

## French C-ITS Deployment Coordination committee

# Common technical specifications for use cases

## Road Work Warning enhanced (I2V)

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### Deliverable 2.4.1.2\_H\_B1a&B1b

#### Activity 2: Studies

#### Sub Activity 2.4 > Specifications

Version 4.00

Publication Date: 14/11/2019



Co-financed by the Connecting Europe  
Facility of the European Union

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## Information on the document

Document: Common technical specifications for use cases - Road Work Warning enhanced (I2V)

Date of publication: 14/11/2019

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Status: Version 4.00 – Release 4

## Publication history

Date	Version	Author(s)	Updates & changes	Diffusion
14/11/2019	4.00	A. AUDIGÉ	<ul style="list-style-type: none"> <li>Consolidated version for release 4</li> </ul>	Release 4

**Black highlighted texts are issues with standards.**

The following legend is used on master document tables (next sub-chapters) and on profiles in each UC documents:

Standard / Field: if status is mandatory in standard: **bold**, If optional: *italic*.

Profile / Status:

- If mandatory:
- If optional in standard:
  - Used (U) when always used
  - Not used ( ) when never used.
  - Sometimes (S) when it depends.

Profile / Content: important settings or information are in ***bold italic pink underline***.

# 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

ID	2.4.X.XX-YYYY-ZZZ
Component(s)	(e.g.) Vru-ITS-S, Vro-ITS-S, R-ITS-S, PKI
Requirement	(e.g.) An ITS station SHALL be able to request and get a Long-Term Certificate (LTC) from the SCOOP Public Key Infrastructure (PKI).
Acceptance	(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
Additional information	

## Acronyms & abbreviations

<b>BAU</b>	Hard Shoulder ("Bande d'arrêt d'urgence" in French)
<b>CC/SCC</b>	causeCode/subCauseCode
<b>CCH</b>	Control CHannel
<b>DE</b>	Data Element
<b>DENM</b>	Decentralized Environmental Notification Message
<b>HMI</b>	Human-Machine Interface
<b>ITS</b>	Intelligent Transport System
<b>N-ITS-S</b>	National ITS Station
<b>PF</b>	Platform
<b>R-ITS-S</b>	Roadside ITS Station
<b>RW</b>	Roadworks
<b>RWW</b>	Roadworks Warning
<b>SCH</b>	Synchronization CHannel
<b>TCC</b>	Traffic Control Center
<b>TMS</b>	Traffic Management System
<b>TPC</b>	Center Divider Strip ("Terre plein central" in French)
<b>V-ITS-S</b>	Vehicular ITS Station
<b>Vro2V</b>	Road Operator Vehicle To Vehicle
<b>Vro-ITS-S</b>	Road Operator Vehicular ITS Station

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# 1. Alert neutralization of a part of a lane, whole lane or several lanes, with alternate mode and closure excluded (B1a) - DENM

## 1.1 Figure

### 1.1.1 Figure for neutralization of a part or whole lane or of several lanes (without carriageway switching)

In order to clarify the data elements, see figures below and following coding.

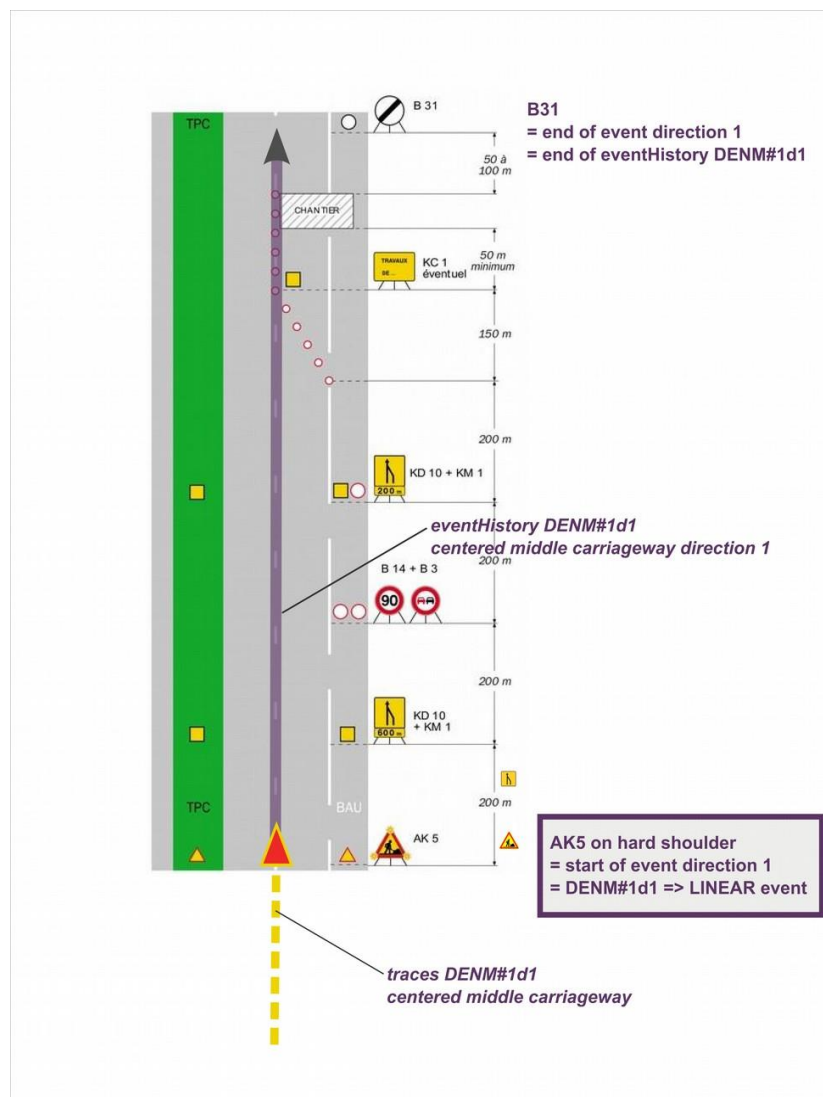


Figure 1- BASIC (SCoop 1): 1 DENM

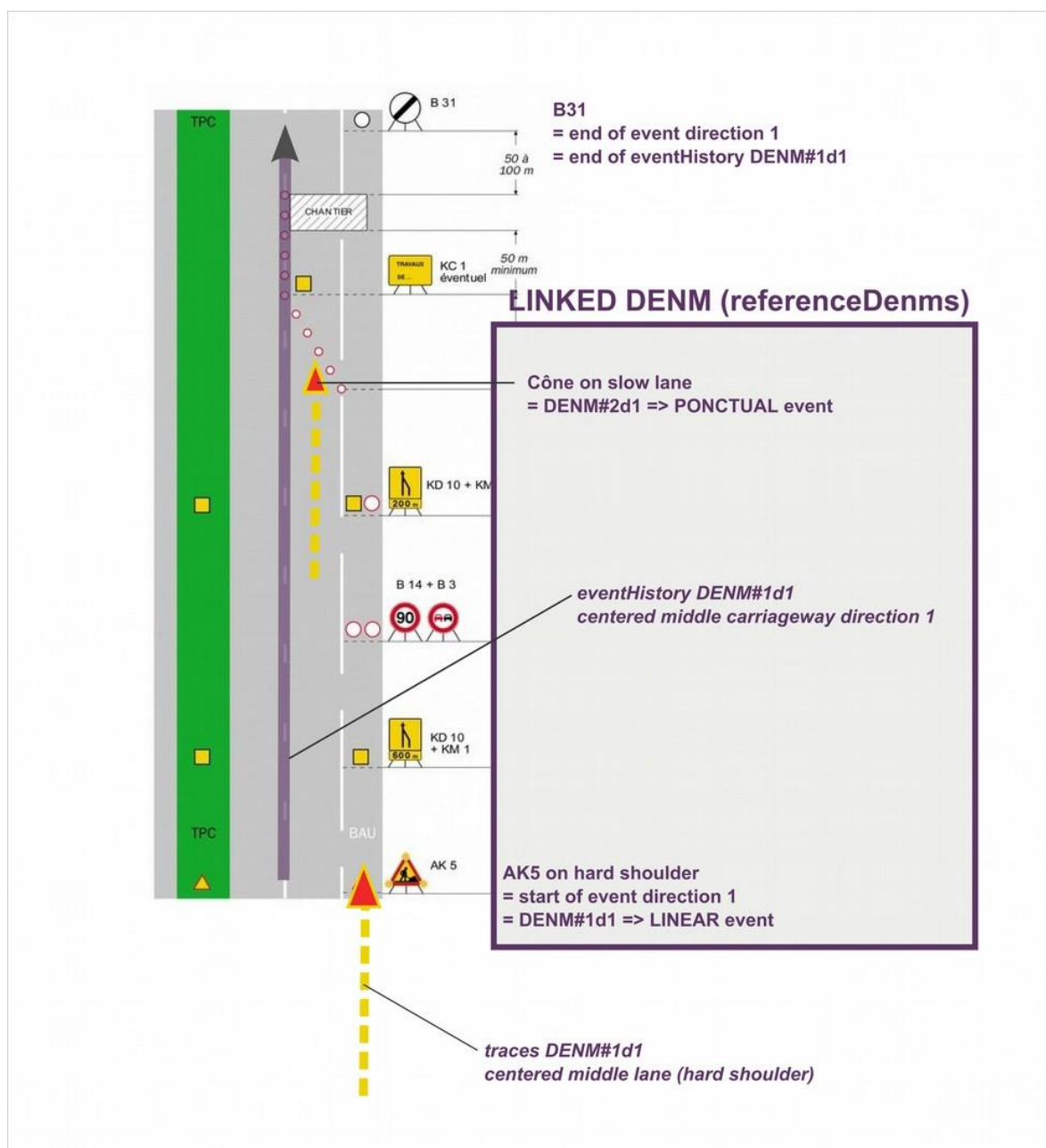


Figure 2 - ENHANCED: 1 group of DENM

**Note:** for traces or eventPosition, the middle of the lane is desired, but the middle of carriageway is accepted. However, lanePosition is absolutely mandatory.

#### Coding principle in TMS (2 options presented: BASIC & ENHANCED):

**BASIC:** operator has set in TMS a RWW “neutralization” event for direction 1, from AK5 of direction 1 to B31 of direction 1.

**ENHANCED:** operator has detailed the event in TMS with:

- A linear global event for direction 1 (from AK5 to B31 of direction 1), and punctual event associated for each new lane blocked.



And TCC is able to code this in TMS (software of the road operator to manage event).

And system (PF) can handle these complexity: linked event.

**Coding of DE (only some key DE are explained):**

	BASIC	ENHANCED	
	DENM	DENM#1	DENM#2
actionID	actionID(DENM)	actionID(DENM#1)	actionID(DENM#2)
eventPosition*	position(AK5d1) centred carriageway d1	position(AK5d1) centred carriageway d1	position(NeutralLane1d1) centred carriageway d1
eventType	3 / 0	3 / 0	3 / 0
linkedCause	None	If RW due to an incident, can be given (CC/sCC)	None
eventHistory*	from AK5d1 to B31d1 centred carriageway d1	from AK5d1 to B31d1 centred carriageway d1	None (punctual)
traces*	approach (AK5d1) centred carriageway d1	approach (AK5d1) centred carriageway d1	approach centred carriageway d1
lanePosition	NONE	0	1
roadWorks Container:			
>closedLanes	None	1 (closed)	1 (closed)
>>hsStatus	None	[0,0,0]	[0,1,0]
>>drivingLaneStatus**	None		
>speedLimit***	90	90	90
>recommendedPath	None for neutralization		
>trafficFlow Rule	None	passToLeft	passToLeft
>reference Denms	None	{aID(DENM#2)}	{aID(DENM#1)}

\*: for eventPosition, traces and eventHistory, accuracy is given centered carriageway. As soon as the system can handle a better accuracy, it should do it.

\*\* : bit '0' (don't care bit) is on the left of the string (Ref. X.691 PER encoding rules) and always set to '0'.

\*\*\*: is the global speed limit of the roadwork event. In the case of the figure, no several speed limits during eventHistory.

**In ENHANCED level, the PF has to properly code the group of events from TMS in consecutive event linked before sending the appropriate Datex II to R-ITS-S or N-ITS-S.**

## 1.1.2 Figure for carriageway switching (to the other carriageway)

In order to clarify the data elements, see figures below and following coding.

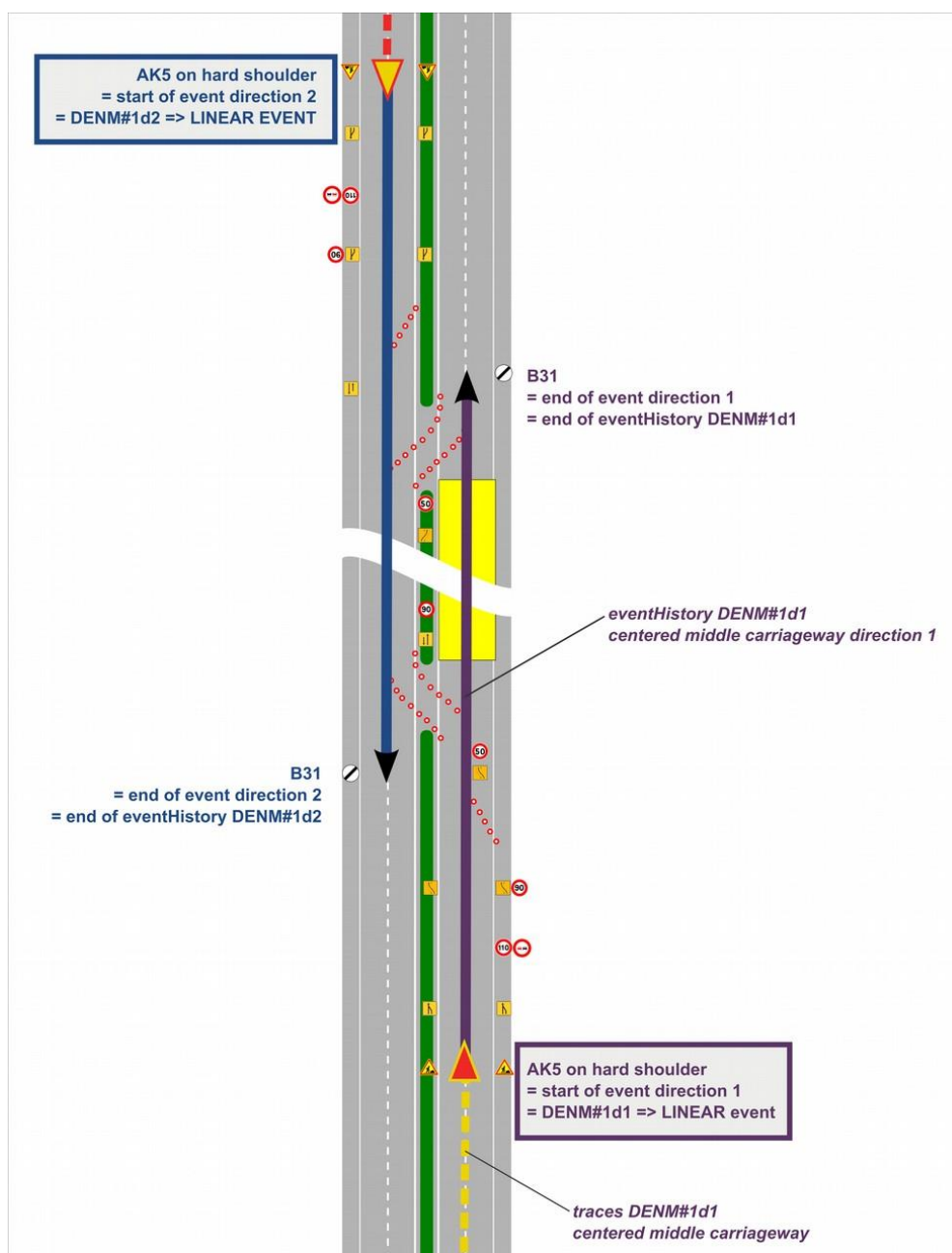


Figure 3 - BASIC (SCoop 1): 1 DENM per direction

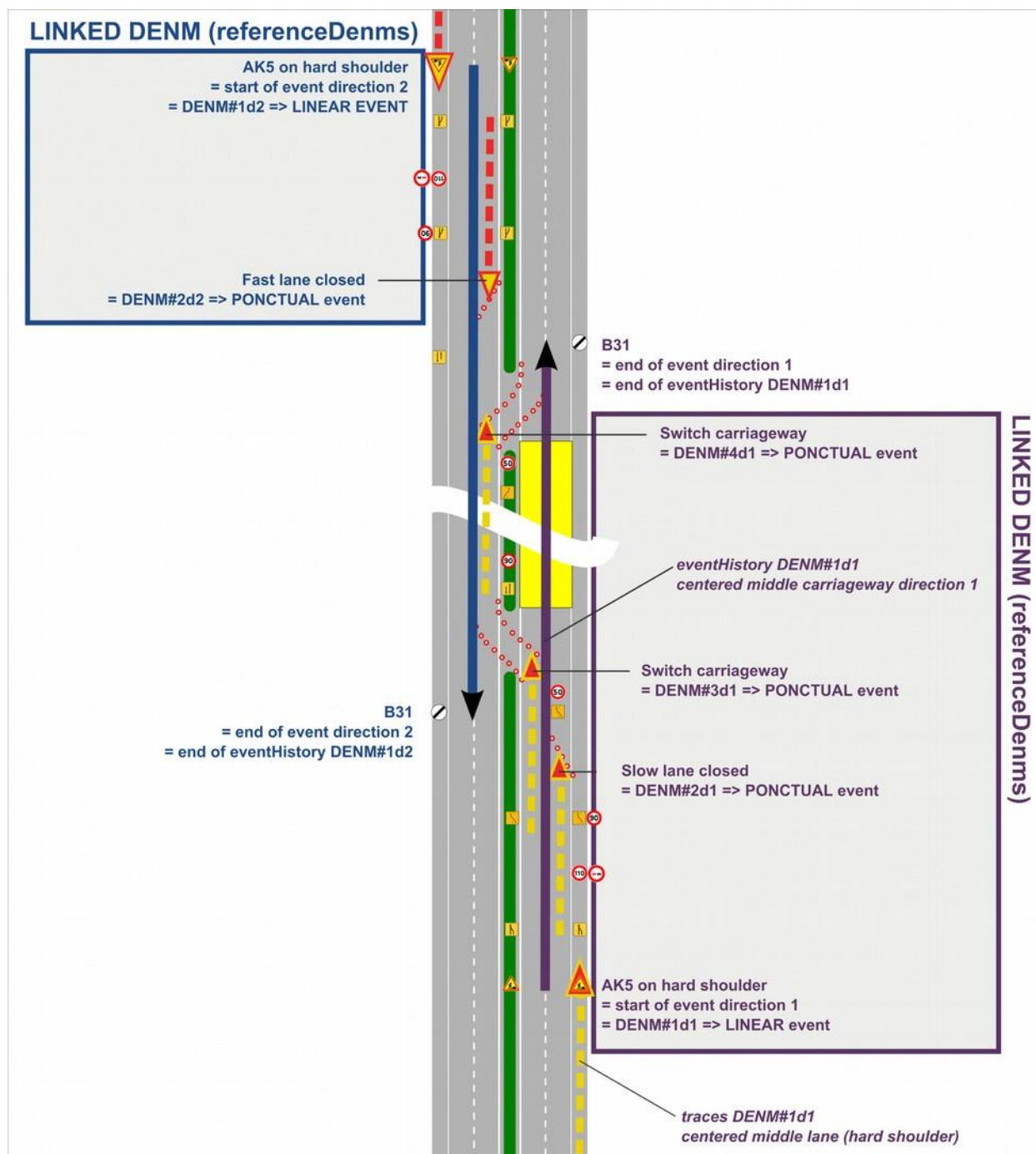


Figure 4 – ENHANCED: 1 group of DENMs per direction

#### Coding principle in TMS (2 options presented: BASIC & ENHANCED):

**BASIC:** operator has set in TMS a RWW “switching carriageway” event for direction 1, from AK5 of direction 1 to B31 of direction 1. Operator has set a “fast lane neutralization” event for direction 2, from AK5 of direction 2 to B31 of direction 2.

**ENHANCED:** operator has detailed the event in TMS with:

- A linear global event for direction 1 (from AK5 to B31 of direction 1), and punctual event associated for each new lane blocked.
- A linear global event for direction 2 (from AK5 to B31 of direction 2) and punctual event associated for each new lane blocked.

And TCC is able to code this in TMS (software of the road operator to manage event).

And system (PF) can handle these complexity: linked event.

**Note: only the direction concerned by the switching movement (direction 1) is detailed below. For the other direction that is concerned by a single lane neutralization, please refer to the previous chapter.**

**Coding of DE (only some DE are explained):**

	BASIC	ENHANCED			
	DENM	DENM#1	DENM#2	DENM#3	DENM#4
actionID	actionID(DENM)	actionID(DENM#1)	actionID(DENM#2)	actionID(DENM#3)	actionID(DENM#4)
eventPosition*	position(AK5d1) centred carriageway d1	position(AK5d1) centred carriageway d1	position (NeutraLane1d1) centred carriageway d1	position (1stswitchd1) centred carriageway d1	position (2ndswitchd1) centred carriageway d1
eventType	3 / 0	3 / 0	3 / 0	3 / 1	3 / 1
linkedCause	None	If RW due to an incident, can be given (CC/SCC)	None	None	None
eventHistory*	from AK5d1 to B31d1 centred carriageway d1	from AK5d1 to B31d1 centred carriageway d1	None (punctual)	None (punctual)	None (punctual)
traces*	approach (AK5d1) centred carriageway d1	approach (AK5d1) centred carriageway d1	approach centred carriageway d1	approach centred carriageway d1	approach centred carriageway d1
lanePosition	None	0	1	2	3
roadWorks Container :					
>closedLanes					
>>hsStatus	None	1 (closed)	1 (closed)	1 (closed)	1 (closed)
>>drivingLaneStatus**	None	[0,0,0]	[0,1,0]	[0,1,1,0]	[0,1,0,1]
>speedLimit***	90*	90*	90	50	50
>recommendedPath	None for switching carriageway movement				
>trafficFlow Rule	None	passToLeft	passToLeft	passToLeft	passToRight
>reference Denms	None	{aID(DENM#2), aID(DENM#3), aID(DENM#4)}	{aID(DENM#1), aID(DENM#3), aID(DENM#4)}	{aID(DENM#1), aID(DENM#2), aID(DENM#4)}	{aID(DENM#1), aID(DENM#2), aID(DENM#3)}

\*: for eventPosition, traces and eventHistory, accuracy is given centered carriageway. As soon as system can handle a better accuracy, it should do it.

\*\* : bit '0' (don't care bit) is on the left of the string (Ref. X.691 PER encoding rules) and always set to '0'.

\*\*\*: is the global speed limit of the roadwork event i.e. the speed after the switch movement. In the description above, speed at punctual event are given (at switch point, for example). They are relevant only on the limited area of this point.

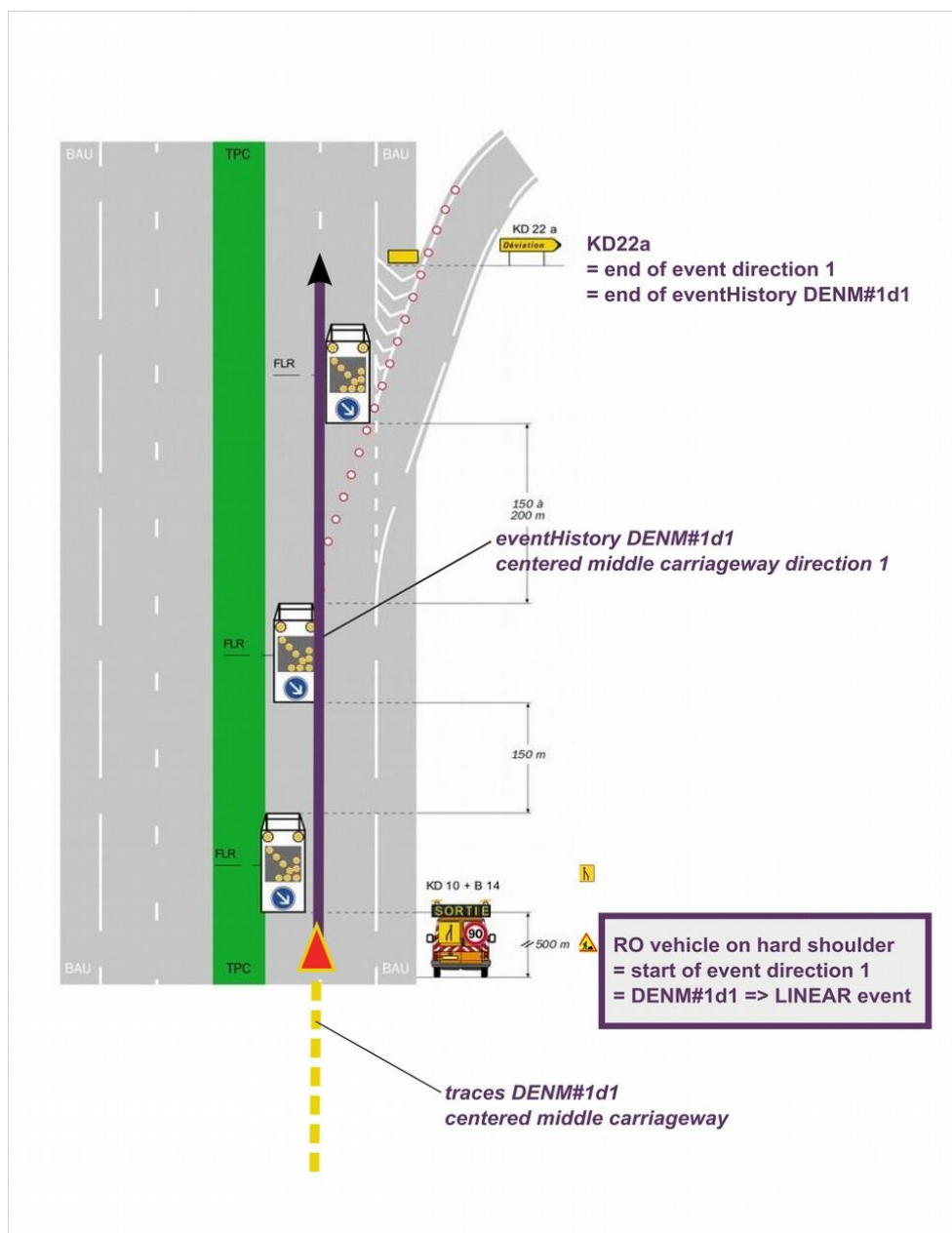
**In ENHANCED level, the PF has to properly code the group of events in consecutive events linked before sending the appropriate Datex II to R-ITS-S or N-ITS-S.**

## 2. Alert planned closure of a road or a carriageway (B1b) - DENM

### 2.1 Figure

#### 2.1.1 Figure for closure of a carriageway

In order to clarify the data elements, see figures below and following coding.



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*Figure 5 - BASIC: 1 DENM for closure*

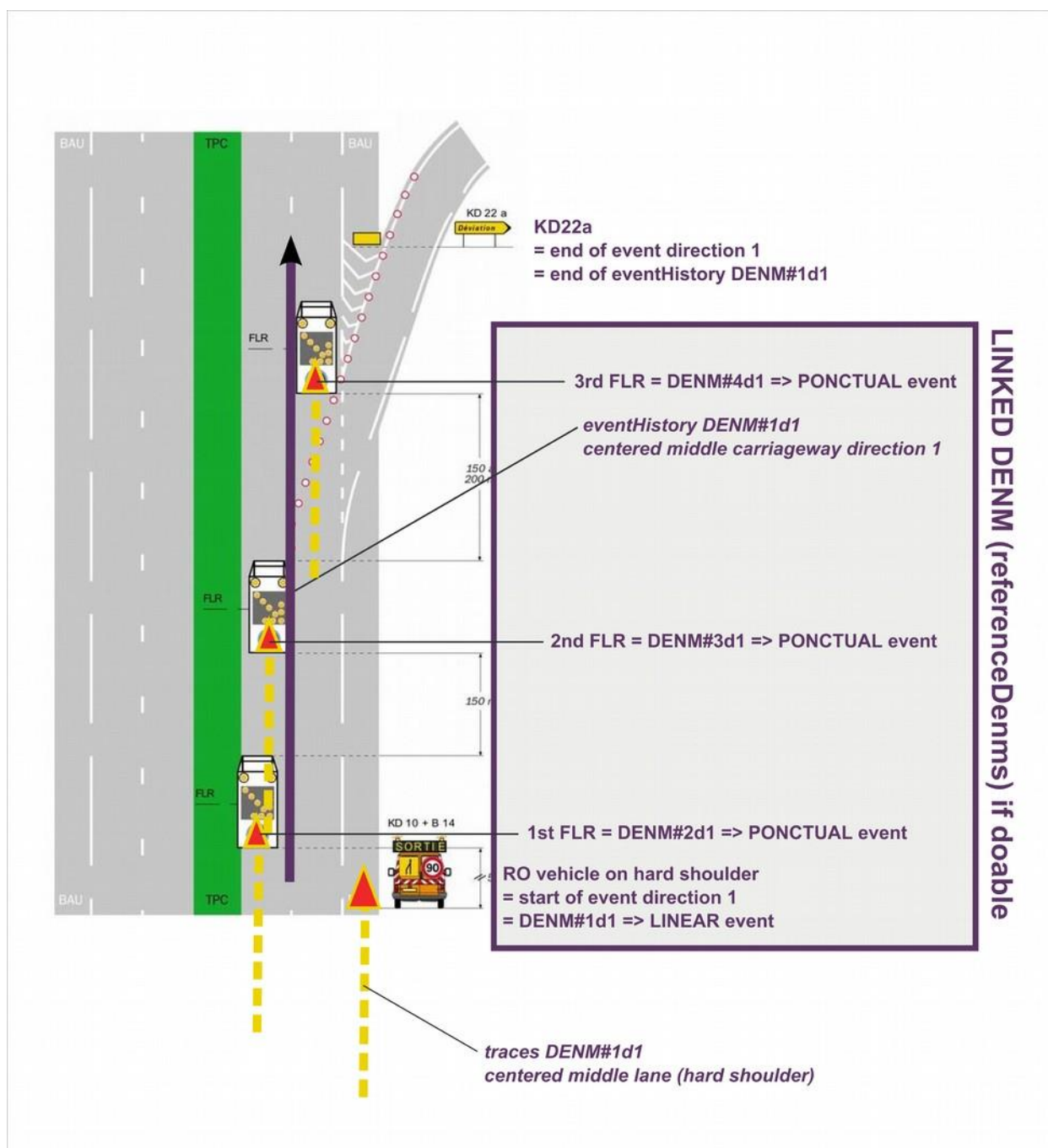


Figure 6 - ENHANCED: 1 group of DENMs per direction

### Coding principle in TMS (2 options presented: BASIC & ENHANCED):

**BASIC:** operator has set in TMS a RWW "road closure" event which start at Vro-ITS-S on hard shoulder and end at KD22a.

**ENHANCED:** operator has detailed the event in TMS with:

A linear global event for direction 1 (from Vro-ITS-S on hard shoulder to KD22a), and punctual event associated for each new lane blocked (vehicles with VMS trailers).



And TCC is able to code this in TMS (software of the road operator to manage event).

And system (PF) can handle these complexity: linked event.

**Coding of DE (only some DE are explained):**

	BASIC	ENHANCED			
	DENM	DENM#1	DENM#2	DENM#3	DENM#4
actionID	actionID(DENM)	actionID(DENM#1)	actionID(DENM#2)	actionID(DENM#3)	actionID(DENM#4)
eventPosition*	position(RO vehicle on HS) centred carriageway d1	position(RO vehicle on HS) centred carriageway d1	position (of 1 <sup>st</sup> trailer vehicle) centred carriageway d1	position (of 2 <sup>nd</sup> trailer vehicle) centred carriageway d1	position (of 3 <sup>rd</sup> trailer vehicle) centred carriageway d1
eventType	3 / 1	3 / 0	3 / 0	3 / 0	3 / 1
linkedCause	None	If RW due to an incident, might be given (CC/SCC)	None	None	None
eventHistory*	from ROvoHS to KD22a centred carriageway d1	from ROvoHS to KD22a centred carriageway d1	None (punctual)	None (punctual)	None (punctual)
traces*	approach (ROvoHS) centred carriageway d1	approach (ROvoHS) centred carriageway d1	approach centred carriageway d1	approach centred carriageway d1	approach centred carriageway d1
lanePosition	None	0	2	2	1
roadWorks Container :					
>closedLanes					
>>hsStatus	None	1 (closed)	1 (closed)	1 (closed)	1 (closed)
>>drivingLaneStatus**	None	[0,0,0]	[0,0,1]	[0,0,1]	[0,1,1]
>speedLimit	90	90	90	90	90
>recommendedPath	None	If set in system	None		
>trafficFlow Rule	None	passToLeft	passToRightt	passToRight	passToRight
>reference Denms	None	{aID(DENM#2), aID(DENM#3), aID(DENM#4)}	{aID(DENM#1), aID(DENM#3), aID(DENM#4)}	{aID(DENM#1), aID(DENM#2), aID(DENM#4)}	{aID(DENM#1), aID(DENM#2), aID(DENM#3)}

\*: for eventPosition, traces an eventHistory, accuracy is given centered carriageway. As soon as system can handle a better accuracy, it should do it.

\*\* : bit '0' (don't care bit) is on the left of the string (Ref. X.691 PER encoding rules) and always set to '0'.

**BASIC + vehicle true position:** the following situation can occur. TCC set BASIC in the system. Trailer are giving their position directly by Vro2V. In this case, eventPosition and traces have best accuracy. But, referenceDenms may not exist.

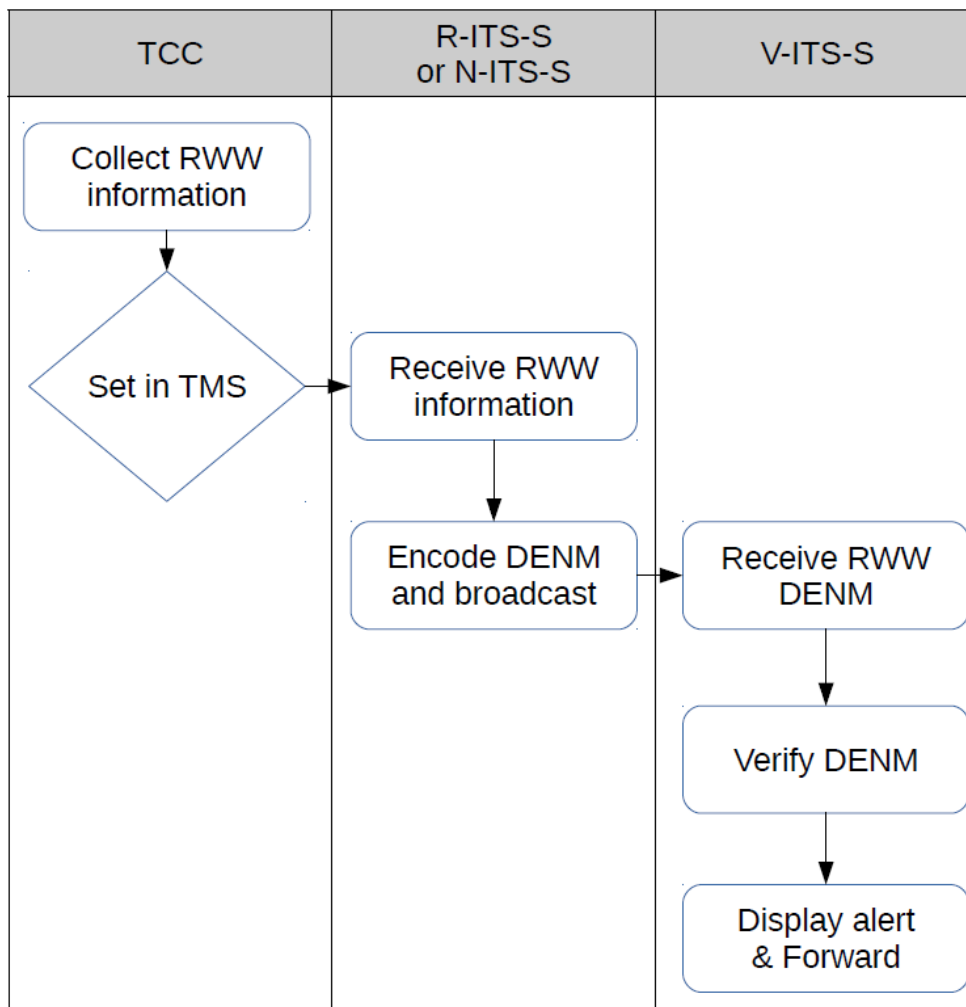
**In ENHANCED level, the PF has to properly code the group of events in consecutive events linked before sending the appropriate Datex II to R-ITS-S or N-ITS-S.**

## 2.1.2 Closure of road

A closure of a road (e.g. major roadworks on a bridge or on a railway level crossing) is set as a closure of one carriageway for each direction (one DENM or one group of DENM for each direction).



### 3. Step by step diagram (B1a and B1b)



**Collect RWW information(s):** for roadworks, detailed information is given before the event happens and fieldworkers give TCC the start of event. Fieldworkers, policemen or emergency services may call TCC to inform road operator about a partial lane blockage. Camera is another source of information...

**Set information in TMS (traffic management system of the traffic control center):** the level of description in TMS will affect the details given by DENMs to the vehicles. The ground level is to set one linear RW zone from the beginning to the end of RW zone only. The top level involves to describe each RW zone which similar driving characteristics.

For the coding, PF has to check the group of the event set in the TMS ("regroupement" in Tipi software, situation with several situationRecord for DATEX) to analyze if the describing given is ground level (only one oriented linear event) or top (a group of road operators' measures). In this second case, appropriate information is given to R-ITS-S and Nfr-ITS-S, through mono-record situations, so they can assume DENM coding. If the group contains a road hazard event, PF also communicated it to R-ITS-S and Nfr-ITS-S so they can set the linkedCause.

**Receive RWW information (R-ITS-S or Nfr-ITS-S):** information incoming from PF is Dutex II.

**Encode DENM and broadcast:** Datex II to DENM would be done in R-ITS-S and Nfr-ITS-S. Canal CCH for 100%-G5 scenario and SCH for hybrid scenario should be used (see 2.4.1\_H for more details). GeoNetwork dissemination and forwarding for 100%-G5 would be the same that for SCOP1 use-cases (10km area and ten times; see 2.4.1\_H also).

If not ground level description in Datex from PF, R-ITS-S and Nfr-ITS-S have to link DENM each other with referenceDENMS and if the RWW is due to a road hazard event, the linkedCause is given.

**Receive RWW information (vehicle):** through architecture. Architecture options are not treated in this document (see 2.4.1\_H). Anyway, whatever route the information has followed, DENM must have the same actionID and the same detectionTime (as presented below in profile). So that vehicle can treat one message or the other, but not both of them. referenceDENMS has also to be checked to group linked-DENMS each other. linkedCause is just given to explain if the measure is due to a road hazard event (accident, incident or else). Displaying of linkedCause information (when given) on HMI is optional for car manufacturers.

**Verify DENM and display alert:** an alert is given to warn the driver at the beginning of the zone of RWW (BASIC) or at the beginning of the zone of RWW and each time a new lane is closed (ENHANCED).









































The process of vehicle receiver can be as followed:

1. The vehicle checks actionID and detectionTime to verify if event is already known, if it is a new event or if it is an update.
2. The vehicle checks validityDuration to know if event is still reputed active.
3. The vehicle checks eventPosition to determine how far of its position it is and calculate its time-to-event.
4. The vehicle checks causeCode/SubCauseCode and relevanceTrafficDirection: it's a RWW and it is upstreamTrafficDirection.
5. The vehicle checks ReferenceDenms: if data in this DE, it's an ENHANCED level. If not, it's BASIC level. Eventually, it's BASIC level with Vro2V direct information from field without linked-references (see "closure of road" example with RO vehicles in previous chapter).
6. If ENHANCED (i.e. linked DENM via referenceDenms), detectionTime of each DENM is reviewed. Should be the same. If not, DENMs are not well synchronized so the pack of linked DENMs is inconsistency and should be rejected.
7. The vehicle checks traces of the linear event (the one with eventHistory). If vehicle is following one of traces, it is concerned by event (which is upstream). If not, the vehicle compares eventPositionHeading with its own heading and the way it is approaching the eventPosition by rear to know if it is concerned or not (difference between headings should be more or less about +/- 30°).
8. The vehicle analyzes especially the linear event (the one with eventHistory). This event gives start position of RWW and end position of RWW. Other DENM (punctual) are new blockage of roads or Vro-ITS-S as major obstacle (see second trailer of "closure of road" example). In ENHANCED level, 3/1 causeCode/subCauseCode are points where vehicle has to change carriageway: exit the road or switch to the other carriageway. In BASIC level, if CC/SCC is 3/1, it means that the carriageway is closed (and vehicle has to exit). In ENHANCED, when the group of DENM has only one with 3/1 it's a carriageway closure and if it has two 3/1 it's a carriageway switching.
9. lanePosition and closedLane give the (new) lane concerned by a blockage and the behavior expected from the driver. Those informations are not given in BASIC level as the details cannot be given.
10. linkedCause can be check to explain the reason of RWW if given (an accident for example)
11. Display the event for example as a linear event with a gauge (the whole roadwork linear) and with point of punctual event on it (each closure of lane). Displaying the linkedCause (when given) is optional.

---

The vehicle displays the event before eventPosition to alert the driver (proper moment is car manufacturer domain).

## 4. Information profile – Message description (in details) (B1a and B1b)

DENM transverse state		Profile B1a (and B1b)		
Field	Status Transverse	Status For the UC	Comments	Value set
<b>Header</b>				
protocol Version			See Master document / DENM	
messageID			See Master document / DENM	(is 1)
stationID			See Master document / DENM	
<b>Management container</b>				
actionID			See Master document / DENM	
detectionTime			See Master document / DENM <i>And in ENHANCED (linked DENMS) has to be the same for the group of DENM.</i>	
referenceTime			See Master document / DENM	
termination			See Master document / DENM	
eventPosition >			See 4 next lines and Master document / DENM	
>latitude			<i>latitude of start of event, and each new blockage in ENHANCED level</i>	
>longitude			<i>longitude of start of event, and each new blockage in ENHANCED level</i>	
>confidencePositionElipse			See Master document / DENM	
>altitude			See Master document / DENM	
relevanceDistance				
relevanceTrafficDirection			Is upstream (the zone of RWW)	is 1 (upStreamTraffic).
validityDuration			An end time is not always set in TCC. See Master document / DENM for the implication. With a default value of 3600s (1 hour) for this UC.	
transmissionInterval				
stationType			See Master document / DENM As an exception the situation can occur than the TMS gives BASIC level (stationType 15) and RO vehicle in field give independent DENM (stationType 9 or 10 in this case).	(is 15) most of time
<b>Situation container</b>				
informationQuality			Set to 6 (information I2V on RWW given by road operator but not from the field).	is 6
eventType			Derived of type of event set in TCC. <i>The causeCode is set to 3 (roadworks).</i> <i>The subCauseCode is set to 0 (unavailable) except for carriageway closure (3/1)</i>	is 3/0 or 3/1
linkedCause			If the RWW in TMS is in a group of events including a road hazard event, a linkedCause should be given (causeCode/subCauseCode). Else, no DE.	
eventHistory			Only for DENM of BASIC or for one DENM in ENHANCED level. Other DENM in ENHANCED are punctual. See Master document / DENM for description of DF.	
<b>Location container</b>				
eventSpeed				

DENM transverse state		Profile B1a (and B1b)		
Field	Status Transverse	Status For the UC	Comments	Value set
event Position Heading	S	S	If given, set as the heading of the carriageway at the eventPosition (for each DENM). Optional.	by PF
traces			Sequence of delta position from event position to "start" of each trace	by PF
roadType	U	U	See Master document / DENM	by PF
À la carte container				
lanePosition	S	U	Used in enhanced level as each new blockage of a lane	by PF
impact Reduction (DF)				
external Temperature				
roadWorks	S	U	See next lines	▼▼▼
>lightBar SirenInUse				
>closedLanes	S	S	<p>Depends on details set in TCC. Given at each point of blockage in ENHANCED level.</p> <p>closedLanes ::= SEQUENCE {hardShoulderStatus HardShoulderStatus OPTIONAL, drivingLaneStatus DrivingLaneStatus, ... }</p> <p>HardShoulderStatus ::= ENUMERATED {availableForStopping(0), closed(1), availableForDriving(2)}</p> <p>DrivingLaneStatus ::= BIT STRING { outermostLaneClosed(1), secondLaneFromOutsideClosed(2) }</p> <p><b>Due to lack of any bit '0' in DrivingLaneStatus definition in standard, after discussion with C-Roads PF partners, bit '0' is always set to 0 (and is a "don't care bit").</b></p>	by PF
>restriction				
>speedLimit	S	S	Depends on details set in TMS. In BASIC level global speed limit of RWW is given but speed can be lower at some points (switch movement for example). In ENHANCED, global speed limit is given by linear event and punctual events give speedLimit at their Positions.	by PF
>incident Indication				
>recommend edPath	S	S	No used for B1a but can be provided for B1b. However, probably not possible through actual TMS to set it. Sequence of referencePosition which could be center of each intersection for example. Seems difficult to interpret by vehicles without navigation... to be tested.	by PF
>startingPoint SpeedLimit				
>trafficFlow Rule	S	S	Depends on details set in TMS. Given at each point of blockage in ENHANCED level.	by PF
>reference Denms	S	S	Depends on details set in TCC: if only one linear zone, no referenceDenms (BASIC level). If ENHANCED level, used.	by PF
positioning Solution				
stationary Vehicle (DF)				