of the doors, the seat belts and the ignition switch).

Use case	Information Quality defined for SCOOP	Trigger conditions	Comments
A2-D4b Warning vehicle breakdown	1	Warning since 30s + Breakdown message on the instrument panel + V=0 since 30s	Risk of non-immobilising breakdown. The driver may be in a stopped situation to perform a diagnosis and decide to start again if not immobilising
	2	Warning since 20s + Breakdown message on the instrument panel + V=0 since 20s + [Neutral since 3s OR parking brake since 3s OR Brake activated since 3s OR seat belt unbuckled since 3s]	Risk of non-immobilising breakdown, especially for the case of a vehicle in neutral. Moreover, the driver may be in a stopped situation to perform a diagnosis and decide to start again if not immobilising
	3	Warning + Breakdown message on the instrument panel + V=0 + [door open during at least 3s OR IGN=OFF <u>since 3s</u>]	

4.1.5 A2-D5: Vehicle in an accident

Transmission conditions: Crash detected by the vehicle's passive safety systems (Stop the transmission if the vehicle moves).

NOTE: the automatic transmission will only occur if the crash is sufficiently strong and there is no loss of Battery.

Use case	Information Quality defined for SCOOP	Trigger conditions	Comments
A2-D5 Warning vehicle in accident (accident not secured)	0	Emergency triggering by the road operator + V=0 + 15s max between the 2 conditions	
	1	V=0 + manual E-call (or emergency button for ITSS-Vg) + 15s max between the 2 conditions	Vehicle stopped for a reason other than an accident (assault, passenger discomfort) and E-Call
	2	[crash without Pyro triggering OR pedestrian crash with reversible triggering] + V=0 15s max after crash	Even if the pyros don't trigger, one is able to know for example whether an APV crash has occurred (independently of the transmission from the crashoutput system --> airbag ECU analyses all signals) --> One can decide to restart for a small crash (vehicle moving) but probably not in a pedestrian crash, which supposes a rescue intervention
	3	Severe crash with Pyro OR Airbag triggering	

4.1.6 A2-D6: Reduced visibility

Transmission conditions: Fog lights and dipped headlights on during at least 20 seconds and taking into account the speed for the level of quality (60 km/h<)

Use case	Information Quality defined for SCOOP	Trigger conditions	Comments
A2-D6 Warning reduced visibility	0	7kmh<V<80kmh + Rear fog lights activated since 20 s	
	1	7kmh<V<80kmh + Rear fog lights and dipped headlights activated since 20 s	
	2	7kmh<V<60kmh since 20s + Rear fog lights and dipped headlights activated since 20 s	
	3	7kmh<V<80kmh + Visibility (fog) less than 80 m since 5s	
	4	7kmh<V<60kmh since 5s + Visibility (fog) less than 80 m since 5s	

4.1.7 A2-D10: Warning emergency brake

Transmission conditions: Automatic activation of emergency brake (Warning) lights and hard braking (>4m/s²)

Cause codes: 99 / 1: Dangerous situation / Emergency electronic brake lights

Use case	Information Quality defined for SCOOP	Trigger conditions	Comments
A2-D10 warning emergency brake	0	Hard braking (>4m/s ²) + brake activated	
	1	Automatic activation of emergency brake (Warning) lights + hard braking (>4m/s ²)	

4.1.8 A2-D11: Warning end of queue

Transmission conditions: Sudden slowdown in vehicle speed or warning lights on at least 3 seconds AND information on neighbouring vehicles (via CAM or vehicle sensor) AND vehicle outside urban zone, based on vehicle's speed and handling of the steering wheel (no 90° turn) in the preceding instants.

NOTE: This cause code (and its meaning) is provided in the DENM, but not in the RHS standard (but recommended in the C2C)

Use case	Information Quality defined for SCOOP	Trigger conditions	Comments
A2-D11 Warning end of queue	TC_0	The ego vehicle has an initial speed up to 80 km / h and a deceleration lower than or equal to - 0.1 m / s. The driver reacts to a dangerous situation end of queue reducing its speed to a lower speed lower than or equal to 30 km / h. The latency of the initial speed at the target speed should be less than 10s. An instantaneous deceleration between the initial speed and the target speed lower than -3.5 m / s is detected.	
	TC_1	The driver of the ego vehicle reacts to the traffic jam by starting the hazard lights for at least 3s.	
	TC_2	At least three other vehicles with a speed of at least 7 km / h have their hazard lights on for at least 3s.	

A DENM is generated if one of the following conditions is met:

- TC_0 and TC_2
- TC_1 and TC_2

The quality level is only 1 (no level 2 or 3).

4.1.9 A2-E6: Exceptional weather conditions

Transmission conditions: Windscreen wipers at maximum speed and dipped headlights on during at least 20 seconds and taking into account the speed for the level of quality

Use case	Information Quality defined for SCOOP	Trigger conditions	Comments
A2-E6 Warning exceptional weather conditions	0	7km/h<V<80km/h since 20s + Windscreen wipers at MAX since 20s	
	1	7kmh<V<80kmh + [Windscreen wipers at MAX + dipped headlights] since 20s	
	2	7kmh<V<60kmh since 20s + [Windscreen wipers at MAX + dipped headlights] since 20s	
	3	7kmh<V<80kmh + Rain Sensor Measurement >90% of max measurable since 20s + [Windscreen wipers at MAX + dipped headlights] since 20s	
	4	7kmh<V<60kmh since 20s + Rain Sensor Measurement >90% of max measurable since 20s + [Windscreen wipers at MAX + dipped headlights] since 20s	

4.2 Automatic transmissions by the Vro-ITS-S

The transmission conditions for the messages sent by the operator vehicles in "user" mode will be the same as the transmission conditions for the messages sent by the user vehicles for the use cases concerned.

The transmission conditions for the messages sent by the operator vehicles in « operator » mode should be as detailed bellow:

		Context	CauseCode	SubCauseCode	Triggering conditions
B1	Planned roadworks - Slow moving road maintenance		3 (roadworks)	3 (slow moving road maintenance)	Activity is « chantier mobile » (mobile roadworks) AND ((manual activation) XOR (automatic : light arrow OR an other equipment is activated))
		In case of a mobile marking operation	15 (rescue and recovery work in progress)	0 (unavailable)	(Activity is « chantier fixe » OR « chantier mobile » (fix or mobile roadworks)) AND ((manual activation) XOR (automatic : beacon OR an other equipment is activated))
B2	Road operator's intervention		15 (rescue and recovery work in progress)	0 (unavailable)	(Activity is « patrouillage » OR « intervention ») AND ((manual activation) XOR (automatic : speed \leq Vstop* AND (beacon OR an other equipment is activated)))
			26 (slow vehicle)	1 (maintenance vehicle)	Activity is « patrouillage » AND ((manual activation) XOR (automatic : Vstop* < speed \leq Vslow* OR (beacon OR an other equipment is activated)))
			95 (emergency vehicle approaching)	0 (unavailable)	Activity is « intervention » AND ((manual activation) XOR (automatic : beacon OR an other equipment is activated))

		Context	CauseCode	SubCauseCode	Triggering conditions
B3	Winter maintenance		26 (slow vehicle)	6 (snow plough)	Activity is « VH » AND ((manual activation) XOR (automatic : snow blade is down))
			26 (slow vehicle)	8 (salting vehicle)	Activity is « VH » AND (triggering conditions for 26/6 are not reached) AND ((manual activation) XOR (automatic : salting is on))
			3 (roadworks)	6 (winter service)	Activity is « VH » AND (triggering conditions for 26/6 OR 26/8 are not reached)

* : Vstop=15km/h and Vslow=90km/h may be first values of reference for SCOOP. But they can be changed by road operator's settings for OBU.

Road operators are invited to choose between manual or automatic for triggering conditions, on a case-by-case basis for each activity.

When trigger conditions are no longer met (eg when changing activity), the current case of use is cancelled.

4.3 Automatic transmissions from the TMS

These transmissions concern the messages transmitted by the TMS, which will then be broadcasted by the Vru-ITS-S.

5. Major display prioritisation principles

The message display principles for the HMI are detailed in the deliverables of specifications 2.4.2.2 and 2.4.2.3.

The parameters taken into account for the display are all of the information in the DENM fields.

The main parameters taken into account to determine the type of display on the screen are:

- the location of the event (eventPosition and eventHistory)
- the type of event (eventType)
- the event's validity duration (validityDuration)
- the quality level (informationQuality)

6. Communication Profiles

A communication profile describes a set of communication protocol. Each communication profile has different characteristics in terms of performance, bandwidth and reliability. A use case may use one or more profiles for exchanging messages between the systems to meet the communications requirements. A C-ITS-S should be able to select an optimal communication profile for each message transmission. This feature is specified as the management entity component.

In wave 1, between C-ITS-S:

- for the exchange of CAM/DENM messages, CP1 will be the used.
- for the PKI requests and logs, CP8 will be the used.

Communication Profile	Transport	Network	Access
CP1	BTP (Basic transport Protocol)	Geonetworking	ITS G5 CCH
CP2	BTP (Basic transport Protocol)	Geonetworking	ITS G5 SCH1
CP3	BTP (Basic transport Protocol)	Geonetworking	ITS G5 SCH2
CP4	BTP (Basic transport Protocol)	Geonetworking	ITS G5 SCH3
CP5	TCP	IPV4	ITS G5 SCH1
CP7	UDP	IPV4	ITS G5 SCH1
CP8	TCP	IPV6	ITS G5 SCH1
CP9	UDP	IPV6	ITS G5 SCH1
CP11	TCP	IPV4	3G/4G
CP12	UDP	IPV4	3G/4G
CP13	TCP	IPV6	3G/4G
CP14	UDP	IPV6	3G/4G
CP15	TCP	IPV4	Ethernet
CP16	UDP	IPV4	Ethernet
CP17	TCP	IPV6	Ethernet
CP18	UDP	IPV6	Ethernet

Table 32: Communication profiles

7. Network and Transport Layer

Regarding geonetworking forwarding algorithms, only the Simple GeoBroadcast forwarding (annex D ETSI TS 102 636) is required in SCOOP. However, other algorithms can also be implemented.

According to GeoNet specifications, the conservation period of the CAM certificate is set to 1s before erasing the CAM certificate.

The HopLimit is set to 10. After each hop, the count is decreased by the value -1.

8. Security

Security aspects are part of deliverables 2.4.4.X

But regarding the pseudonym changes, none of them can occur during PKI request, transmission of logs, or sending a DENM message.