



French C-ITS Deployment Coordination committee

# Vro-Global-System 2422\_M – VroES DENM services

## 2.4.2.2\_M\_DENM\_Event

**Activity 2: Studies**

Sub Activity 2.4 > Specifications



## Information on the document

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# Quality rules

## Reference to the version administration

Version number to be composed of 3 digits > vR.XY

- **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

Once the deliverable is release, its version number is upgraded from vR.XY to v(R+1).00

As illustration:

- 0.03 > Work in progress version
- 0.10 > Del. Approved by SC Studies but not released
- 2.00 > Del. approved & released (in release 2)
- 2.05 > Del. Updated - in progress version

## Requirements identification & traceability

In this document, the following verbal forms are used to indicate requirements: **Shall / Shall not**

Recommendations shall be indicated by the verbal forms: **Should / Should not**

Permissions shall be indicated by the verbal forms: **May / May not**

Possibility and capability shall be indicated by the verbal forms: **Can / Cannot**

Inevitability used to describe behaviour of systems beyond of the scope of this del. shall be indicated by: **Will / Will not**

Facts shall be indicated by the verbal forms: **Is / Is not**

In the table here below:

2.4.X.XX > is the number given to the deliverable (e.g. 2.4.4.8)

YYYY > for digit are given to identifying which component/entity the requirement is addressing (e.g. LTCA for long term certificate authority)

ZZZ > is the numeration of the requirement

<b>ID</b>	<b>2.4.X.XX-YYYY-ZZZ</b>
<b>Component(s)</b>	(e.g.) Vru-ITS-S, Vro-ITS-S, R-ITS-S, PKI
<b>Requirement</b>	(e.g.) An ITS station SHALL be able to request and get a Long-Term Certificate (LTC) from the SCOOP Public Key Infrastructure (PKI).
<b>Acceptance</b>	(e.g.) CA1: Vru-ITS-S sends a LTC request to the LTCA CA2: R-ITS-S relays the LTC request CA3: The LTCA verifies the request and sends a response CA4: The R-ITS-S relays the response CA5: The response is received by the Vru-ITS-S and is valid
<b>Additional information</b>	

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# 1 Introduction

## 1.1 Purpose of the document

The present document is an annex of “Vro-Global-System 2422\_M - Main Document”. It completes the main document by specifying the handling of DENM and the events supported by this type of messages.

**/!\ Warning:** The requirements of the present document absolutely cannot be extracted without taking into account the master’s ones.  
e.g., some general phrasing in the present document might indicate that the requirement is applicable in all case, while the master limits the usage via a filtering process.

## 1.2 Context

This document is added to the 2.4.2.2x bundle during a restructuration of the bundle. It is created to split the handling of events depending on the type of message that carries the information. This document covers all DENM defined in Scoop 1, parts of Scoop 2 and C-Roads. The handled events supported by DENM messages are listed in Annex A.

## 1.3 Document organisation

In order both to specify the current supported events, and to easily add new events based on DENM, the document contains:

- ❑ The list of events treated in the present document along with a short description (§ 3)
- ❑ A description (§ 4) of the functional requirements of the DEN services to be implemented to handle properly the events based on DENM. Each service implements partially the [VroES service] defined in [DA1]. When needed, an activity diagram specifies the responsibilities’ distribution between the different sub-systems of the VroES.
- ❑ The general requirements applicable no matter the DEN service (§ 5) including the DEN service identification diagram in § 5.1.
- ❑ The distribution DEN service ⇔ VroES service (§ 6) allowing a direct link between the master document [DA1] and the present document.

## 1.4 Definitions and Abbreviations

### 1.4.1 Abbreviations

Term	Definition
<b>CAM</b>	Cooperative Awareness Message
<b>CAN</b>	Car Access Network – standard access bus to the vehicle electronics
<b>C-ITS</b>	Cooperative – Intelligent Transport Systems
<b>[DAX]</b>	Document Applicable n°x
<b>DENM</b>	Decentralized Environmental Notification Message
<b>[DRx]</b>	Document de Référence n°x
<b>DSL</b>	Dynamic Speed Limit
<b>eVMS</b>	Embedded Variable Message Signal
<b>ICPU</b>	Information and Communication Processing Unit
<b>HMI</b>	Human-Machine Interface
<b>MRI</b>	Multi-lane road-information
<b>Nfr-ITS-S</b>	National French ITS Station
<b>PKI</b>	Public Key Infrastructure
<b>POI</b>	Point Of Interest
<b>PFro</b>	Platform road operator
<b>R-ITS-S</b>	Roadside ITS station
<b>SCOOP@F</b>	French C-ITS pre-deployment project – European Project
<b>SRI</b>	Single-lane road-information
<b>TMS</b>	Traffic Management System
<b>TSL</b>	Temporary Speed Limit
<b>V-ITS-S</b>	Vehicle ITS station
<b>VroES</b>	Vro Embedded System



## 1.4.2 Definitions

Term	Definition
DE	As defined in [DA1], data type that contain one single data.
DF	As defined in [DA1], data type that contain more than one data element in a predefined order (it may imply presence of others DF)
Triggering condition	Generic terms used when there is no need to differentiate the three possible triggering sources. As defined in [DA1], the three triggering sources are: <ul style="list-style-type: none"> <li>□ Declaration via the tablet,</li> <li>□ Equipment data,</li> <li>□ CAN Bus data.</li> </ul>
Event	As defined in [DA1], corresponds to the “use cases” in the project context. e.g. D2a Animal on the Road, C3 eVMS, D7 Wrong Way Driving, D10 emergency breaking
Rx Event	As defined in [DA1], abstract concept that regroups events which are received by the Vro ITS S, whether they are received from the PFro, Nfr or other C-ITS-S.
Tx event	As defined in [DA1], abstract concept that regroups events which origin is the Vro-ITS-S, whether they are automatically or manually triggered
DEN service	Use cases defined in the present document (see Figure 1) allowing the Vro-ITS-S to handle the events supported by DENM. E.g., Manage punctual events
VroES service	Service as defined in the master document [DA1]. e.g., Display events on the HMI.
DTE	“Distance to event” in meters. Represents the distance to reach the event considering that the Vro-ITS-S will take the shortest path to the event.
TTE	“Time to event”, in seconds. Represents the time to reach the event considering the DTE and that the Vro-ITS-S will keep its current speed.

## 1.5 Parameter naming and usage

There are 3 different levels of parameters used to implement the setting of the Vro-Global-System. All those parameters are configurable via the Scoop Server. The following table sums up their usage and meaning:

Type	Description
General (_GEN_)	Those parameters allow to set up the general behavior of the application (setting of the DENMs, settings of the logs, exchange with PFro, Road Operator Specific Software...) They are relevant for the all Vro-ITS-S

	<p>connected to the Scoop Server.</p> <p>Those parameters are used by the Scoop Tablet Software and Scoop ICPU Software</p>
Vehicle (_VEH_)	<p>Those parameters allow the customization of each Vro-ITS-S vehicle characteristics (vehicle dimensions, position of the antennas, Mobile-R-ITS-S identification, CAN dictionary...)</p> <p>Those parameters are used by the Scoop ICPU Software and the Basic ICPU Software.</p>
ICPU (_ICPU_)	<p>Those parameters only impact the behavior of the Basic ICPU Software. They are all set in the Scoop Server which provides a service to download this setting.</p> <p>However, contrary to the General and Vehicle setting, those parameters can also be generated and managed by the Vro-ITS-S server. The choice to either use one setting or the other is up to the road operator organizations and their ICPU sub-contractor.</p> <p>Those parameters can be either specific to each ICPU or global to all the road operator's ICPU.</p>

Each time a parameter is used, its type is indicated: *GEN – VEH – ICPU*.  
In addition, if the parameter applies only to one ICPU, it is stated.

## 2 Documents

### 2.1 Reference documents

Id.	Reference	Version	Title / Content
[DR1]	-	-	-

### 2.2 Applicable documents

Id.	Reference	Version	Title / Content
[DA1]	2.4.2.2_M_Vro_System	0.40	Specifications of the Vro-Global-System 2422_M - Main Document
[DA2]	2.4.1.2_M	see Master	Master technical specifications for I2V use cases
[DA3]	2.4.1.1_M	V4.70(*)	Master technical specifications for V2X use cases
[DA4]	2.4.1.1_M_D12(EVA)	V0.20	Common technical specifications for use cases Emergency vehicle approaching
[DA5]	2.4.1.2_M_E7(TJA)	V0.10	Common technical specifications for use cases Traffic Jam Ahead (I2V)
[DA6]	2.4.1.1_M_I5	V0.10	Common technical specifications for use cases Vulnerable user at a public transport stop
[DA7]	2.4.1.1_M_L2(SLEV)	V0.10	Common technical specifications for use cases Stationary law enforcement vehicle (V <sub>LE</sub> V2V)
[DA8]	C2CCC_RS_2006_StationaryVehicle	R_1.6.1	Triggering Conditions and Data Quality Stationary Vehicle Warning
[DA9]	C2CCC_RS_2003_DangerousSituation	R_1.6.1	Triggering Conditions and Data Quality Dangerous Situation
[DA10]	C2CCC_RS_2002_AdverseWeather	R_1.6.1	Triggering Conditions and Data Quality Adverse Weather Conditions
[DA11]	C2CCC_RS_2007_TrafficJam	R_1.6.1	Triggering Conditions and Data Quality Traffic Jam
[DA12]	ETSI EN 302 637-3	v1.3.1	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service
[DA13]	2.4.1.4_M ANNEXE 1	v4.80	Datex II adapted for DENM between PF and R-ITS-S
[DA14]	2.4.1.4_M	see Master	Specification of DATEX II v2.3 messages in conjunction with C-ITS messages
[DA15]	Infrastructure mobile ITS-G5 System Profile	see Master	Infrastructure mobile ITS-G5 System Profile
[DA16]	2.4.2.2_M_DENM_Event annexA	0.20	Event based on DENM, description of expected emission and reception

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(\*) This version does not correctly take into account C-Roads PF 2.0. The requirements contained in this document [DA3] should be reconsidered in the event of any discrepancies.

Note: The listed version of [DA13] is not the latest approved version.

## 3 Project use case description

New created events of the project have a proper document describing the usage, filling rules and the context of an event.

As most of the events supported by DENM messages don't have such a description, this chapter defines in short terms the events.

**!/\ This is informative and not normative!**

### 3.1 Dx – Hazardous location notifications

#### 3.1.1D1-Temporary slippery road

“Temporary slippery road” is an event that describes a location in which the risk of low adherence is high. This event can be either triggered by:

- ❑ The road operator in the TMS based on different data sources (e.g. camera, road user's reports),
- ❑ A vehicle automatically.
  - ➔ The vehicle detects the tire slip and aggregate all those punctual detections to create a zone where the event is relevant.



#### 3.1.2D2a-Animal on the road

“Animal road” is an event that describes a location in which the risk of encountering one/many animal(s) is high. This event can be either triggered by:

- ❑ The road operator in the TMS based on different data sources (e.g. camera, road user's reports),
- ❑ A vehicle manually by the driver when the animal is encountered.



#### 3.1.3D2b-People on the road

“People on road” is an event that informs of the whereabouts of person. It has the same characteristics as the event [D2a Animal on the road](#).



#### 3.1.4D3-Obstacle on the road

“Obstacle on the road” is an event that describes a location in which one/many obstacle(s) may impact the driver's behavior. This event can be either triggered by:

- ❑ The road operator in the TMS based on different data sources (e.g. camera, road user's reports),
- ❑ A vehicle manually by the driver when the obstacle is encountered.



### 3.1.5D4a-Stationary vehicle

“Stationary vehicle” is an event that informs of the presence of stationary vehicle at a specific location. The event is thus described by a punctual reference where the vehicle is located. This event can be either triggered by:

- ❑ The road operator in the TMS based on different data sources (e.g. camera, road user’s reports),
- ❑ A vehicle automatically. The vehicle that triggers is the one that is stationary.



### 3.1.6D4b-Vehicle in breakdown

“Vehicle in breakdown” is an event similar to [D4a Stationary vehicle](#). The difference lies in the fact that the vehicle is intended to stay still for a moment due to breakdown.



### 3.1.7D6-Reduced visibility

“Reduced visibility” is an event similar to [D1-Temporary slippery road](#). The difference lies in the fact that apart from the driving condition involved: low visibility instead of low grip.



### 3.1.8D5-Vehicle in an accident

“Vehicle in an accident” is an event that informs of the presence of an accident on the road. This event can be either triggered by:

- ❑ The road operator in the TMS based on different data sources (e.g. camera, road user’s reports),
- ❑ A vehicle automatically if the vehicle itself is crashed.
- ❑ A vehicle manually if it informs of other’s accident close to its position.



### 3.1.9D7- Wrong way driving

This I2V event only informs of the presence of a vehicle driving on the opposite direction as the allowed flow on a carriageway. It is a critical event that may imply lethal accidents. It is only triggered by the road operator in the TMS based on different data sources (e.g. camera, road user’s reports).



### 3.1.10 D8-Unsecured blockage of a road

“Unsecured blockage of the road” is an event that informs that a road is not usable past a certain reference. This allows rerouting of the vehicles driving towards the blocked road. This event can be either triggered by:

- ❑ The road operator in the TMS based on different data sources (e.g. camera, road user’s reports),
- ❑ A vehicle manually.



### 3.1.11 D10-Warning - emergency brake

“Emergency Brake” is an event triggered by a vehicle after a breaking that implies a risk of collision. The vehicle transmitting this message is considered as a point as it emits it during a really short period.

This event can only be triggered automatically by a vehicle.



### 3.1.12 D11- Warning end of queue

« Warning end of queue » is an event that informs of the accurate position of the start of a traffic jam. This event can be either triggered by:

- ❑ The road operator in the TMS based on different data sources (e.g. camera, road user’s reports), needs to be accurate
- ❑ A vehicle automatically.



⚠ This use is to be differentiated from the E7 of § 3.2.2 which is less accurate, but gives more information like the length of the traffic jam.

**Note:** The trigger from the infrastructure requires a translation from Datex which is not yet available. At the date of writing, only the trigger from vehicle is applicable.

### 3.1.13 D12-Emergency vehicle approaching

This use case is described in [DA4].

The event represents the location of a vehicle which might have unconventional speed/behavior due to the emergency status.



## 3.2 Ex – Traffic information and smart routing

### 3.2.1 E6-Exceptional weather conditions

“Exceptional weather conditions” is an event similar to [D1-Temporary slippery road](#) apart from the driving condition involved: thunderstorm instead of low grip.



### 3.2.2 E7-Traffic jam ahead

This use case is described in [DA5].

⚠ This use case is to be differentiated from the D11 of § 3.1.12. Both concern traffic jam, but E7 is a zone in which the traffic jam is located (beginning and end), the delay to go over it etc. It is less accurate than § 3.1.12 D11- Warning end of queue but contains more information.



## 3.3 Ix – Vulnerable Users

### 3.3.1 I5-Vulnerable user at a public transport stop

This use case is described in [DA6].

Warns that a public transport vehicle is stop at a specific location, implying a risk of collision.

This use case is partially covered by § 3.1.3 D2b-People on the road.



## 3.4 Lx - Law enforcement

### 3.4.1 L2- Stationary law enforcement vehicle

This use case is described in [DA7].

The event represents the location of a vehicle which is stopped due to a law enforcement situation. The vehicle might be stationary at an unconventional location.



## 3.5 Bx - Road works warning

Bx events are all triggered by the Vro-ITS-S. All those events are meant to inform of the position of the Vro and the work in progress.

### 3.5.1 B2a-Road operator vehicle approaching

“Operator vehicle approaching” is an event triggered by an operator vehicle to inform nearby vehicle of its movement. The expected behaviour from the vehicles on the reception side is to let a free passageway on the carriageway.

This event can only be triggered automatically by a vehicle.



### 3.5.2 B2b-Road operator vehicle in intervention

“Road operator vehicle in intervention” is an event triggered by an operator vehicle to inform nearby vehicle that it is stopped on the carriageway. It is not a stationary vehicle as the purpose of the vehicle is linked to the road management (e.g. protection of a stopped vehicle, removal of an obstacle on the road etc.).

This event can only be triggered automatically by a vehicle.



### 3.5.3 B2c-Road operator vehicle in patrol

“Road operator vehicle in patrol” is an event triggered by an operator vehicle to inform nearby vehicle that the vehicle is driving at a low speed. This allows the operator to check the state of the carriageway (= patrol).

This event can only be triggered automatically by a vehicle.





### 3.5.4B3a-Salting in process

“Salting in process” is an event triggered by an operator vehicle to inform nearby vehicle that the vehicle is driving at a low speed and that it is forbidden to overtake it. This allows the operator to safely spread salt on the carriageway. This event can only be triggered automatically by a vehicle.



### 3.5.5B3b-Snow removal in process

“Snow removal in process” is an event triggered by an operator vehicle to inform nearby vehicle that the vehicle is driving at a low speed and that it is forbidden to overtake it. This allows the operator to safely remove the snow from the carriageway. This event can only be triggered automatically by a vehicle.



### 3.5.6B3c-Winter maintenance - alert vehicle moving

“Winter maintenance - alert vehicle moving” is an event triggered by an operator vehicle to alert the road user that the vehicle has unusual dimensions. (due to snow plough, salting trailer etc.). This event can only be triggered automatically by a vehicle.



### 3.5.7B1c-Mobile planned roadwork

“Mobile planned roadwork” describes the whereabouts of road operator vehicles realising roadworks while in displacement.

This event can be either triggered by:



- The road operator in the TMS based on different data sources (e.g. camera, road user's reports): estimation of the zone in which the road operator vehicle is manoeuvring.
- A vehicle automatically: real time detection of the position of the vehicle realising the mobile roadworks.

### 3.5.8B1a & B1b Roadworks Warning

Topic still pending

## 4 VroES DENM services

In order to facilitate the addition of future events supported by DENM messages, this document introduces the concept of **DEN services**.

The current distribution of [Event] in the DENM services is described in Annex A.

Figure 1 represents the services supported by the Vro-ITS-S in the scope of the usage of DEN messages.

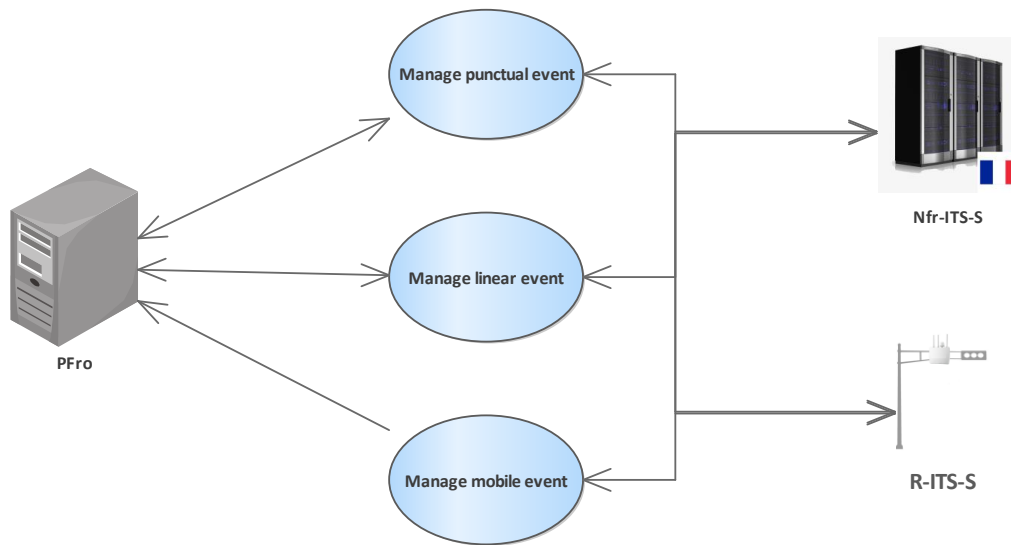


Figure 1: DEN services

The term "Manage" covers the requirements related to the DATEX translation function (Mobile R-ITS-S function is defined in [DA1]) as well as those related to the triggering and the display.

The above [DEN services] are therefore a specialization of the more generic [VroES services] of the Master document [DA1]. The coverage of the [VroES services] by the [DEN services] is described in § 6.

## 4.1 Manage punctual event

The events concerned by this service are identified in Annex A. (DEN Service = Punctual)  
The activity diagram Figure 11 completes the requirements defined in this paragraph.

### 4.1.1 Display

ID	2.4.2.2_Denm-PCTL-001(1)
Component(s)	VroES; Scoop Server
Requirement	When a DENM is received, the Vro-ITS-S shall identify a punctual event by checking that: <ul style="list-style-type: none"> <li>The DF eventHistory is not present in the message,</li> <li>The Rx event is configured with p_GEN_RxMobileEvent set to "False"</li> </ul>
Additional information	See DEN service identification in § 5.1 The events with p_GEN_RxMobileEvent set to "False" are defined in Annex A

ID	2.4.2.2_Denm-PCTL-002(1)
Component(s)	VroES

Requirement	When a DATEX is received, the Vro-ITS-S shall identify a punctual event following the requirements in § 4.1.5
Additional information	N/A

#### 4.1.1.1 Display an icon

ID	2.4.2.2_Denm-PCTL-003(1)
Component(s)	VroES
Requirement	When a punctual event is received, an icon shall be displayed on the map at the map-matched position of the event defined by the DF <i>eventPosition</i> .
Additional information	The concept of icon is defined in [DA1].

ID	2.4.2.2_Denm-PCTL-004(1)
Component(s)	VroES
Requirement	The icon's textual description and pictogram of a received punctual event shall respect Annex A. The icon's Quality of Information shall respect § 5.2.
Additional information	N/A

ID	2.4.2.2_Denm-PCTL-027(1)
Component(s)	VroES
Requirement	When a punctual event is triggered, an icon shall be displayed on the map at the map-matched position of the event defined by the DF <i>eventPosition</i> .
Additional information	The concept of icon is defined in [DA1].

ID	2.4.2.2_Denm-PCTL-005(1)
Component(s)	VroES
Requirement	The icon's textual description and pictogram of a triggered punctual event shall respect Annex A.
Additional information	N/A

#### 4.1.1.2 Display an alert

ID	2.4.2.2_Denm-PCTL-006(1)
Component(s)	VroES; Scoop Server
Requirement	<p>The Vro-ITS-S shall display an alert of a punctual event when:</p> <ul style="list-style-type: none"> <li>- The event is on the trajectory of the Vro-ITS-S,</li> <li>- The event is at a relevant distance from the Vro-ITS-S: <ul style="list-style-type: none"> <li>o <math>TTE &lt; p\_GEN\_DisplayTTE</math>,</li> </ul> </li> </ul> <p><math>p\_GEN\_DisplayTTE</math> shall be configurable per event.</p>
Additional information	N/A

ID	2.4.2.2_Denm-PCTL-007(1)
Component(s)	VroES
Requirement	<p>The Vro-ITS-S shall display an alert until the event is no more on the trajectory of the Vro-ITS-S.</p>
Additional information	N/A

ID	2.4.2.2_Denm-PCTL-008(1)
Component(s)	VroES; Scoop Server
Requirement	<p>The Vro-ITS-S shall display an alert at least <math>p\_GEN\_MinDisplayingDuration</math> seconds.</p>
Additional information	This avoids the display of flash alerts.

ID	2.4.2.2_Denm-PCTL-009(1)
Component(s)	VroES
Requirement	<p>An alert of punctual event shall contain the following information:</p> <ul style="list-style-type: none"> <li>o The same content as the icon (described in 4.1.1.1)</li> <li>o The DTE</li> </ul>
Additional information	N/A

ID	2.4.2.2_Denm-PCTL-010(1)
Component(s)	VroES
Requirement	<p>The DTE of a punctual event's alert shall evolve with the movement of the vehicle.</p>
Additional information	N/A

ID	2.4.2.2_Denm-PCTL-011(2)
Component(s)	VroES; Scoop Server
Requirement	When an alert is displayed, the Vro-ITS-S shall emit the alert sound associated to the Rx event.
Additional information	<p>The alert sound is configurable per event.</p> <p>The contents of sound alert are described in 2.4.2.2_M_DENM_Event_annexA. The audio files for sound alert are configured by a Scoop super administrator. The choice of whether or not to associate a sound alert with a Rx event is made by a Scoop super administrator.</p>

## 4.1.2 Manual triggering – Field filling rules

The events manually triggerable are defined in Annex A. (tab “Emission\_Vro” => Manu/Auto)  
The activity diagram Figure 12 completes the requirements defined in this paragraph.

ID	2.4.2.2_Denm-PCTL-012(1)
Component(s)	VroES
Requirement	<p>After the manual trigger of a punctual event, the Vro-ITS-S shall create a DENM that complies with [DA3] §2.4 for all “mandatory” and “used” fields.</p> <p>To complete [DA3], the filling of the <i>DF Trace</i> and <i>StationType</i> shall be implemented following § 5.</p>
Additional information	<p>/!\ Some DE/DF are event dependant and defined in §3 of [DA3]:</p> <ul style="list-style-type: none"> <li>- relevanceTrafficDirection</li> <li>- validityDuration</li> <li>- eventType</li> </ul>

ID	2.4.2.2_Denm-PCTL-013(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall set the field positioningSolution in accordance with the GNSS system used to estimate the event position.
Additional information	This field is “optional” in [DA3] but is mandatory for Vro-ITS-S.

ID	2.4.2.2_Denm-PCTL-014(1)
Component(s)	VroES
Requirement	<p>The Vro-ITS-S shall not fill a DENM with the following fields, optional in [DA3]:</p> <ul style="list-style-type: none"> <li>• eventHistory,</li> <li>• eventPositionHeading,</li> <li>• eventSpeed,</li> <li>• roadType,</li> <li>• impactReduction,</li> <li>• roadWorks,</li> <li>• stationaryVehicle.</li> </ul>
Additional information	N/A

ID	2.4.2.2_Denm-PCTL-015(1)
Component(s)	VroES
Requirement	<p>A driver shall be able to modify the relevanceTrafficDirection of a manually triggered punctual event. The driver can select between the following values:</p> <ul style="list-style-type: none"> <li>▪ upstreamTraffic(1)</li> <li>▪ oppositeTraffic(3)</li> <li>▪ allTrafficDirections(0).</li> </ul>
Additional information	N/A

ID	2.4.2.2_Denm-PCTL-016(1)
Component(s)	VroES
Requirement	<p>When the driver modifies the relevanceTrafficDirection of a manually triggered event, the Vro-ITS-S shall trigger an update DENM with the new values of relevanceTrafficDirection.</p>
Additional information	N/A

ID	2.4.2.2_Denm-PCTL-017(1)
Component(s)	VroES
Requirement	<p>A driver shall be able to modify the position of a manually triggered punctual event.</p>
Additional information	<p>This allows to trigger an event far from the vehicle's position.</p>

ID	2.4.2.2_Denm-PCTL-018(2)
Component(s)	VroES
Requirement	<p>When the driver updates the position of a manually triggered punctual event, it shall trigger an update DENM with the following modifications:</p> <ul style="list-style-type: none"> <li>- position.latitude is set to the new value,</li> <li>- position.longitude is set to the new value,</li> <li>- position.confidencePositionEllipse is set to unavailable,</li> <li>- position.altitude is set to unavailable,</li> <li>- locationContainer.trace is emptied i.e no pathpoint in the DF.</li> </ul>
Additional information	N/A

ID	2.4.2.2_Denm-PCTL-019(1)
Component(s)	VroES
Requirement	<p>When the driver cancels a manually triggered punctual event, the Vro-ITS-S shall trigger a cancellation DENM following [DA3] §2.4 DE <i>termination</i>.</p>
Additional information	This also includes dissemination rules for cancellation DENM.

### 4.1.3 Automatic triggering – Field filling rules

The events automatically triggerable are defined in Annex A. (emission side => Manu/Auto)  
The activity diagram Figure 13 completes the requirements defined in this paragraph.

Punctual events automatically triggered are defined in C2C specifications.  
The association event <=> C2C specification is defined in Table 1.

Event	Applicable document	C2C event name
D4a-Stationary vehicle	[DA8]	Stopped vehicle
D4b-Vehicle in breakdown	[DA8]	Broken-down vehicle
D5-Vehicle in an accident	[DA8]	Post-crash
D10-Warning - emergency brake	[DA9]	Electronic emergency brake light
D11-Warning end of queue	[DA11]	Dangerous end of queue

Table 1: Correspondence punctual event <-> C2C events

ID	2.4.2.2_Denm-PCTL-020(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall automatically trigger a punctual event when the triggering conditions are reached. The triggering conditions shall be set as described in the C2C specifications (see Table 1)
Additional information	N/A

ID	2.4.2.2_Denm-PCTL-021(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall create DENMs following the C2C specifications (see Table 1) for triggering, update and cancellation unless a requirement of the present document contradicts the C2C specifications
Additional information	N/A

ID	2.4.2.2_Denm-PCTL-022(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall fill the DF <i>Trace</i> of a DENM following § 5.4.
Additional information	This requirement is not compliant with C2C specifications.

ID	2.4.2.2_Denm-PCTL-023(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall fill the DE <i>stationType</i> of a DENM following § 5.5
Additional information	This requirement is not compliant with C2C specifications.

#### 4.1.4 Inform PFro

The activity diagram Figure 16 completes the requirements defined in this paragraph.

ID	2.4.2.2_Denm-PCTL-024(1)
Component(s)	VroES
Requirement	<p>The Vro-ITS-S shall translate into C-ITS DATEX a DENM (received or emitted) corresponding to a punctual event following the translation rules defined in [DA13] and [DA14].</p> <p>The translation rules are specific for each event based on the pair causeCode/subCauseCode of the DENM.</p>
Additional information	/!\ The translation for event D5 – “Accident” is different whether it is manually (causeCode 2) or automatically triggered (causeCode 94)



## 4.1.5 Relay information from PFro

The activity diagram Figure 17 completes the requirements defined in this paragraph.

ID	2.4.2.2_Denm-PCTL-025(1)
Component(s)	VroES; Scoop Server
Requirement	<p>When a Datex is received, the Vro-ITS-S shall identify a punctual event by checking that:</p> <ul style="list-style-type: none"> <li>- The tag &lt;LinearWithinLinearElement&gt; is absent in the Datex</li> <li>- The Rx event associated to the Datex is configured with p_GEN_RxMobileEvent set to "False"</li> </ul>
Additional information	The Rx event identification from a Datex is realised thanks to [DA13], tab <i>Downward_usecases_B_and_D</i> , field [B.4 Situation_B.17 EventType]

ID	2.4.2.2_Denm-PCTL-026(1)
Component(s)	VroES
Requirement	<p>The Vro-ITS-S shall translate into DENM a received C-ITS DATEX corresponding to a punctual event following the translation rules defined in [DA13] and [DA14].</p> <p>To complete [DA13] and [DA14], the filling of the DE <i>informationQuality</i> and <i>StationType</i> shall be implemented following respectively § 5.2 and § 5.5.</p>
Additional information	The events concerned by the translation are listed in Annex A column R-ITS-S. Thus, the Vro-ITS-S is able to translate from C-ITS Datex the same events that can be received from a R-ITS-S.

## 4.2 Manage linear event

The events concerned by this service are identified in Annex A. (DEN Service = Linear)

### 4.2.1 Display

The activity diagram Figure 11 completes the requirements defined in this paragraph.

ID	2.4.2.2_Denm-LINE-001(1)
Component(s)	VroES
Requirement	When a DENM is received, the Vro-ITS-S shall identify a linear event by checking: <ul style="list-style-type: none"> <li>The presence of DF eventHistory in the message,</li> </ul>
Additional information	See DEN service identification in § 5.1 The list of linear events is defined in Annex A.

ID	2.4.2.2_Denm-LINE-002(1)
Component(s)	VroES
Requirement	When a DATEX is received, the Vro-ITS-S shall identify a linear event following the requirements in 4.2.4.
Additional information	N/A

#### 4.2.1.1 Display an icon

ID	2.4.2.2_Denm-LINE-003(1)
Component(s)	VroES
Requirement	When a linear event is received, the Vro-ITS-S shall display an icon at the closest map-matched position in <i>[eventPosition and eventHistory]</i> with regards to the Vro-ITS-S location. (Distance as a crow flies)
Additional information	Indeed, the eventPosition is not always the closest position of the event. (e.g. road with entry slip road)

ID	2.4.2.2_Denm-LINE-004(1)
Component(s)	VroES
Requirement	When a linear event is received, the Vro-ITS-S shall display its map-matched eventHistory on the map.
Additional information	N/A

ID	2.4.2.2_Denm-LINE-005(1)
Component(s)	VroES
Requirement	The icon's textual description and pictogram of a received punctual event shall respect Annex A. <ul style="list-style-type: none"> <li>The icon's Quality of Information shall respect § 5.2.</li> </ul>
Additional information	N/A

**Note:** At the date of writing, the Vro-ITS-S does not emit any linear event that shall be displayed.

Thus, no such requirements are defined.

### 4.2.1.2 Display an alert

The alert for a linear event is split in two:

- The “approaching” alert, when the vehicle is driving **towards** the linear event,
- The “zone” alert, when the vehicle is driving **inside** the linear event.

ID	2.4.2.2_Denm-LINE-006(1)
Component(s)	VroES; Scoop Server
Requirement	<p>The Vro-ITS-S shall display an “approaching” alert of a linear event when:</p> <ul style="list-style-type: none"> <li>- The event is on the trajectory of the Vro-ITS-S, (map-matched location of eventPosition and eventHistory)</li> <li>- The event is at a relevant distance from the Vro-ITS-S: <ul style="list-style-type: none"> <li>○ <math>TTE &lt; p\_GEN\_DisplayTTE</math>,</li> </ul> </li> </ul> <p><math>p\_GEN\_DisplayTTE</math> shall be configurable per event.</p>
Additional information	TTE considers the closest point to the event. In this case, it can either be the eventPosition, or a point of the eventHistory.

ID	2.4.2.2_Denm-LINE-007(1)
Component(s)	VroES; Scoop Server
Requirement	The Vro-ITS-S shall display an alert at least $p\_GEN\_MinDisplayingDuration$ seconds.
Additional information	This avoids the display of flash alerts.

ID	2.4.2.2_Denm-LINE-008(1)
Component(s)	VroES
Requirement	<p>The Vro-ITS-S shall display an “approaching” alert until:</p> <ul style="list-style-type: none"> <li>▪ the event is reached,</li> </ul> <p>or</p> <ul style="list-style-type: none"> <li>▪ the event is no more on the trajectory of the Vro-ITS-S</li> </ul>
Additional information	N/A

ID	2.4.2.2_Denm-LINE-009(1)
Component(s)	VroES
Requirement	An “approaching” alert of linear event shall contain the following information: <ul style="list-style-type: none"> <li>○ The same content as the icon (described in 4.2.1.1)</li> <li>○ The DTE</li> </ul>
Additional information	N/A

ID	2.4.2.2_Denm-LINE-010(1)
Component(s)	VroES
Requirement	The DTE of an “approaching” alert shall evolve with the movement of the vehicle.
Additional information	N/A

ID	2.4.2.2_Denm-LINE-011(2)
Component(s)	VroES; Scoop Server
Requirement	When an “approaching” alert is displayed, the Vro-ITS-S shall emit the alert sound associated to the Rx event.
Additional information	The alert sound is configurable per event. The contents of sound alert are described in 2.4.2.2_M_DENM_Event_annexA. The audio files for sound alert are configured by a Scoop super administrator. The choice of whether or not to associate a sound alert with a Rx event is made by a Scoop super administrator.

ID	2.4.2.2_Denm-LINE-012(1)
Component(s)	VroES
Requirement	When the Vro-ITS-S reaches the map-matched eventHistory of a linear event, and until the Vro-ITS-S is no more on the eventHistory, the Vro-ITS-S shall display a “zone” alert.
Additional information	N/A

ID	2.4.2.2_Denm-LINE-013(1)
Component(s)	VroES
Requirement	A “zone” alert of linear event shall contain the following information: <ul style="list-style-type: none"> <li>○ The same content as the icon (described in 4.2.1.1)</li> <li>○ The geographical extent of the linear event. (i.e. length of eventHistory)</li> </ul>
Additional information	N/A

## 4.2.2 Automatic triggering – Field filling rules

The events manually triggerable are defined in Annex A. (tab “Emission\_Vro” => Manu/Auto)  
The activity diagram Figure 13 completes the requirements defined in this paragraph.

Linear events automatically triggered are defined in C2C specifications.  
The association event <=> C2C specification is defined in Table 2.

Event	Applicable document	C2C event name
D1-Temporary slippery road	[DA10]	Traction loss
D6-Reduced visibility	[DA10]	Fog
E6-Exceptional weather conditions	[DA10]	Precipitation

Table 2: Correspondence linear event <-> C2C events

ID	2.4.2.2_Denm-LINE-014(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall automatically trigger a linear event when the triggering conditions are reached. The triggering conditions shall be set as described in the C2C specifications (see Table 2)
Additional information	N/A

ID	2.4.2.2_Denm-LINE-015(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall create DENMs following the C2C specifications (see Table 2) for triggering, update and cancellation unless a requirement of the present document contradicts the C2C specifications
Additional information	N/A

ID	2.4.2.2_Denm-LINE-016(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall fill the DF <i>Trace</i> of a DENM following § 5.4.
Additional information	This requirement is not compliant with C2C specifications.

ID	2.4.2.2_Denm-LINE-017(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall fill the DE <i>stationType</i> of a DENM following § 5.5
Additional information	This requirement is not compliant with C2C specifications.

### 4.2.3 Inform PFrö

The activity diagram Figure 16 completes the requirements defined in this paragraph.

ID	2.4.2.2_Denm-LINE-018(1)
Component(s)	VroES
Requirement	<p>The Vro-ITS-S shall translate into C-ITS DATEX a DENM (received or emitted) corresponding to a linear event following the translation rules defined in [DA13] and [DA14].</p> <p>The translation rules are specific for each event based on the pair <i>causeCode/subCauseCode</i> of the DENM.</p>
Additional information	N/A

### 4.2.4 Relay information from PFrö

The activity diagram Figure 17 completes the requirements defined in this paragraph.

ID	2.4.2.2_Denm-LINE-019(1)
Component(s)	VroES
Requirement	<p>When a C-ITS Datex is received, the Vro-ITS-S shall identify a punctual event by checking that:</p> <ul style="list-style-type: none"> <li>▪ The tag &lt;LinearWithinLinearElement&gt; is present in the Datex</li> </ul>
Additional information	N/A

ID	2.4.2.2_Denm-LINE-020(1)
Component(s)	VroES
Requirement	<p>The Vro-ITS-S shall translate into DENM a received C-ITS DATEX corresponding to a linear event following the translation rules defined in [DA13] and [DA14].</p> <p>To complete [DA13] and [DA14], the filling of the DE <i>informationQuality</i> and <i>StationType</i> shall be implemented following respectively § 5.2 and § 5.5.</p>
Additional information	The events concerned by the translation are listed in Annex A column R-ITS-S. Thus, the Vro-ITS-S is able to translate from C-ITS Datex the same events that can be received from a R-ITS-S.

## 4.3 Manage mobile event

The events concerned by this service are identified in Annex A. (DEN Service = Mobile)  
A mobile event is characterised by the displacement of the position of the event over time.  
This displacement is:

- Continuous and automatic (to be distinguished from manual position update)
- Wide or small depending on the event triggering conditions. (e.g. B2a is high speed while B2b is nearly stationary.)

### 4.3.1 Display

The activity diagram Figure 11 completes the requirements defined in this paragraph.

ID	2.4.2.2_Denm-MOBL-001(1)
Component(s)	VroES; Scoop Server
Requirement	<p>When a DENM is received, the Vro-ITS-S shall identify a mobile event by checking that:</p> <ul style="list-style-type: none"> <li>▪ The DF eventHistory is not present in the message,</li> <li>▪ The Rx event has its parameter p_GEN_RxMobileEvent set to “True”</li> </ul>
Additional information	<p>See DEN service identification in § 5.1</p> <p>The events with p_GEN_RxMobileEvent set to “True” are defined in Annex A</p>

#### 4.3.1.1 Display an icon

ID	2.4.2.2_Denm-MOBL-002(1)
Component(s)	VroES
Requirement	When a mobile event is received, an icon shall be displayed on the map at the map-matched position of the event defined by the DF <i>eventPosition</i> .
Additional information	The concept of icon is defined in [DA1].

ID	2.4.2.2_Denm-MOBL-003(1)
Component(s)	VroES
Requirement	The icon's textual description and pictogram of a received mobile event shall respect Annex A. The icon's Quality of Information shall respect § 5.2.
Additional information	N/A

ID	2.4.2.2_Denm-MOBL-004(1)
Component(s)	VroES
Requirement	When a mobile event is triggered, an icon shall be displayed on the map at the map-matched position of the event defined by the DF <i>eventPosition</i> .
Additional information	The concept of icon is defined in [DA1].

ID	2.4.2.2_Denm-MOBL-005(1)
Component(s)	VroES
Requirement	The icon's textual description and pictogram of a triggered mobile event shall respect Annex A.
Additional information	N/A

### 4.3.1.2 Display an alert

ID	2.4.2.2_Denm-MOBL-006(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall determine the speed of a mobile event via: <ul style="list-style-type: none"> <li>the DF <i>speed</i> of the DENM if present</li> <li>the <i>eventPosition</i> variation over time otherwise.</li> </ul>
Additional information	N/A

ID	2.4.2.2_Denm-MOBL-007(1)
Component(s)	VroES



Requirement	The Vro-ITS-S shall consider the speed of the event for the TTE and DTE calculation for mobile event.
Additional information	N/A

ID	2.4.2.2_Denm-MOBL-008(1)
Component(s)	VroES; Scoop Server
Requirement	<p>The Vro-ITS-S shall display an alert of a mobile event when:</p> <ul style="list-style-type: none"> <li>- the event is slower than the Vro-ITS-S,</li> <li>- the event is ahead of the Vro-ITS-S,</li> <li>- the event is at a relevant distance from the Vro-ITS-S: <ul style="list-style-type: none"> <li>o <math>TTE &lt; p\_GEN\_DisplayTTE</math> ,</li> </ul> </li> </ul> <p><math>p\_GEN\_DisplayTTE</math> shall be configurable per event.</p>
Additional information	N/A

ID	2.4.2.2_Denm-MOBL-009(1)
Component(s)	VroES; Scoop Server
Requirement	<p>The Vro-ITS-S shall display an alert of a mobile event when:</p> <ul style="list-style-type: none"> <li>- the event is faster than the Vro-ITS-S,</li> <li>- the event is behind the Vro-ITS-S,</li> <li>- the event is at a relevant distance from the Vro-ITS-S: <ul style="list-style-type: none"> <li>o <math>TTE &lt; p\_GEN\_DisplayTTE</math> ,</li> </ul> </li> </ul> <p><math>p\_GEN\_DisplayTTE</math> shall be configurable per event.</p>
Additional information	N/A

ID	2.4.2.2_Denm-MOBL-010(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall display an alert until the condition defined in 2.4.2.2_Denm-MOBL-009(1) and 2.4.2.2_Denm-MOBL-008(1) are fulfilled.
Additional information	N/A

ID	2.4.2.2_Denm-MOBL-011(1)
Component(s)	VroES; Scoop Server
Requirement	The Vro-ITS-S shall display an alert at least <i>p_GEN_MinDisplayingDuration</i> seconds.
Additional information	This avoids the display of flash alerts.

ID	2.4.2.2_Denm-MOBL-012(1)
Component(s)	VroES
Requirement	An alert of mobile event shall contain the following information: <ul style="list-style-type: none"> <li>○ The same content as the icon (described in 4.1.1.1)</li> <li>○ The DTE</li> </ul>
Additional information	N/A

ID	2.4.2.2_Denm-MOBL-013(1)
Component(s)	VroES
Requirement	The DTE of a mobile event's alert shall evolve with the movement of the vehicle.
Additional information	N/A

ID	2.4.2.2_Denm-MOBL-014(2)
Component(s)	VroES; Scoop Server
Requirement	When an alert is displayed, the Vro-ITS-S shall emit the alert sound associated to the Rx event.
Additional information	<p>The alert sound is configurable per event.</p> <p>The contents of sound alert are described in 2.4.2.2_M_DENM_Event_annexA. The audio files for sound alert are configured by a Scoop super administrator. The choice of whether or not to associate a sound alert with a Rx event is made by a Scoop super administrator.</p>

ID	2.4.2.2_Denm-MOBL-015(1)
Component(s)	VroES; Scoop Server
Requirement	<p>If the event is critical (i.e. <i>p_GEN_criticalDarkScreen</i> is set to true), the Vro-ITS-S shall hide the nominal alert displayed thanks to a dark screen.</p> <p>This dark screen shall be displayed from the moment the nominal alert is displayed and during <i>p_GEN_criticalDisplayDuration</i>.</p> <p>After this duration, the nominal scenario is followed.</p>
Additional information	<i>p_GEN_criticalDarkScreen</i> is defined for each Rx event.

p\_GEN\_criticalDisplayDuration is set once for all Rx events.

### 4.3.2 Automatic emission

The activity diagram Figure 14 and Figure 15 completes the requirements defined in this paragraph.

<b>ID</b>	<b>2.4.2.2_Denm-MOBL-016(1)</b>
<b>Component(s)</b>	VroES
<b>Requirement</b>	The Vro-ITS-S shall trigger a mobile event when the triggering condition defined in Annex A are fulfilled.
<b>Additional information</b>	N/A

<b>ID</b>	<b>2.4.2.2_Denm-MOBL-017(1)</b>
<b>Component(s)</b>	VroES
<b>Requirement</b>	<p>After the trigger of a mobile event, the Vro-ITS-S shall create a DENM that complies with [DA3] §2.4 for all “mandatory” and “used” fields.</p> <p>To complete [DA3], the filling of the <i>DF Trace</i> and <i>StationType</i> shall be implemented following § 5.</p>
<b>Additional information</b>	<p>/!\ Some DE/DF are event dependant:</p> <ul style="list-style-type: none"> <li>• relevanceTrafficDirection</li> <li>• validityDuration</li> <li>• eventType</li> </ul> <p>The filling of the <i>DF Trace</i> is described in 5.4</p>

<b>ID</b>	<b>2.4.2.2_Denm-MOBL-018(1)</b>
<b>Component(s)</b>	VroES
<b>Requirement</b>	The Vro-ITS-S shall set the field positioningSolution in accordance with the GNSS system used to estimate the event position.
<b>Additional information</b>	This field is “optional” in [DA3] but is mandatory for Vro-ITS-S.

<b>ID</b>	<b>2.4.2.2_Denm-MOBL-019(1)</b>
<b>Component(s)</b>	VroES
<b>Requirement</b>	<p>The Vro-ITS-S shall fill a DENM with the following fields, optional in [DA3]:</p> <ul style="list-style-type: none"> <li>• eventPositionHeading,</li> <li>• eventSpeed.</li> </ul>
<b>Additional information</b>	N/A

ID	2.4.2.2_Denm-MOBL-020(2)
Component(s)	VroES
Requirement	When the information is available for the mobile event, the Vro-ITS-S shall fill the DENM with roadWorks.trafficFlowRule
Additional information	N/A

ID	2.4.2.2_Denm-MOBL-021(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall not fill a DENM with the following fields, optional in [DA3]: <ul style="list-style-type: none"> <li>• eventHistory,</li> <li>• roadType,</li> <li>• impactReduction,</li> <li>• stationaryVehicle.</li> </ul>
Additional information	N/A

ID	2.4.2.2_Denm-MOBL-022(1)
Component(s)	VroES; Scoop Server
Requirement	As long as the triggering conditions of a mobile event are fulfilled, the Vro-ITS-S shall update the corresponding message each <i>p_GEN_UpdateInterval</i> . <i>p_GEN_UpdateInterval</i> is defined per event and described in [DA3].
Additional information	This update might impact any field of the DENM apart from the one taking part in the unicity of the event (see [DA12]) In most cases, only the location information changes.

ID	2.4.2.2_Denm-MOBL-023(1)
Component(s)	VroES
Requirement	When the triggering conditions of a mobile event are not fulfilled anymore, the Vro-ITS-S shall trigger a cancellation DENM following [DA3] §2.4 DE termination.
Additional information	This also includes dissemination rules for cancellation DENM.

### 4.3.2.1 Manual emission (degraded mode)

ID	2.4.2.2_Denm-MOBL-024(1)
Component(s)	VroES; Scoop Server

Requirement	In case of a mobile event with <i>p_GEN_DegradedAutoTrig</i> set to True, the DENM filling and transmission are the same as the nominal scenario (automatic triggering defined in 4.3.2) at the exception that: <ul style="list-style-type: none"> <li>the triggering of a mobile event is manually realised.</li> <li>the cancellation of an event is manually realised.</li> </ul>
Additional information	No modification of the position and/or trafficFlowRules is allowed.

### 4.3.3 Inform PFro

The activity diagram Figure 16 completes the requirements defined in this paragraph. As a reminder, the transmission rules and filtering processes are defined in [DA1].

ID	2.4.2.2_Denm-MOBL-025(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall translate into C-ITS DATEX a DENM (received or emitted) corresponding to a mobile event following the translation rules defined in [DA13] and [DA14].  The translation rules are specific for each event based on the pair causeCode/subCauseCode of the DENM.
Additional information	N/A

**Note:** At the date of writing, mobile events are only emitted by vehicles. Thus, no translation from Datex is realised.

## 4.4 Manage B1a & B1b.

Topic still pending

## 5 DENM general requirements

ID	2.4.2.2_Denm-GNRL-022(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall respect the DENM standard following RS_MSP_076(1) extracted from [DA15].
Additional information	N/A

### 5.1 DEN service identification

The identification of the service concerned by a received DENM is described in Figure 2.

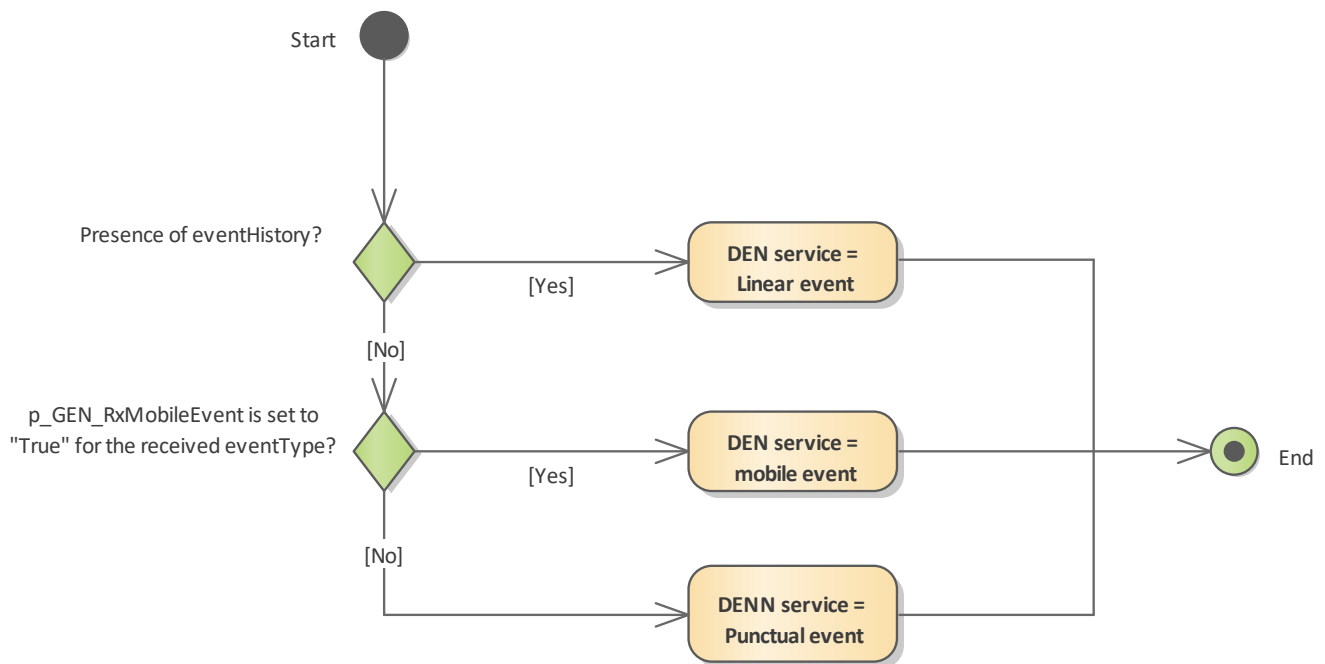


Figure 2: DEN service identification

## 5.2 InformationQuality management

An event based on the DENM is associated to a concept of confidence. This confidence may depend on different factors: the triggering conditions leading to emission, the source of the emitter etc.

This confidence value is present in the messages:

- The DENM data element InformationQuality: integer between 1 and 7.
- The Datex field <probabilityOfOccurrence>: string "Riskof", "Probable" or "Certain"

ID	2.4.2.2_Denm-GNRL-001(1)
Component(s)	VroES
Requirement	<p>If:</p> <ul style="list-style-type: none"> <li>○ an event is triggered by the Vro-ITS-S</li> </ul> <p>and</p> <ul style="list-style-type: none"> <li>○ the event is based on the project specifications, (not based on C2C),</li> </ul> <p>the Vro-ITS-S shall fill the DE <i>InformationQuality</i> following § 3.3 of [DA3] "Emission by a V-ITS-S"</p>
Additional information	N/A

ID	2.4.2.2_Denm-GNRL-002(1)
Component(s)	VroES
Requirement	<p>If:</p> <ul style="list-style-type: none"> <li>an event is triggered by the Vro-ITS-S</li> </ul> <p>and</p> <ul style="list-style-type: none"> <li>the event is based on the C2C specifications,</li> </ul> <p>the Vro-ITS-S shall fill the DE <i>InformationQuality</i> following C2C specification.</p>
Additional information	N/A

ID	2.4.2.2_Denm-GNRL-003(1)
Component(s)	VroES
Requirement	<p>In case of a translation of a C-ITS Datex into DENM, the Vro-ITS-S shall translate the Datex field &lt;probabilityOfOccurrence&gt; into the DE <i>InformationQuality</i> following § 3.2 of [DA2].</p>
Additional information	N/A

ID	2.4.2.2_Denm-GNRL-004(1)
Component(s)	VroES
Requirement	<p>In case of a translation of a DENM into C-ITS-S Datex, the Vro-ITS-S shall translate the Datex field &lt;probabilityOfOccurrence&gt; into the DE <i>InformationQuality</i> following § 3.3 of [DA3] "Reception by a R-ITS-S".</p>
Additional information	N/A

ID	2.4.2.2_Denm-GNRL-005(1)
Component(s)	VroES
Requirement	<p>The icon's "Quality of Information" shall reflect the value of &lt;probabilityOfOccurrence&gt; associated to an event.</p> <p>This is applicable whether the Mobile R-ITS-S function is active or not.</p>
Additional information	<p>The probabilityOfOccurrence is a scale of three level with explicit meaning: riskOf = 1, Probable = 2, Certain = 3.</p>

ID	2.4.2.2_Denm-GNRL-006(1)
Component(s)	VroES
Requirement	<p><b>Topic still pending</b></p> <p>If a received DENM has no known translation in Datex, the icon's "Quality of Information" shall follow the following logic:</p> <p>If Informationquality <math>\leq 2</math>, the Quality of Information is associated to RiskOf</p> <p>If <math>2 &lt; \text{Informationquality} \leq 5</math>, the Quality of Information is associated to Probable</p> <p>If <math>5 &lt; \text{Informationquality}</math>, the Quality of Information is associated to Certain.</p>
Additional information	N/A

**Note:** Discussion on Mantis ticket 1328 still ongoing, a conclusion is required to finalize 2.4.2.2\_Denm-GNRL-006.

## 5.3 Dissemination rules

The dissemination rules defined in this part are applicable to the G5 interface. For other interfaces, the dissemination rules are defined in [DA1].

ID	2.4.2.2_Denm-GNRL-007(1)
Component(s)	VroES
Requirement	<p>If:</p> <ul style="list-style-type: none"> <li>○ an event is triggered inside the Vro-ITS-S (manual or auto)</li> </ul> <p>and</p> <ul style="list-style-type: none"> <li>○ the event is based on the project specifications (not based on C2C),</li> </ul> <p>then the Vro-ITS-S shall respect the dissemination parameters defined in [DA3] "DENM transmission elements"</p> <p>This includes:</p> <ul style="list-style-type: none"> <li>- repetitionDuration</li> <li>- repetitionInterval</li> <li>- Destination Area</li> <li>- Maximum hop limit</li> </ul>
Additional information	In case of a cancellation, more information is contained in the comment of "DE termination".



ID	2.4.2.2_Denm-GNRL-008(1)
Component(s)	VroES
Requirement	<p>If:</p> <ul style="list-style-type: none"> <li>○ an event is triggered inside the Vro-ITS-S (manual or auto) and</li> <li>○ the event is based on the C2C specifications,</li> </ul> <p>Then the Vro-ITS-S shall respect the dissemination parameters of C2C documents.</p> <p>This includes:</p> <ul style="list-style-type: none"> <li>- repetitionDuration</li> <li>- repetitionInterval</li> <li>- Destination Area</li> <li>- Traffic class</li> </ul> <p>In addition, the maximum hop limit shall be set to 10.</p>
Additional information	N/A

ID	2.4.2.2_Denm-GNRL-009(1)
Component(s)	VroES
Requirement	<p>If an event is translated from a Datex, then the Vro-ITS-S shall respect the dissemination parameters defined in [DA2] "DENM transmission elements"</p> <p>This includes:</p> <ul style="list-style-type: none"> <li>- repetitionDuration</li> <li>- repetitionInterval</li> <li>- Destination Area</li> <li>- Maximum hop limit</li> </ul>
Additional information	In case of a cancellation, more information is contained in the comment of the DE "termination".

ID	2.4.2.2_Denm-GNRL-010(1)
Component(s)	VroES
Requirement	To complete [DA2] and [DA3], the Vro-ITS-S shall comply with the requirement RS_MSP_077(1) extracted from [DA15] concerning the repetition implementation
Additional information	N/A

## 5.4 Location filling rules (trace heading position)

ID	2.4.2.2_Denm-GNRL-023(1)
Component(s)	VroES
Requirement	When an event is triggered from the tablet, the DE eventPosition is the map-matched location of the Vro-ITS-S. This is mentioned in Figure 12. In other cases, the DE is the data given by the GNSS sensor.
Additional information	N/A

ID	2.4.2.2_Denm-GNRL-011(1)
Component(s)	VroES
Requirement	When driving forward, the Vro-ITS-S shall fill the DE eventPositionHeading of the DENM with the value used for the CAM DE Heading.
Additional information	N/A

As defined in a [DA12] « trace describes a set of consecutive PathPoint positions leading to the event position. »

ID	2.4.2.2_Denm-GNRL-012(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall use the equidistant points method to create the traces. This is illustrated in Figure 3
Additional information	The internal settings are per default set to 25m between two points.

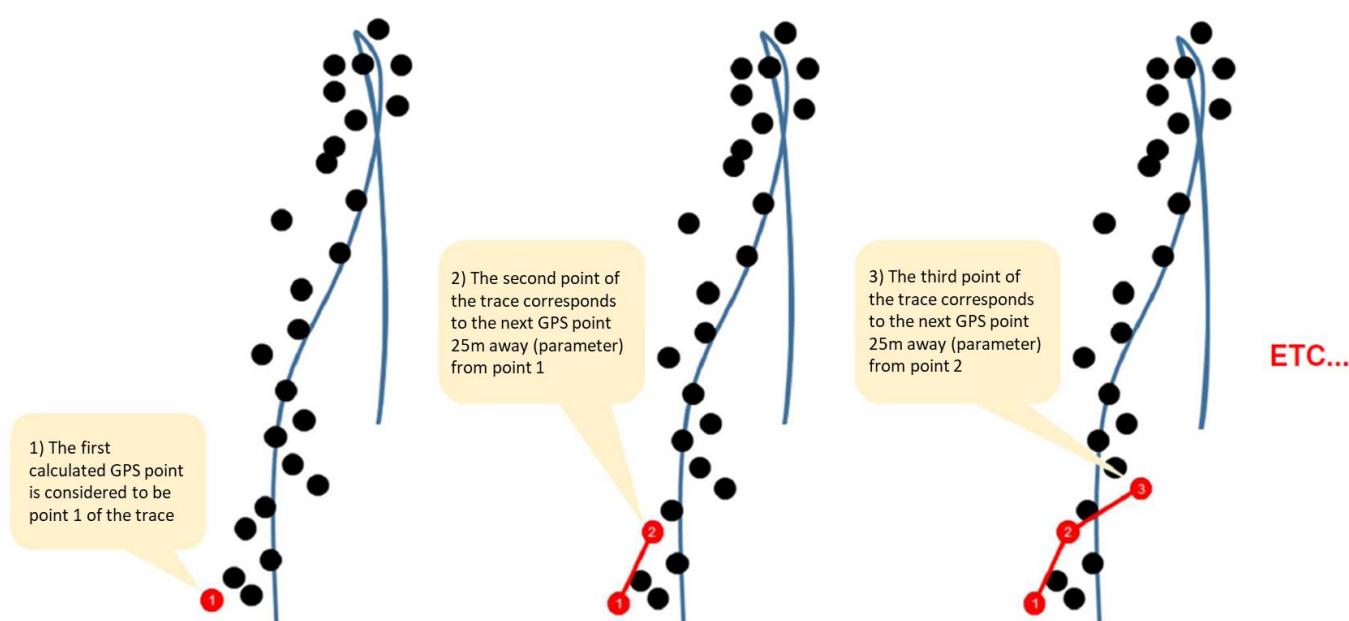


Figure 3: Equidistant points method

Note: in the third case (top right), if an event is triggered, the DENM will be built as follows:

- eventPosition: point n°3
- trace first pathPoint: position n°2
- trace second pathoint: position n°1

ID	2.4.2.2_Denm-GNRL-013(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall detect a reverse speed and manage the trace creation as described in [Back-and-Forth algorithm] to respect the definition of [DA12]: « <i>trace describes a set of consecutive PathPoint positions <b>leading to the event position.</b></i> »
Additional information	This prevents from “zigzags” in the trace, due to back and forth driving due to road operator line of work.  Thus, the trace is different from the pathHistory of the CAM message.

ID	2.4.2.2_Denm-GNRL-014(1)
Component(s)	VroES
Requirement	In order to create traces, the Vro-ITS-S shall comply with the requirement listed in Table 3 extracted from [DA15].
Additional information	RS_MSP_087(1) is not applicable as only one trace is provided by the Vro-ITS-S

MSP requirements	Requirement's topic
RS_MSP_078(1)	Min length
RS_MSP_079(1)	Max length
RS_MSP_080(1)	Update trace
RS_MSP_081(1)	Max points
RS_MSP_082(1)	Description
RS_MSP_083(1)	DeltaTime
RS_MSP_084(1)	Heading
RS_MSP_085(1)	Stationary
RS_MSP_086(1)	Stationary

Table 3: MSP applicable requirements for trace creation

### Back-and-Forth algorithm:

ID	2.4.2.2_Denm-GNRL-015(1)
Component(s)	VroES
Requirement	The Vro-ITS-S shall detect a reverse speed following Figure 4. It shall then enter the “Back-and-Forth algorithm”. The trace in memory at this moment is called the “reference trace”
Additional information	This prevents from “zigzags” in the trace, due to back and forth driving due to road operator line of work.

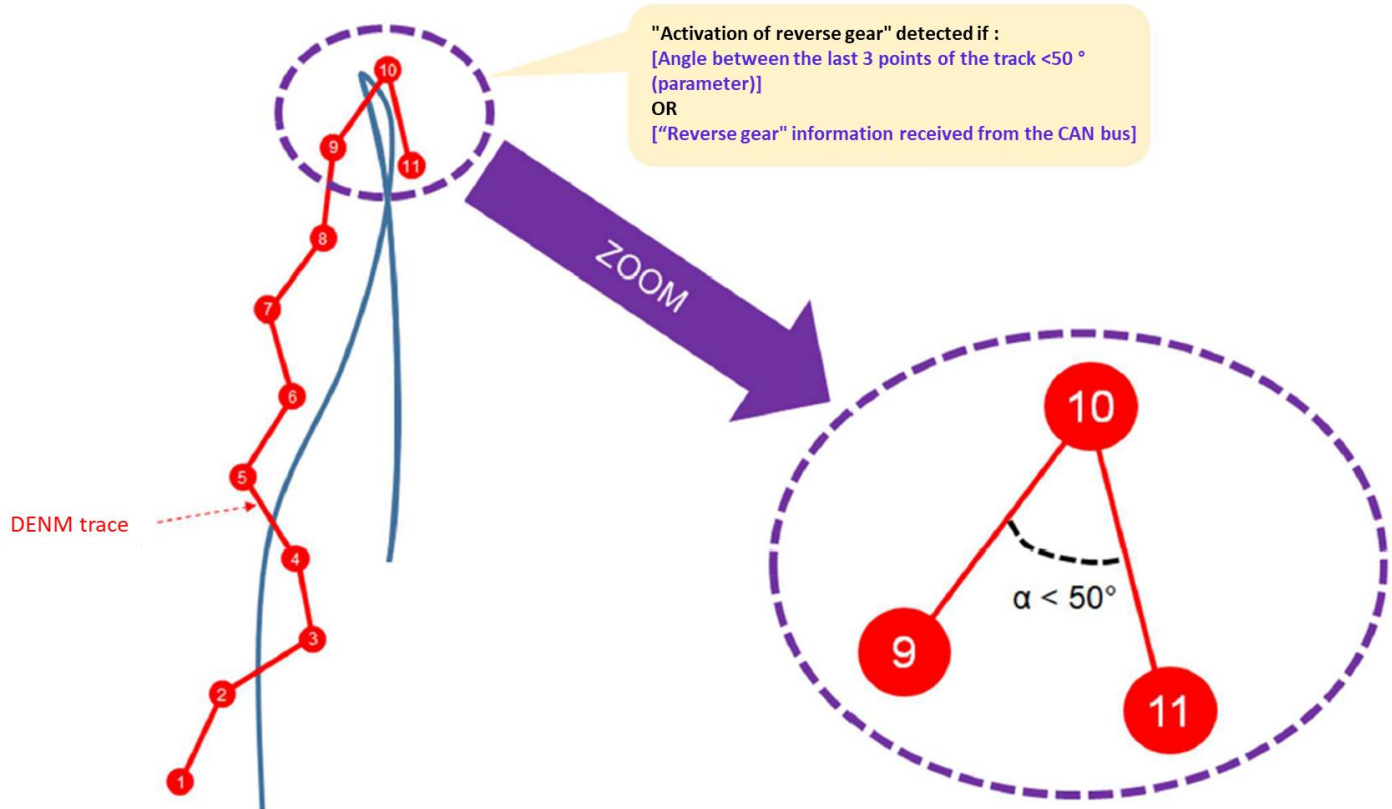


Figure 4: Reverse gear detection

**Note:** the points number in the figures are in the counter order than the one in the trace DF. In the requirements, the used numeration is the one of the trace DF.

ID	2.4.2.2_Denm-GNRL-016(1)
Component(s)	VroES
Requirement	When the Back-and-Forth algorithm is activated, the Vro-ITS-S shall latch the eventPositionHeading to the last known value <u>before</u> activating the Back-and-Forth algorithm. This latching shall only be released when the Back-and-Forth algorithm is cancelled.
Additional information	The eventPositionHeading may thus be opposite to the DE heading in the CAM.

ID	2.4.2.2_Denm-GNRL-017(1)
Component(s)	VroES
Requirement	While the Back-and-Forth algorithm is activated:  When driving backward the Vro-ITS-S shall map-match its position to the points of the "reference trace" and remove them following Figure 5, Figure 6 and Figure 7.
Additional information	N/A

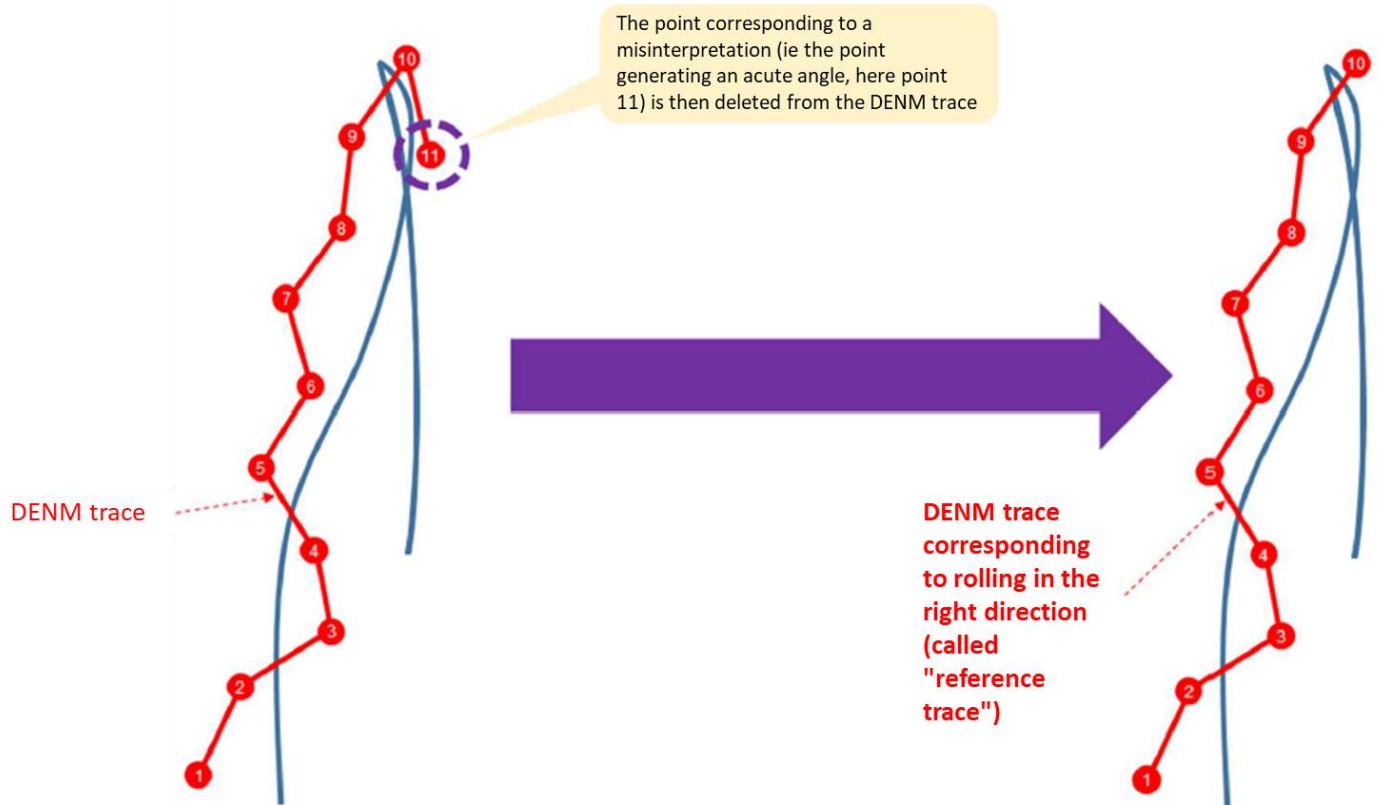


Figure 5: DENM trace strategy in reverse gear

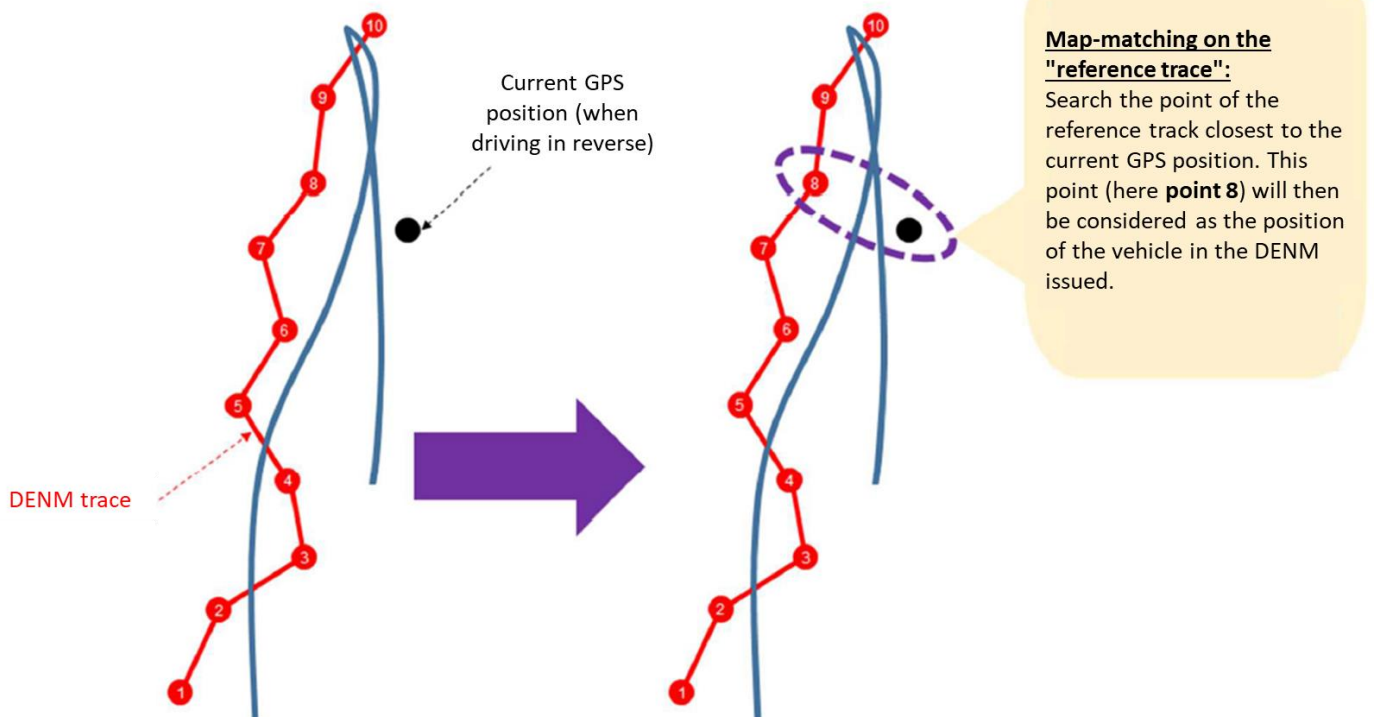


Figure 6: Map-matching on the "reference trace"

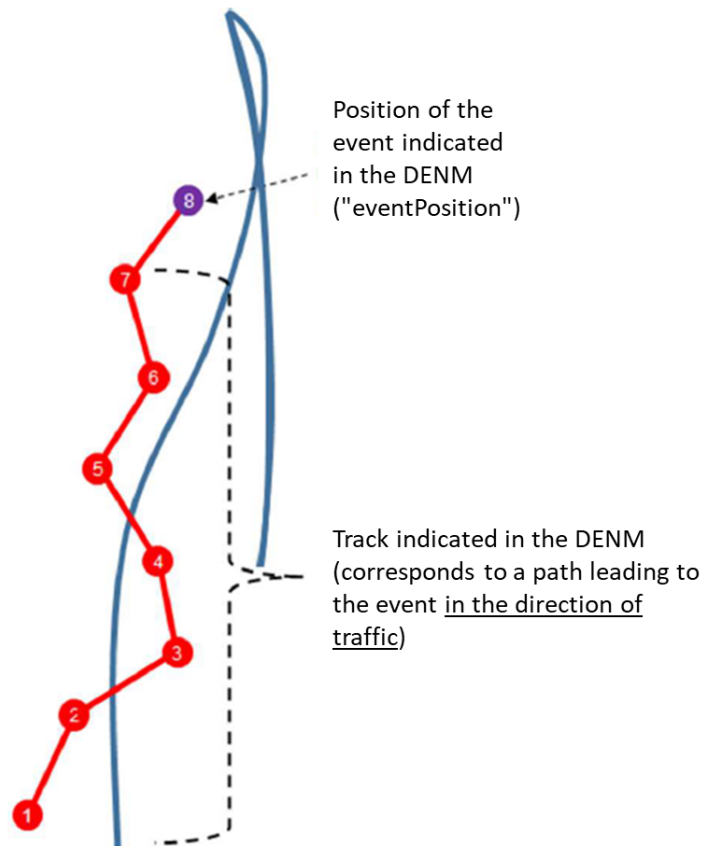


Figure 7: DENM trace after map-matching on the "reference trace"

ID	2.4.2.2_Denm-GNRL-018(1)
Component(s)	VroES
Requirement	<p>When the Vro-ITS-S removes points due to backward driving:</p> <p>In order to fulfil the trace length required in 2.4.2.2_Denm-GNRL-014(1), the Vro-ITS-S shall re-add the erased points <b>at the end</b> of the "reference trace" (older points). To do so, the Vro-ITS-S shall always keep in memory its last 200 positions. (Except at start up).</p>
Additional information	<p>e.g.: If the trace is 40 points long and the backward driving erases the points 1, 2 and 3 of the trace, the Vro-ITS adds the previously erased points 41, 42 and 43. (thus, they become points 38, 39 and 40)</p>



ID	2.4.2.2_Denm-GNRL-019(1)
Component(s)	VroES
Requirement	While the Back-and-Forth algorithm is activated, When driving forward, the Vro-ITS-S shall re-add the encountered points of the "reference trace". This is illustrated on Figure 8.
Additional information	This is implemented as it is difficult to detect that the Vro-ITS-S is driving forward after a reverse manoeuvre.

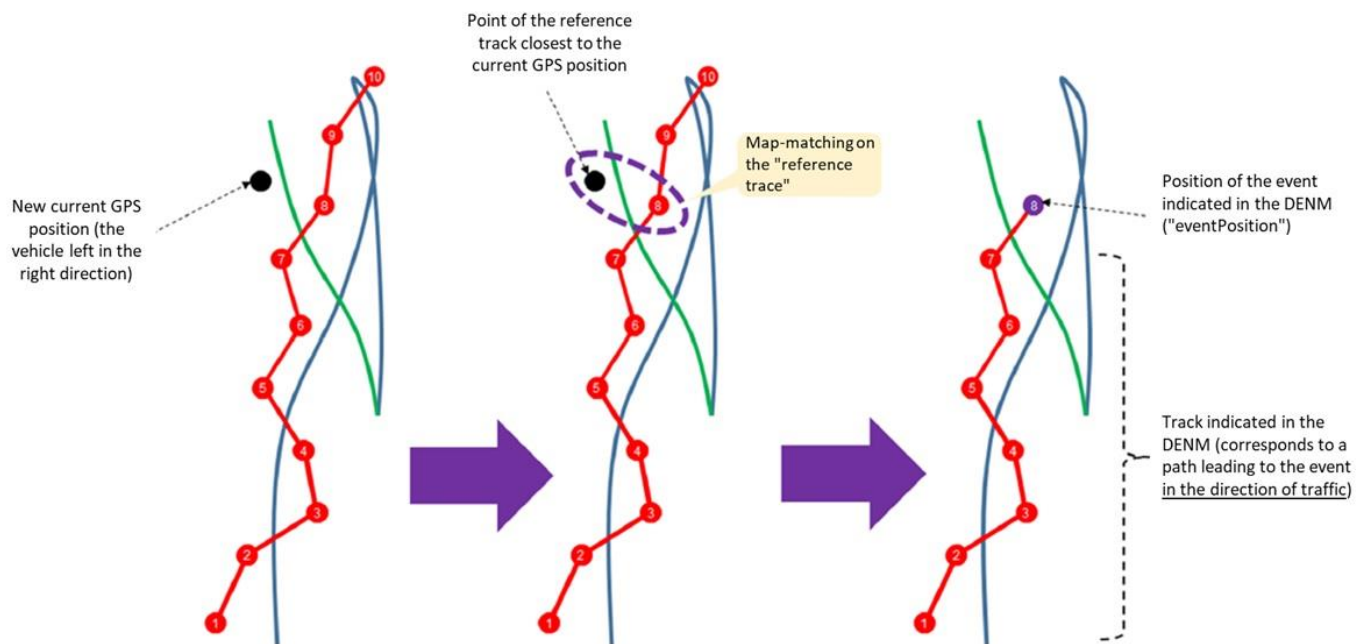


Figure 8: Map-matching on the "reference trace" still going in correct direction

ID	2.4.2.2_Denm-GNRL-024(1)
Component(s)	VroES
Requirement	The Back-and-Forth algorithm shall be cancelled when: <ul style="list-style-type: none"> <li>- the Vro-ITS-S reaches the position where the Back-and-Forth algorithm was activated. (see Figure 9) <ul style="list-style-type: none"> <li>➔ The Vro-ITS-S shall resume the nominal trace functionality.</li> </ul> </li> <li>- the Vro-ITS-S GNSS position is more than 50m from the "reference trace". <ul style="list-style-type: none"> <li>➔ The Vro-ITS-S shall restart its trace from scratch.</li> </ul> </li> </ul>
Additional information	N/A

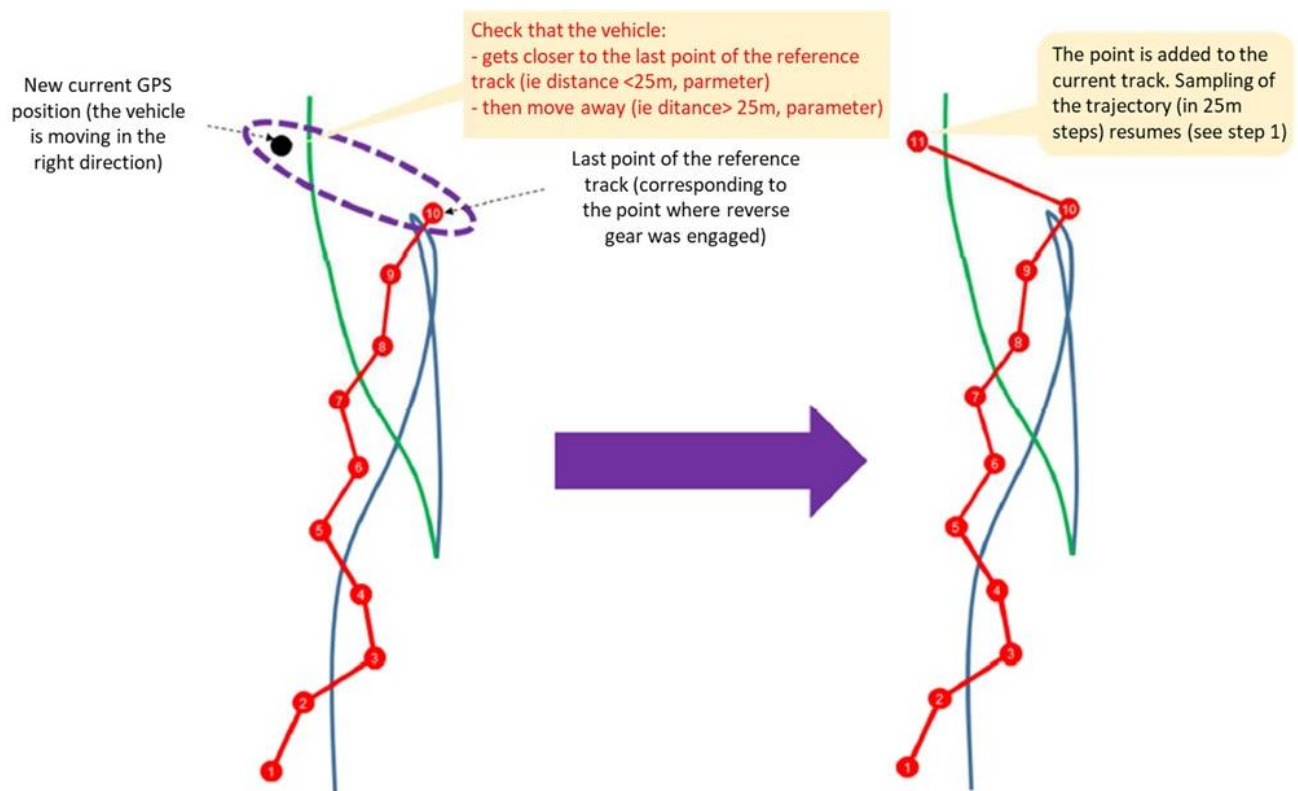


Figure 9: Resuming nominal after the point where reverse gear was activated

## 5.5 StationType filling rules

ID	2.4.2.2_Denm-GNRL-020(1)
Component(s)	VroES
Requirement	When the Vro-ITS-S creates a DENM after an internal trigger, it shall fill the DE <i>stationType</i> with the same value as the one provided in the CAM. The filling of CAM is defined in [DA1].
Additional information	N/A

ID	2.4.2.2_Denm-GNRL-021(1)
Component(s)	VroES
Requirement	When the Vro-ITS-S creates a DENM a translation from a C-ITS Datex, it shall fill the DE <i>stationType</i> with the value <i>roadSideUnit</i> (15)
Additional information	N/A



## 6 VroES service realisation

As described in § 4, the [DEN services] are specific realisations of the more general services described in the master document [DA1].

The concerned [VroES services] are represented on Figure 10.

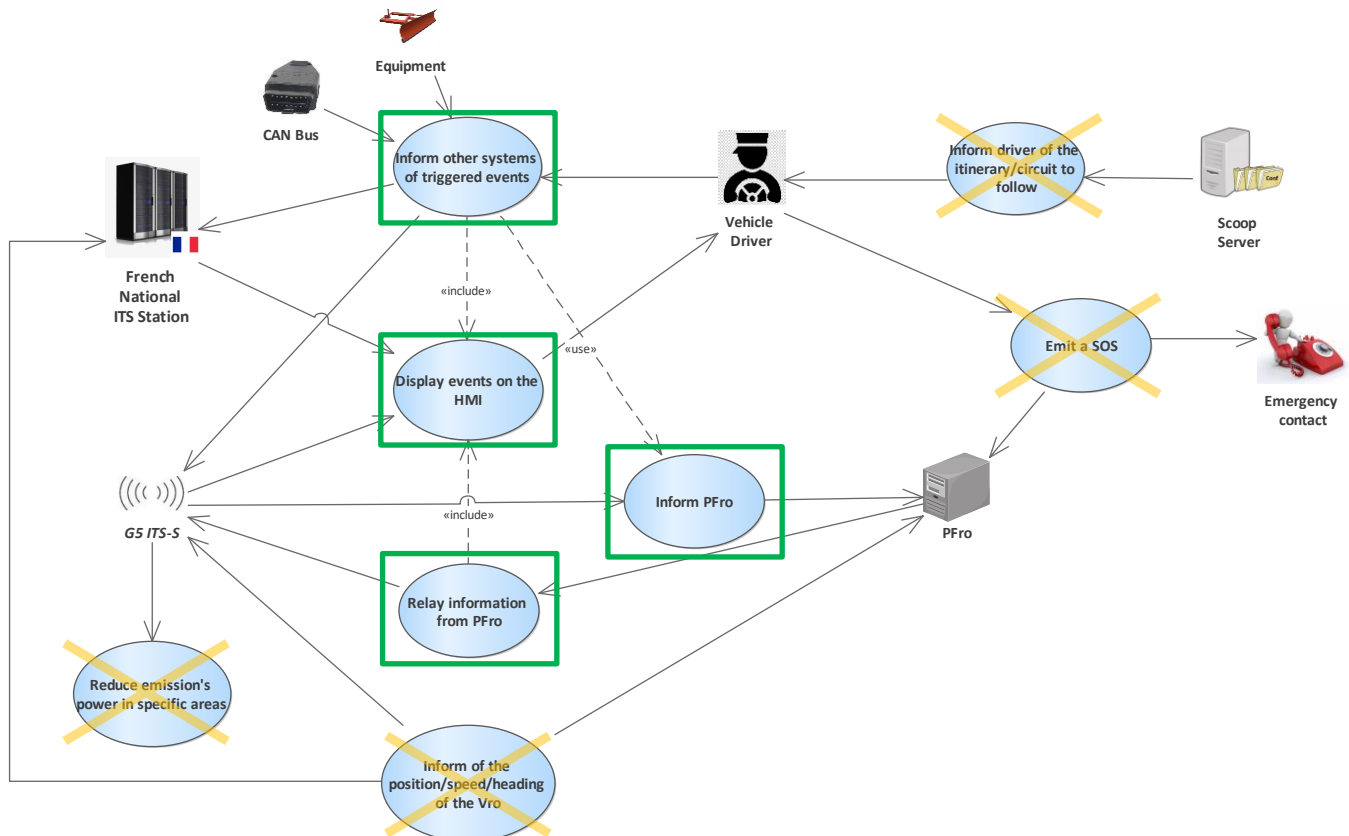


Figure 10: VroES services concerned by the DEN services – use case diagram

The following sub-chapters contain activity diagram(s) that define for each [VroES services] the responsibility distribution between the different sub-systems composing the Vro Global System, and the data flow between those sub-systems.

## 6.1 Display event on the HMI

As mentioned in the master document [DA1], “Display event on the HMI” is a service included in other services. Thus, Figure 11 only describes the scenarios not already mentioned in the other activity diagrams.

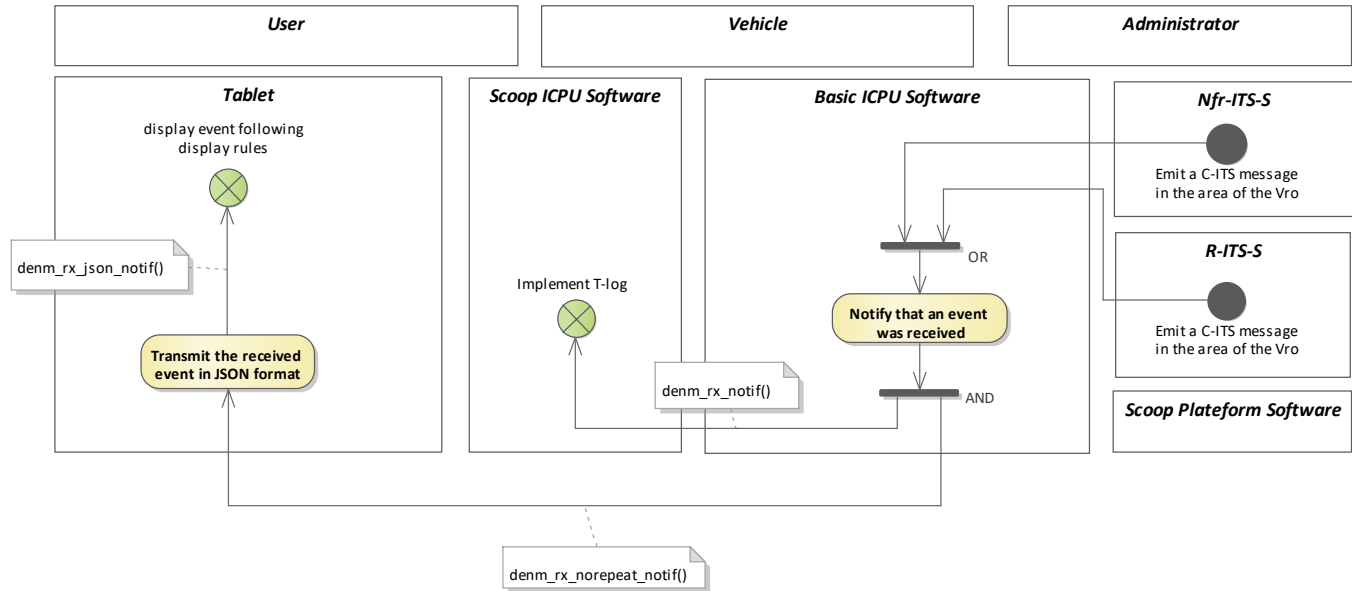


Figure 11: Display an event – activity diagram

The table below specifies certain behaviours of those methods in the activity diagram context. The list of parameters mentioned is not exhaustive compared to the definition of the method.

Method	Particularities
[denm_rx_notif]	<code>eventGenerator</code> set to 0 as it is a received event
[denm_rx_norepeat_notif]	<code>eventGenerator</code> set to 0 as it is a received event
[denm_rx_json_notif]	Tablet internal method

## 6.2 Inform other systems of triggered events

### 6.2.1 Manual triggering

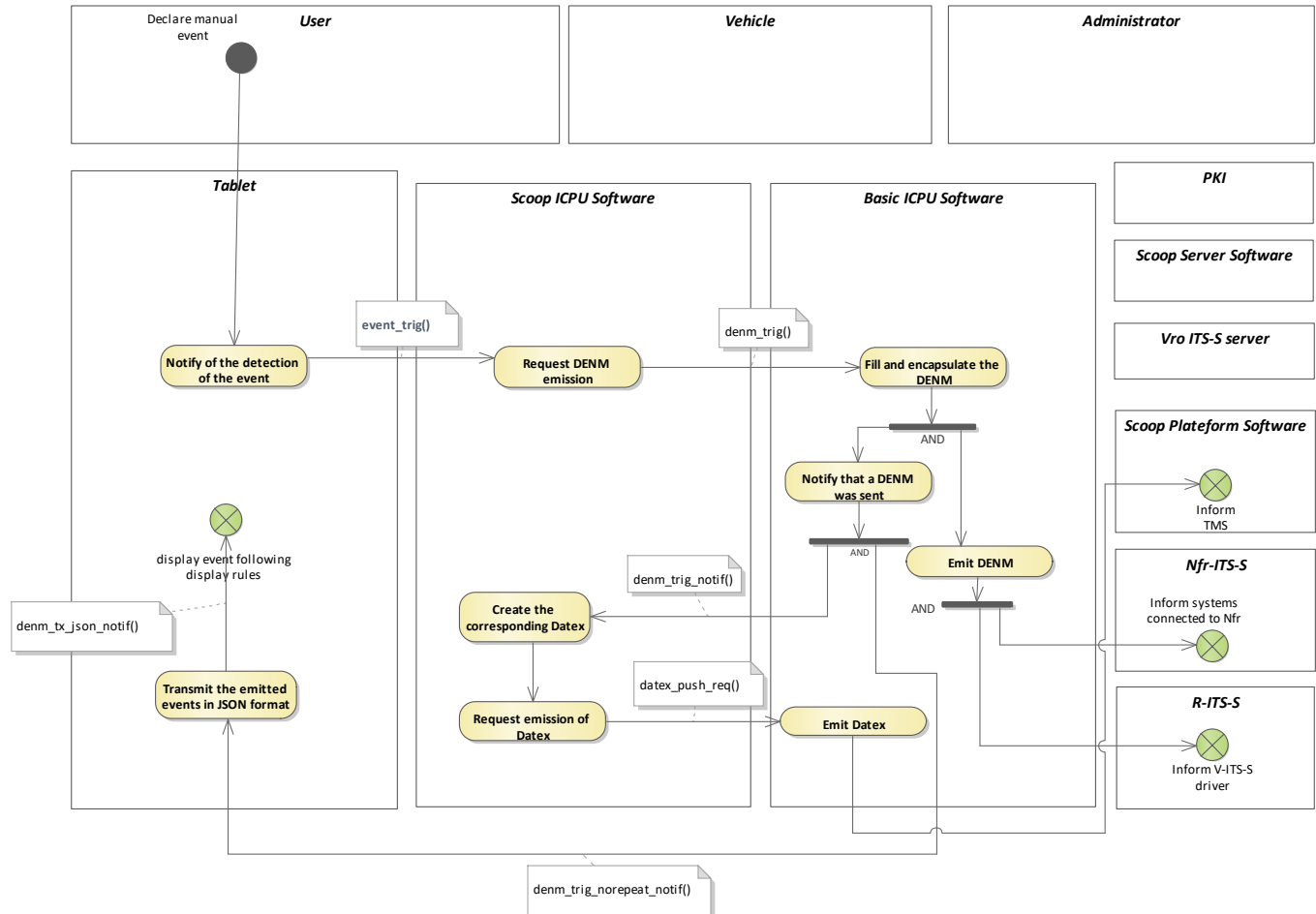


Figure 12 : Inform of manually triggered event – activity diagram

The table below specifies certain behaviours of those methods in the activity diagram context. The list of parameters mentioned is not exhaustive compared to the definition of the method.

Method	Particularities
[event_trig]	<b>position:</b> <ul style="list-style-type: none"> <li>- If the position of the event is selected on the map by the driver, this position is filled in this parameter.</li> <li>- If the position is not specified by the driver, this parameter is not used. (the vehicle's position is used per default)</li> </ul>
[denm_trig]	<b>eventGenerator</b> : set to 1 as event generated via tablet. <b>actionID</b> : present if update or cancellation via the tablet <b>stationType</b> : not present, only used when event from Datex.
[denm_trig_notif]	<b>eventGenerator</b> : set to 1 as event generated via tablet.
[datex_push_req]	N/A
[denm_trig_norepeat_notif]	N/A
[denm_tx_json_notif]	Tablet internal method

## 6.2.2 Automatic triggering

Three ways to trigger automatically are defined for events supported by DENM.

### Figure 13 : Automatic trigger of event from CAN Data

- ➔ The triggering AND the life cycle of the event is handled by the Basic ICPU Software,
- ➔ Concerns only events specified by C2C.

Figure 14 : Automatic trigger of event from equipment status triggered by Basic ICPU

- ➔ The triggering is handled by the Basic ICPU Software but the life cycle of the event is handled by Scoop ICPU Software,
- ➔ Concerns only mobile events.

Figure 15 : Automatic trigger of event from equipment status triggered by Scoop ICPU

- The triggering AND the life cycle of the event is handled by the Scoop ICPU Software, Concerns only mobile events.

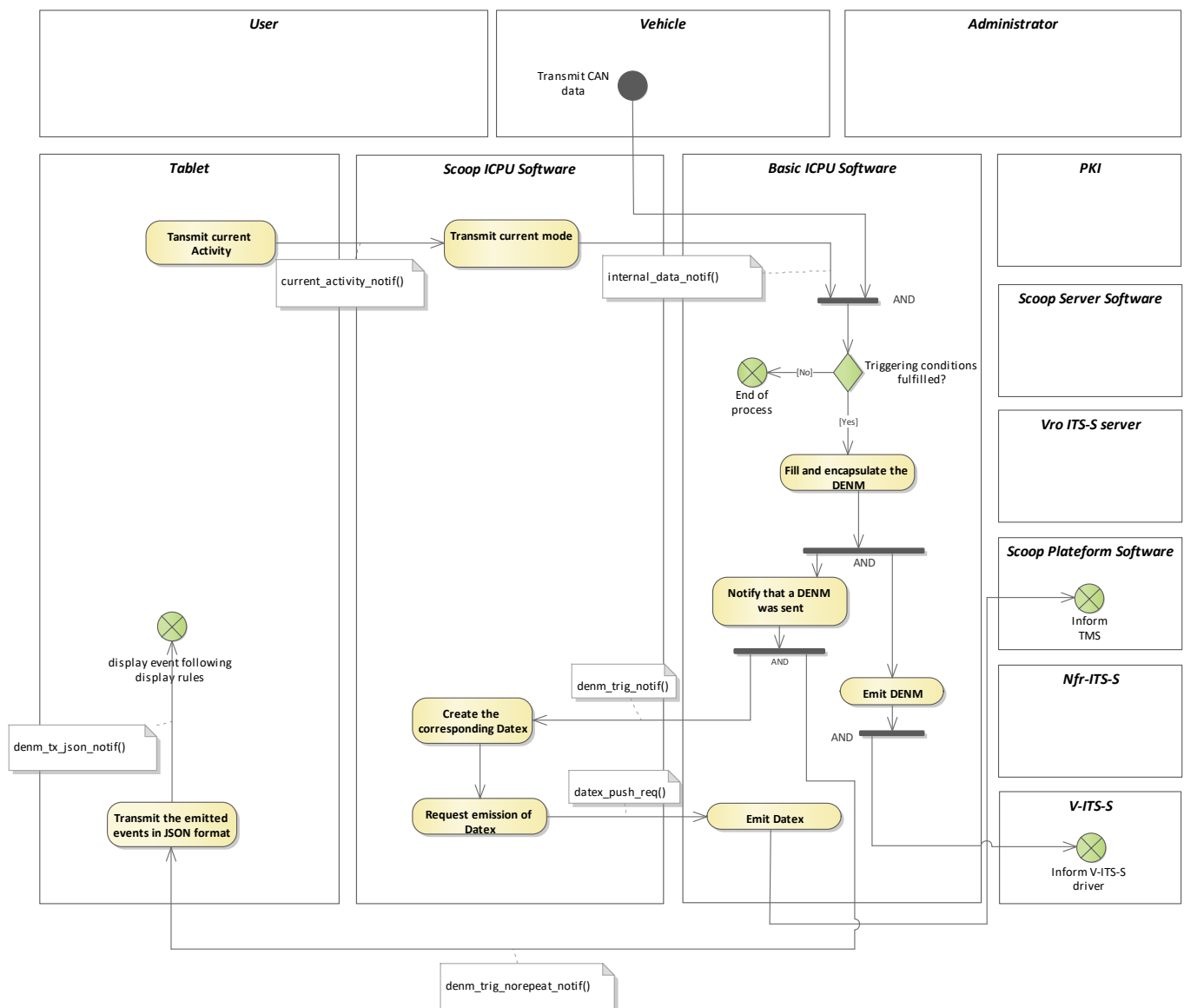


Figure 13 : Automatic trigger of event from CAN Data – activity diagram

The table below specifies certain behaviours of those methods in the activity diagram context.





The table below specifies certain behaviours of those methods in the activity diagram context. The list of parameters mentioned is not exhaustive compared to the definition of the method.

Methode	Specificities and parameters
[current_activity_notif]	<b>activity</b> : set to "operator" for event triggered by equipment
[internal_data_notif]	e.g. for snow removal: - <b>B3B_DETECTABLE</b> is set to 1 (Scoop ICPU detects it) - Equipment status e.g. <b>snowplowBladeValue</b> set to 1
[denm_trig]	<b>actionID</b> : present if update or cancellation of the event <b>stationType</b> : not present
[denm_trig_notif]	<b>eventGenerator</b> : set to 2 as generated from equipment states
[datex_push_req]	N/A
[denm_trig_norepeat_notif]	N/A
denm_tx_json_notif	Tablet internal method

## 6.3 Communicate with PFro

### 6.3.1 Inform PFro

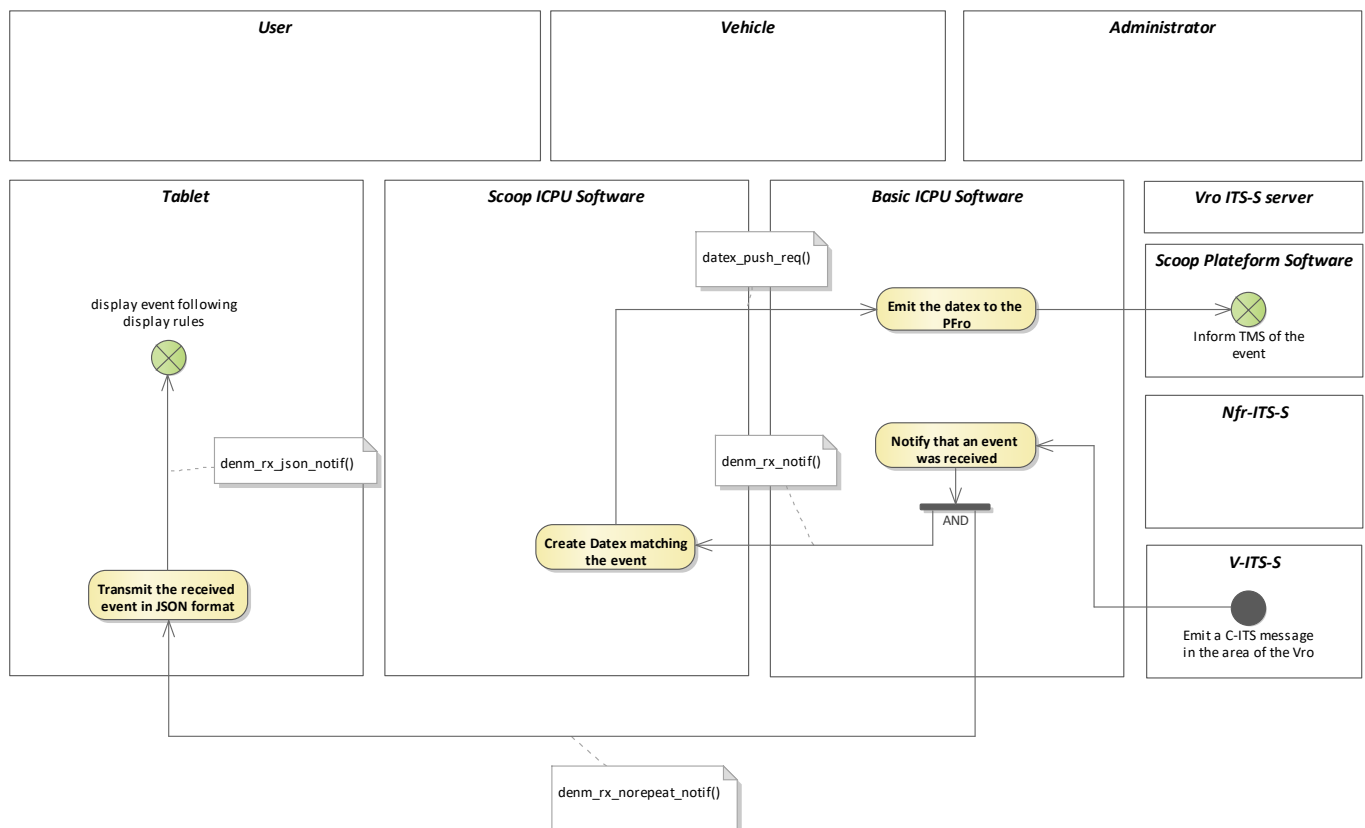


Figure 16 :Inform PFro – Received punctual event – activity diagram

The table below specifies certain behaviours of those methods in the activity diagram context.

The list of parameters mentioned is not exhaustive compared to the definition of the method.

Methode	Specificities and parameters
[denm_rx_notif]	N/A
[datex_push_req]	N/A
[denm_rx_norepeat_notif]	N/A
[denm_rx_json_notif]	Tablet internal method

### 6.3.2 Relay information from PFro

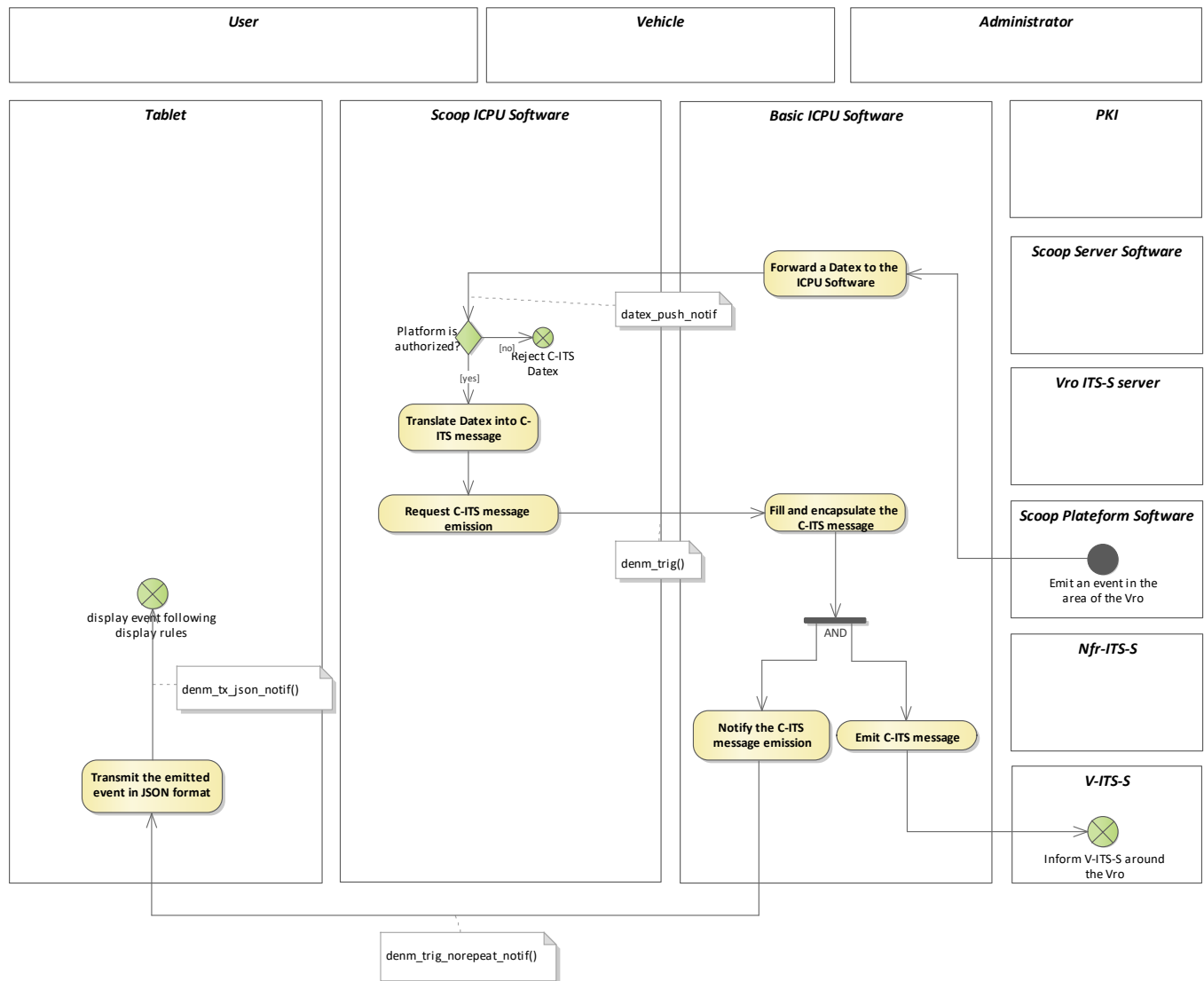


Figure 17 : Relay information from PFro – Linear event – activity diagram

!/\ some methods are used for emission of event, even if it is a reception in this case. The parameters in the method allows to differentiate if the VroES is the source of the message or not.

The table below specifies certain behaviours of those methods in the activity diagram context. The list of parameters mentioned is not exhaustive compared to the definition of the method.



Methode	Specificities and parameters
[datex_push_notif]	N/A
[denm_trig]	<div>eventGenerator</div> set to 0 as it is a received event <div>ActionID</div> is filled. <div>StationType</div> set to 15 as it is translated from Datex.
[denm_trig_norepeat_notif]	<div>eventGenerator</div> set to 0 as it is a received event
[denm_tx_json_notif]	Tablet internal method

---

## 7 Communication Bus specificities

In extension to [DA1] § “Interfaces inside the VroES”, this part defines the additional methods on the bus used to implement the DENM services depending on the concerned interface.

### 7.1 IF\_1 - Interface Scoop ICPU <—> Basic ICPU

denm\_rx\_notif  
denm\_trig  
denm\_trig\_notif  
datex\_push\_req  
set\_internal\_data  
internal\_data\_notif  
datex\_push\_notif

### 7.2 IF\_2 - Interface Scoop ICPU <—> Scoop Tablet

event\_trig  
current\_activity\_notif

### 7.3 IF\_7 - Interface Basic ICPU <—> Scoop Tablet

denm\_rx\_norepeat\_notif  
denm\_trig\_norepeat\_notif

---

## 8 Annexes

### Annex A.

The document 2.4.2.2\_M\_DENM\_Event\_annexA contains the characteristics of the events supported by DENMs (reception and emission). It is referenced as [DA16]