



French C-ITS Deployment Coordination committee

# Common technical specifications for use cases - emergency vehicle approaching

## 2.4.1.1 M\_D12

**Activity 2: Studies**

Sub Activity 2.4 > Specifications

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## Information on the document

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## Distribution

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Black highlighted text are problem with standards.

The following legend is used on the document tables :

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

Profile / Status:

- . If mandatory: **v**
- . If optional in standard:
  - . Used (**U**) when always used.
  - . Not used (**X**) 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 behavior 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 terme certificate authority)

ZZZ > is the numeration of the requirement

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

# Acronyms & abbreviations

ADAS	Advanced Driver Assistance Systems
CAM	Cooperative Awareness Message
C-ITS	Cooperative Intelligent Transport Systems
C-ITS-S	Central ITS Station (national ITS station)
DENM	Decentralized Environmental Notification Message (réf. ETSI standard for C-ITS messages)
GPS	Global Positioning System
ITS-G5	ITS-G5 is a European standard for ad-hoc short-range communication of vehicles among each other (V2V) and with Road ITS Stations (V2I). ITS-G5 refers to the approved amendment of the IEEE 802.11 (standard IEEE 802.11p). This technology (possibly others) uses the 5.9 GHz frequency band to support safety- and non-safety ITS applications. In this document ITS-G5 stands for IEEE802.11p/ETSI ITS-G5.
IVI	Infrastructure to Vehicle Information (réf. ETSI standard for C-ITS messages)
LDM	Local Dynamic Map
MAPData	Geometric information for the intersection (réf. ETSI standard for C-ITS messages)
OEM	Original Equipment Manufacturer
R-ITS-S	Roadside ITS Station (RSU or ITS-S R in the French Terminology)
SPAT	Signal Phase and Timing (réf. ETSI standard for C-ITS messages)
TCC	Traffic Control Centre (the place where road management measure are decided)
TMS	Traffic Management System (the usual system in which the road operator sets its road measures and events)
V-ITS-S	Vehicle ITS Station (any vehicles)
Vev-ITS-S	Emergency vehicule station, including law enforcement agency vehicle ITS Station
Vro-ITS-S	Road operator vehicle ITS Station
Vu-ITS-S	User vehicle ITS Station (in that case, road operator vehicle are excluded when they are not in user mode)
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V2X	V2V and/or V2I
N/A	<i>Not Applicable</i>
TBC	<i>To Be Checked, with MS or associated partner</i>
WIP	<i>Work in progress : when mentioned next to the version number, it means the document is an in-between version</i>

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This deliverable presents the specifications of Emergency Vehicle Approaching (emission and reception). It completes the existing Vru-ITS-S specifications (2.4.1.1\_M\_Master\_V2X). This V2V application will use the standardized DENM defined in ETSI 302 637. It will be particularly transmitted by the special vehicles like the security forces in intervention, to warn the driver of each receiving V2X vehicle about the vicinity of an emergency vehicle.

## 1. Description of EVA

The current emergency vehicles use light bars and/or sonic sirens to warn the road users, with the goal to obtain an easier way to reach their destination. These sonic sirens are loud enough to be heard, but are often difficult to be localized by drivers due to the multiple reflections of sounds, particularly in urban conditions. Consequently, some drivers react only when they see directly these emergency vehicles.

The principle of EVA is to consider that emergency vehicles like law enforcement agency vehicles (LEA) will be equipped with an additional V-ITS-S. This embedded V2X station, called Vev-ITS-S, will be used to warn electronically the other Vru-ITS-S or Vro-ITS-S present in the vicinity.

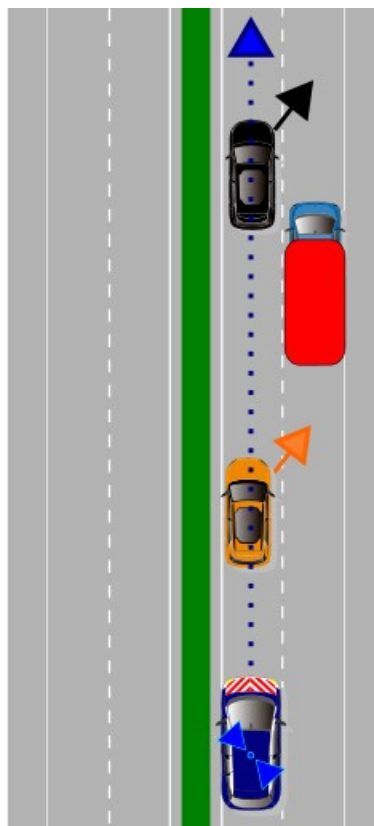


Figure : give the way to the emergency vehicle (here, law enforcement vehicle)

The DENM is chosen for this application, accordingly to the C-Roads Platform work with the Car2Car consortium. When the emergency vehicle approaching is activated, the desired behavior for the vehicle in the vicinity is to clear the lane used by the emergency vehicle (according to the road regulations) e.g. by making a lane change.

## 2. Message description - Emergency Vehicle transmitting

ID	2.4.1.1_M_D12-EmergencyVehicle-Activation
Component(s)	V <sub>EV</sub> -ITS-S
Requirement	The UC <b>SHALL</b> be activated manually by the driver or a passenger in the embedded system.
Acceptance	CA1 : Activation is manual, except if the partner has explicitly decided to do either and derogate to this requirement.
Additional information	Especially, the police wants to have a full control of what is emitted in C-ITS by their vehicles.

ID	2.4.1.1_M_D12-EmergencyVehicle-DENMProfile
Component(s)	V <sub>EV</sub> -ITS-S (for emission), V-ITS-S (for reception)
Requirement	The DENM transmitted by the V <sub>EV</sub> <b>SHALL</b> respect what's expected in the following table (DENM profile for D12).
Acceptance	Referring to the "Status for the UC" column in the table : CA1 : All mandatory <span style="color: green;">v</span> DE and used <span style="color: green;">v</span> DE shall be present in the message emitted, with the defined values. CA2 : All optional <span style="color: yellow;">s</span> DE can be present in the message emitted. See expected values in the table when defined. CA3 : All not used <span style="color: red;">x</span> DE shall be absent in the message emitted,
Additional information	At reception, V-ITS-S receiving a message with not used <span style="color: red;">x</span> DE shall not discard the message.

DENM profile for D12 :

DENM Master_V2X status		EVA attributes		
Field	Status (Master)	Status For the UC	Comments	Value set
<b>Header</b>				
protocolVersion	<span style="color: green;">v</span>	<span style="color: green;">v</span>	See Master_V2X document / DENM	
messageID	<span style="color: green;">v</span>	<span style="color: green;">v</span>	See Master_V2X document / DENM	(is 1)
stationID	<span style="color: green;">v</span>	<span style="color: green;">v</span>	See Master_V2X document / DENM	
<b>Management container</b>				
actionID	<span style="color: green;">v</span>	<span style="color: green;">v</span>	See Master_V2X document / DENM	
detectionTime	<span style="color: green;">v</span>	<span style="color: green;">v</span>	See Master_V2X document / DENM	
referenceTime	<span style="color: green;">v</span>	<span style="color: green;">v</span>	See Master_V2X document / DENM	
termination	<span style="color: yellow;">s</span>	<span style="color: red;">x</span>	Not used (due to short validityDuration)	
eventPosition >	<span style="color: green;">v</span>	<span style="color: green;">v</span>	See 4 next lines and Master_V2X document / DENM	
>latitude	<span style="color: green;">v</span>	<span style="color: green;">v</span>	Latitude of vehicle position	
>longitude	<span style="color: green;">v</span>	<span style="color: green;">v</span>	Longitude of vehicle position	
>confidencePositionEllipse	<span style="color: green;">v</span>	<span style="color: green;">v</span>	See Master_V2X document / DENM	
>altitude	<span style="color: green;">v</span>	<span style="color: green;">v</span>	See Master_V2X document / DENM	
relevanceDistance	<span style="color: red;">x</span>			
relevanceTrafficDirection	<span style="color: green;">v</span>	<span style="color: green;">v</span>	allTrafficDirections. It involves that the message <b>CAN</b> be displayed to opposite traffic of a road with separation. However, it is justified by the fact that emergency vehicles (and especially law enforcement vehicles) <b>CAN</b> enter on the opposite lanes of a road to go faster to an event or even in case of a pursuit.	is allTrafficDirections
validityDuration	<span style="color: green;">v</span>	<span style="color: green;">v</span>	2(s).	
transmissionInterval	<span style="color: red;">x</span>			
stationType	<span style="color: green;">v</span>	<span style="color: green;">v</span>	The Vev-ITS-S <b>SHALL</b> use (10) specialVehicles (as for the road operator vehicles)	(is 10)
<b>Situation container</b>				
informationQuality	<span style="color: green;">v</span>	<span style="color: green;">v</span>	is 6	is 6

DENM Master V2X status		EVA attributes		
Field	Status (Master)	Status For the UC	Comments	Value set
eventType	v	v	The causeCode is set to 95 (Emergency vehicle approaching). The subcauseCode is set to 1 (Emergency vehicle approaching).	is 95/1
linkedCause	x	x	Not used in V2X	
eventHistory	s	x	Event linked to the Vev-ITS-S's trajectory (sent by the Vev-ITS-S) is a ponctual event (no event history).	
Location container				
eventSpeed	s	s	This field will be filled in by the Vev-ITS-S with its speed and its confidence of the moving speed information. See also Master V2X.	by Vev-ITS-S
eventPositionHeading	s	s	This field will be filled in by the Vev-ITS-S thanks to its path history. This information is built with information from GNSS or CAN bus.	By Vev-ITS-S
traces	v	v	The trace <b>SHOULD</b> be the PathHistory of the vehicle as defined in the CA basic service ETSI EN 302 637 – 2 Note: however the trace is here not really needed to be used by receiver (the event is downstream and not upstream).	By Vev-ITS-S
roadType	s	s	Provided if the station can do it. "The road type information at the event position."	
À la carte container				
lanePosition	s	s	Not provided in V2X (except if the V-ITS-S <b>CAN</b> really do so). If data is provided, the V-ITS-S is required to predefined confidence level as defined by the ITS applications (e.g. 95 %).	
impactReduction (DF)	s	x	Not applicable to the use case.	
externalTemperature	s	s	<b>CAN</b> be emitted if doable, but no particular value for the use case.	
roadWorks (DF)	s	x	Not applicable to this UC	
positioningSolution	v	v	<b>SHALL</b> be emitted in V2X. This field may be among noPositioningSolution(0), sGNSS(1), dGNSS(2), sGNSSplusDR(3), dGNSSplusDR(4), dR(5), ..	By V-ITS-S
stationaryVehicle (DF)	s	x	Not applicable to this UC	

ID	2.4.1.1_M_D12-EmergencyVehicle-UpdateCycle
Component(s)	V <sub>EV</sub> -ITS-S
Requirement	The update cycle <b>CAN</b> be 250 or 500 milliseconds due to the fact that when in motion the position of this special vehicle has to be regularly updated.
Acceptance	
Additional information	

ID	2.4.1.1_M_D12-EmergencyVehicle-CAMProfile
Component(s)	V <sub>EV</sub> -ITS-S (for emission), V-ITS-S (for reception)
Requirement	The CAM transmitted by the V <sub>EV</sub> <b>SHOULD</b> respect what's expected in the following table (CAM profile related to D12 activation).
Acceptance	Referring to the "Status for the UC" column in the table : CA1 : All mandatory v DE and used s DE shall be present in the message emitted, with the defined values. CA2 : All optional s DE can be present in the message emitted. See expected values in the table when defined. CA3 : All not used x DE should be absent in the message emitted,
Additional information	The CAM message does not trigger the UC for the receiver. It is the DENM message which do it. However, the information present in the CAM messages can be processed by receiver to enhance the alert.



## CAM profile related to D12 activation :

CAM ETSI Norm status		Profile EVA (D12)		
Field	Status (ETSI)	Status For the UC	Comments	Value set
<b>Header</b>				
protocolVersion	v	v	See Master_V2X document / CAM	
messageID	v	v	See Master_V2X document / CAM	(is 2)
stationID	v	v	See Master_V2X document / CAM	
<b>CoopAwareness</b>				
generationDeltaTime	v	v	See Master_V2X document / CAM	
<b>BasicContainer</b>				
StationType	v	v	<b>StationType SHALL be 10 (specialVehicles).</b>  <b>Note: When a LEA is not in an emergency mode, the stationType CAN be 5 (passengerCar) or even no CAM may be emitted (to permit LEA to be fully undetectable)</b>	is 10
ReferencePosition >	v	v		
>latitude	v	v	latitude of emergency vehicle position	
>longitude	v	v	longitude of emergency vehicle position	
>confidencePositionEllipse	v	v	See Master_V2X	
>altitude	v	v	See Master_V2X	
<b>HighFrequencyContainer &gt; basicVehicleContainerHighFrequency</b>				
heading	v	v		
speed	v	v		
driveDirection	v	v		
vehicleLength	v	v	(Not really needed to be used by receiver)	
VehicleWidth	v	v	(Not really needed to be used by receiver)	
longitudinalAcceleration	v	v	(Not really needed to be used by receiver)	
curvature	v	v	(Not really needed to be used by receiver)	
curvatureCalculationMode	v	v	(Not really needed to be used by receiver)	
yawRate	v	v	(Not really needed to be used by receiver)	
accelerationControl	S	x		
lanePosition	S	S	Difficulties : have the lane information, provide it in the good format (change between CDD 1.2.1 and 1.3.1) and EV changes frequently from one lane to other. And even, can be in-between to lanes, which can not be coded in the standard	
steeringWheelAngle	S	x		
lateralAcceleration	S	x		
verticalAcceleration	S	x		
performanceClass	S	x		
cenDsrcTollingZone	S	x		
LowFrequencyContainer> basicVehicleContainerLow Frequency	S		All CAM does not contain this data field. Following DE are mandatory when the container is present in the message	
vehicleRole	v	v	<b>vehicleRole SHALL be 'emergency' (6).</b>  Note : for police vehicles (LEA), when the UC is not active and they don't want to be detected, they <b>should</b> have the possibility to switch to vehicleRole = 'default' (0) or to stop to emit CAMs.	is emergency (6)
exteriorLights	v	v	(Not really needed to be used by receiver)	
pathHistory	v	v	(Not really needed to be used by receiver)	
SpecialVehicleContainer	S	S	<b>The emergency vehicle will broadcast CAM as specified in ETSI EN 302 637-2 : "For special vehicles, the special-vehicle container shall be included in the first CAM generation since the CA basic service activation. After that, a special vehicle container shall be included if the time elapsed since the generation of the last CAM with a special vehicle container is equal to or greater than 500 ms."</b>	

CAM ETSI Norm status		Profile EVA (D12)		
Field	Status (ETSI)	Status For the UC	Comments	Value set
<i>publicTransportContainer</i>	S	x		
<i>specialTransportContainer</i>	S	x		
<i>dangerousGoodsContainer</i>	S	x		
<i>dangerousGoodsBasic</i>	S	x		
<i>roadWorksContainerBasic</i>	S	x		
<i>rescueContainer</i>	S	x		
<i>emergencyContainer</i>	S	U	See three next lines	
> <i>lightBarSirenInUse</i>	S	U	<b>The value of the <i>lightBarSirenInUse</i> SHALL be filled accordingly to light bar and siren status (this may involve a connection between the HMI and the equipment).</b> By default, this value <b>MAY</b> be [1,1] to indicate that both the light bar and the siren are activated. However, if the Vev-ITS-S is connected to the light bar and siren systems, this value <b>SHALL</b> be filled in accordingly.	
> <i>incidentIndication</i>	S	S		
> <i>emergencyPriority</i>	S	S		
<i>safetyCarContainer</i>	S	J		

<b>ID</b>	<b>2.4.1.1_M_D12-EmergencyVehicle-lanePosition</b>
<b>Component(s)</b>	V <sub>EV</sub> -ITS-S (for emission), V-ITS-S (for reception)
<b>Requirement</b>	For the attribute "lanePosition" (in both CAM and DENM), if the Vev-ITS-S is not connected to the suitable system to detect the current lane of the vehicle, this value <b>MAY</b> be selected on the HMI. Or, it <b>MAY</b> be the far-left lane (or the most used lane for the Vev-ITS-S according to the road type).
<b>Acceptance</b>	
<b>Additional information</b>	LanePosition can be interesting to enhance the alert in the receiver-vehicle.

<b>ID</b>	<b>2.4.1.1_M_D12-EmergencyVehicle-Desactivation</b>
<b>Component(s)</b>	V <sub>EV</sub> -ITS-S
<b>Requirement</b>	When the emergency mode is not activated or desactivated, the Vev-ITS-S operator(driver or passenger) <b>SHALL</b> have the choice to broadcast CAM or not through the HMI.
<b>Acceptance</b>	
<b>Additional information</b>	Especially, the police wants to have a full control of what is emitted in C-ITS by their vehicles.

### 3. Emergency vehicle detection in receiving-vehicle

ID	2.4.1.1_M_D12-EmergencyVehicle-Detection
Component(s)	V-ITS-S (receiver of the D12 DENM)
Requirement	In each V2X vehicle (receiver), DENM received from EVA (D12) <b>SHALL</b> be analyzed. By the analysis of the relative position, heading and path history, these DENM <b>COULD</b> be considered relevant in term of collision risk by receiver.
Acceptance	CA1 : DENM and optionally CAM are processed by the V-ITS-S (receiver) CA2 : principles of the following chapter can be applied
Additional information	Processing by vehicle-receiver is mandatory, but the information contained in the current chapter (way to determine the relevancy) are not mandatory. Indeed, the receiver can processed differently.

We **COULD** distinguish two main conditions to determine if the information is relevant :

- Distance (1)
- EV overlapping the pathHistory of vehicle-receiver (2).

#### 1. Condition of distance

Any emergency vehicle which is less than 100m of distance of the vehicle-receiver **should** imply an alarm in the vehicle-receiver.

An additional condition **COULD** be based on a **predictive perspective** e.g time to contact (TTC) is lower than 10 seconds.

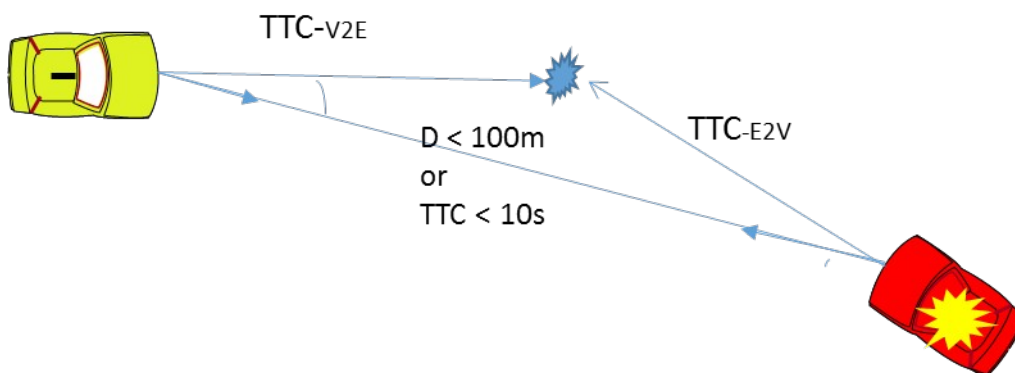
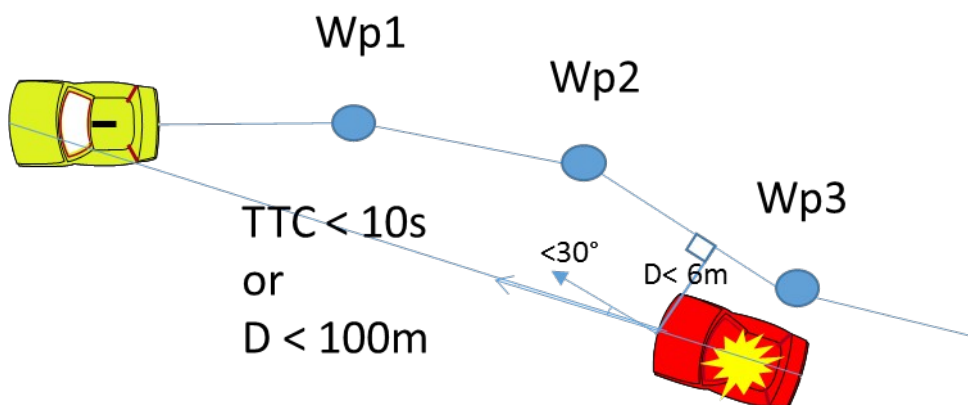


Illustration : distance and/or time-to-contact

#### 2. EV overlapping the pathHistory of vehicle-receiver

The detection of an emergency vehicle present in the rear sector of the receiver **COULD** be done through the following condition : the vehicle is **approaching** (prediction computing) and is **located in the closed vicinity of the path history of receiving vehicle** (e.g the angle between emergency vehicle and the closest segment of the path history is less than 30° and the distance between emergency vehicle this segment is less than 6 m.)



*Illustration for emergency approaching by the rear  
(wp = way point which constitutes the pathHistory of the vehicle-receiver, in yellow)*

## 4. Emergency vehicle Alarm in Receiving Vehicle

ID	2.4.1.1_M_D12-EmergencyVehicle-Alert
Component(s)	V-ITS-S (receiver of the D12 DENM)
Requirement	The alert given to the driver of the vehicle-receiver <b>SHOULD</b> be significant.
Acceptance	CA1 : compared to the reception of most of the DENM messages, the alert should be a stronger advice. CA2 : arrival of a priority vehicle and its position and direction should be displayed.
Additional information	Depending on car manufacturer choices the alarm could be displayed by different solutions. However, the use-case presented in the current document is important to ensure the safety of emergency vehicles and road user vehicles. It implies that <b>a quite intrusive alert should be given to the driver of the revealing vehicles</b> .  Additionally, if the human-machine interface of the vehicle can be used to set whether the driver is deaf or hard of hearing, then it should display the emergency vehicle so that the driver can be aware of the arrival of a priority vehicle and its position and direction in order to adapt his driving accordingly.  This display can also be very useful for any driver when vehicles are located in a dense urban environment when the echo makes it very difficult to locate the sound source of the Ev siren.