
Triggering Conditions and Data Quality Special Vehicle Warning

CAR 2 CAR Communication Consortium



CAR 2 CAR

COMMUNICATION CONSORTIUM

About the C2C-CC

Enhancing road safety and traffic efficiency by means of Cooperative Intelligent Transport Systems and Services (C-ITS) is the dedicated goal of the CAR 2 CAR Communication Consortium. The industrial driven, non-commercial association was founded in 2002 by vehicle manufacturers affiliated with the idea of cooperative road traffic based on Vehicle-to-Vehicle Communications (V2V) and supported by Vehicle-to-Infrastructure Communications (V2I). The Consortium members represent worldwide major vehicle manufactures, equipment suppliers and research organisations.

Over the years, the CAR 2 CAR Communication Consortium has evolved to be one of the key players in preparing the initial deployment of C-ITS in Europe and the subsequent innovation phases. CAR 2 CAR members focus on wireless V2V communication applications based on ITS-G5 and concentrate all efforts on creating standards to ensure the interoperability of cooperative systems, spanning all vehicle classes across borders and brands. As a key contributor, the CAR 2 CAR Communication Consortium and its members work in close cooperation with the European and international standardisation organisations.

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Table 1: Document information

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1.6.6	2024-07-12	No changes	Release Management	Steering Committee
1.6.5	2023-12-15	No changes	Release Management	Steering Committee
1.6.4	2023-07-21	Consideration of aftermarket aspects in the requirements by reworked use cases: <ul style="list-style-type: none"> • <i>emergency vehicle in operation TO emergency, recovery, prioritized vehicle</i> approaching • <i>stationary safeguarding emergency vehicle TO emergency, recovery, prioritized vehicle at a location</i> • Removal of use case: <ul style="list-style-type: none"> ○ stationary recovery service warning 	Release Management	Steering Committee
1.6.3	2022-12-16	Minor editorial changes	Release Management	Steering Committee
1.6.2	2022-07-22	<ul style="list-style-type: none"> • Correction of mixed up use of <i>stationType</i> and <i>vehicleRole</i> <ul style="list-style-type: none"> ○ <i>stationType</i> is not set to <i>specialVehicle</i> (10) anymore but rather in accordance with [TS 102 894-2]. • For further corrections please refer to clause 5 of [C2CCC RelOv] 	Release Management	Steering Committee
1.6.1	2021-12-17	Added marking of requirements, indicating relevance for interoperability according to [CPOC]	Release Management	Steering Committee
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Table 2: Changes since last release

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1 Introduction

Other (informational)

RS_tcSpVe_220

This document describes the triggering conditions for the special vehicle warning. The vehicle C-ITS service is divided in the following two sub-services:

- 'special vehicle warning – emergency, recovery, prioritized vehicle approaching';
- 'special vehicle warning – emergency, recovery, prioritized vehicle at a location';

2 Definitions

Definition

RS_tcSpVe_642

'*Vehicle speed*' is the length of the velocity-vector of the reference position point.

Definition

RS_tcSpVe_244

There is a wide range of vehicles with a special role that participate in traffic and that need other road users to give way or to facilitate their passage, when they are on a mission. The vehicle C-ITS service definition in the present document applies to the following categories of vehicle roles.

1. **Emergency vehicle:** This vehicle has the absolute right of way according to national traffic regulations, when it activates its emergency signals - usually a light bar, often used together with a siren. Depending on local laws, emergency vehicle drivers are often not required to follow certain traffic rules, such as compliance to traffic lights, speed limits or road markings. Other road users have to give way to the emergency vehicle (drive to the right; stop, when required) and resume normal driving after the emergency vehicle has passed. Emergency vehicles are typically used by emergency services, such as police, ambulance, or fire departments.
2. **Prioritized vehicle:** This vehicle has some kind of priority that is not the absolute right of way, but other road users have to facilitate its passage or to give way to the extent necessary that it can fulfil its mission. Prioritized vehicles are described in traffic regulations in certain countries (e.g. road operator vehicles in Austria). This kind of priority could also be temporarily assigned from an authority (e.g. Police).
3. **Recovery vehicle:** This vehicle supports technical recovery or technical rescue, e.g. removal and transport of a broken-down vehicle. It has no right of way. Its lightbar signals a hazardous location, where rescue or recovery work is in progress. Other road users are expected to drive attentively when approaching the potentially hazardous location.

Since the rights of these vehicles and the expected behaviour of road users being in their vicinity differ per country (esp. in case of prioritized vehicles), it is important for the implementer to check which of the vehicle categories above align with the national traffic regulation under which the vehicle operates.

Note: These vehicles are usually operated by designated agencies, often part of the government, but also run by charities, non-governmental organizations and – esp. in case of recovery vehicles – also by commercial companies.

3 Parameter settings

Definition

RS_tcSpVe_243

Table 3: Parameter settings

Parameter	Value	Unit	Description
pAtLocationSpeed	1,5	m/s	Below threshold until switching to 'vehicle at a location'
pAtLocationRadius	40	m	Circle around centre point (geofence)
pAtLocationTime	30	s	Elapsing time until switching to 'vehicle at a location'

4 Requirement specifications

Information

RS_tcSpVe_245

This vehicle C-ITS service deals with vehicles which are ‘at a location’ (safeguarding) or ‘approaching’ (moving).

Safeguarding special vehicles maybe have the need to reposition themselves by a few meters. To avoid an immediate change to the ‘approaching’ special vehicle warning, the ‘safeguarding’ special vehicle warning (at a location) is not terminated immediately when the vehicle starts moving – instead, it remains in ‘safeguarding’ state until it leaves its location (defined by a radius) and exceeds a certain speed threshold. Stop-and-go driving manoeuvres after the ‘safeguarding’ had been entered would not result in a change to ‘approaching’.

The vehicle’s position for the safeguarding use case is buffered in the ITS-S and the buffer is updated as long as the safeguarding vehicle is ‘at a location’. Only if the vehicle is moving faster than $pAtLocationSpeed$, the position is no longer updated. If the safeguarding vehicle continues to move that fast away from the buffered position, the use case changes from “at a location” to “approaching”. The desired behaviour and the changes between the use cases are reflected in Figure 1.

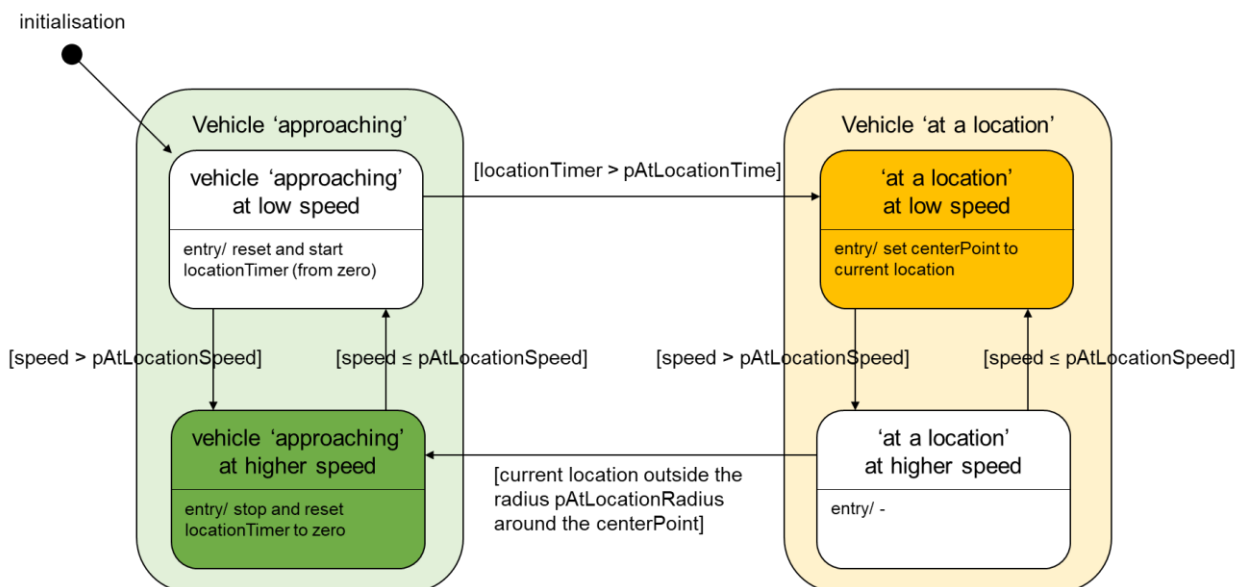


Figure 1: State change diagram with the transitions between the special vehicle use cases for emergency vehicles.

Information

RS_tcSpVe_246

Figures 2 and 3 provide an example for a set of driving manoeuvres in time and space domain: In manoeuvres 1-4 the C-ITS station is in the ‘approaching’ state, where the *locationTimer* is started and stopped several times, and it finally expires during movement 4, manoeuvres 5 and 6 demonstrate the C-ITS station ‘at a location’, where the geofence (given by the centre position and the radius $pAtLocationRadius$) is left during manoeuvre 6.

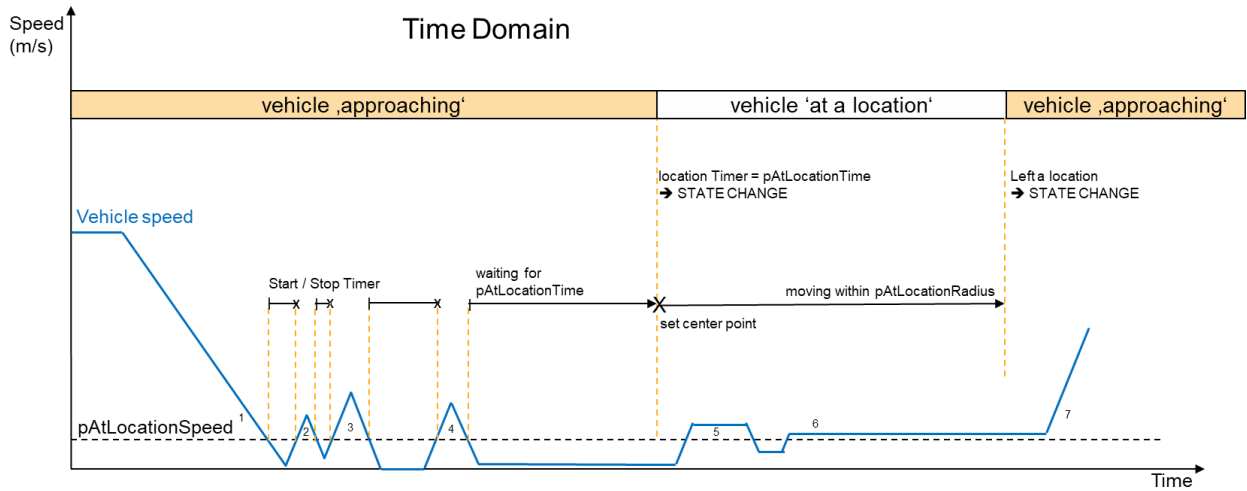


Figure 2: Time Domain – velocity profile

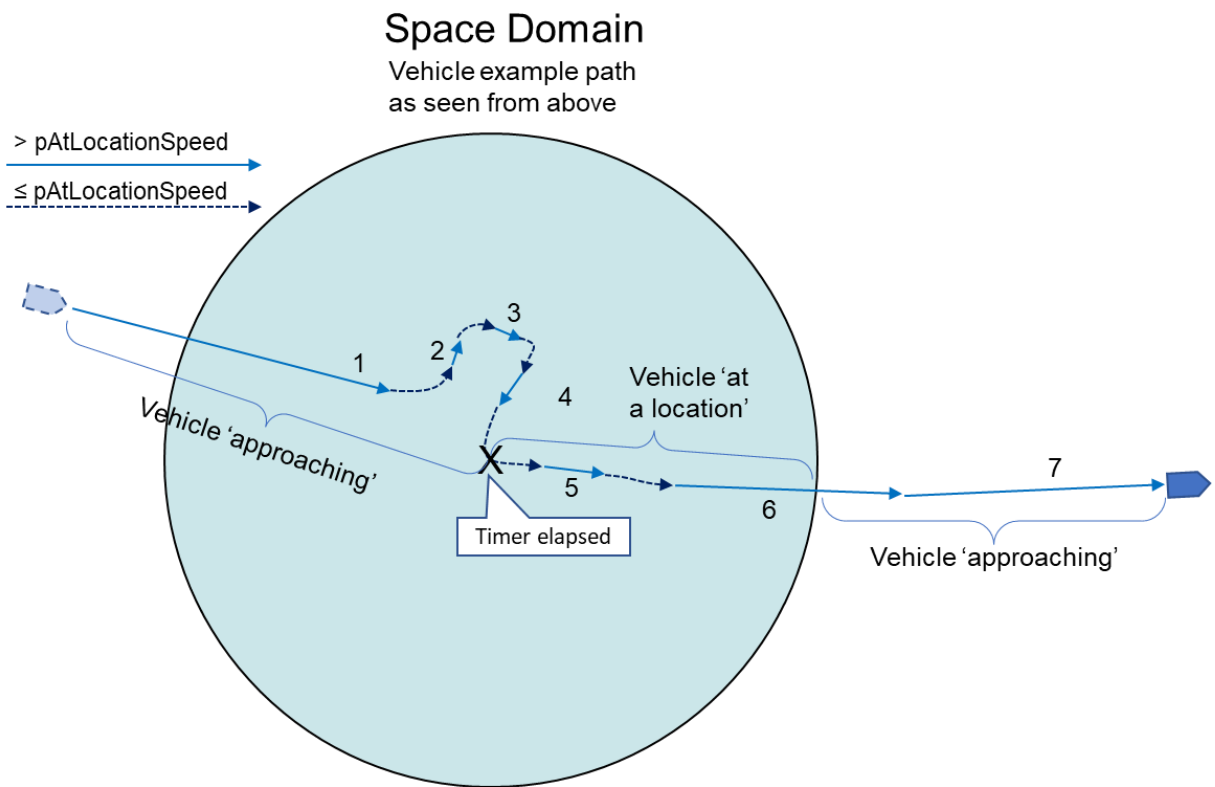


Figure 3: Space Domain – example path

4.1 Special vehicle warning – emergency, recovery, prioritized vehicle approaching

4.1.1 Description of vehicle C-ITS service

Other (informational)

RS_tcSpVe_221

This use case is used to warn road users about an approaching emergency, prioritized, or recovery vehicle in order to facilitate the passage of such vehicles, when they are on a mission and not yet at a location.

Other (informational)

RS_tcSpVe_222

This clause describes the triggering conditions for the emergency, prioritized, or recovery vehicle warning C-ITS service. This vehicle C-ITS service informs drivers of nearby vehicles about an emergency, prioritized, or recovery vehicle moving to an operation scene, which is signalled by the use of the light bar.

Requirement (i)

RS_tcSpVe_117

In case of an emergency, prioritized, or recovery vehicle according to RS_tcSpVe_244: as soon as the vehicle C-ITS service is triggered, a DENM shall be transmitted by the vehicle C-ITS station

All emergency, recovery, prioritized vehicle shall set data fields of CAM in accordance with the rules specified in the current clause.

Note: A parallel activation with the vehicle C-ITS service *emergency, recovery, prioritized vehicle at a location* has to be avoided. For an emergency vehicle C-ITS station the default vehicle C-ITS service is *emergency, recovery, prioritized vehicle approaching*.

Tested by:

Other (informational)

RS_tcSpVe_224

The following vehicle C-ITS services are related to this service, because they share similar triggering conditions:

- ‘special vehicle warning – emergency, recovery, prioritized vehicle at a location’.

Requirement (i)

RS_tcSpVe_118

The default vehicle C-ITS service for an emergency, prioritized, or recovery vehicle C-ITS station is ‘*emergency vehicle in operation*’. A change to the ‘*emergency, recovery, prioritized vehicle at a location*’ vehicle C-ITS service shall be triggered only under the conditions set out in clause 4.2.

Tested by:

4.1.2 Triggering conditions

4.1.2.1 Preconditions

Requirement (i)

RS_tcSpVe_119

The following preconditions shall be satisfied when this use case is triggered:

- the vehicle is an emergency, prioritized, or recovery vehicle as defined in RS_tcSpVe_244 and

- the triggering conditions regarding ‘emergency, recovery, prioritized vehicle at a location’ shall not be satisfied, see clause 4.2.2.

Tested by:

4.1.2.2 Service-specific conditions

Requirement (i)

RS_tcSpVe_120

If the preconditions in RS_tcSpVe_119 and the following condition are satisfied, the generation of a DENM shall be triggered.

- a) the light bar is in use;

Tested by:

Requirement (i)

RS_tcSpVe_121

The level of information quality can be improved by the following conditions:

- b) the siren is in use;
- c) the vehicle is in the state “approaching at higher speed” (see Figure 1).

Tested by:

4.1.2.3 Information quality

Requirement (i)

RS_tcSpVe_123

The value of the data element *informationQuality* in the DENM depends on how the event is detected. The *informationQuality* value shall be set in accordance with the following table (highest possible value shall be used):

Table 4: Information quality of ‘emergency, recovery, prioritized vehicle approaching’

Event detection	Value of InformationQuality
No TRCO-compliant implementation	unknown(0)
Condition a) is fulfilled	1
Conditions a) and b) are fulfilled	2
Conditions a) and c) are fulfilled	3
Conditions a), b), and c) are fulfilled	4

Tested by:

Requirement (i)

RS_tcSpVe_124

If the triggering conditions change between two updates, the *informationQuality* shall not be changed until the next update. If the changed conditions are still fulfilled while the DENM is updated, the *informationQuality* shall be updated.

Tested by:

4.1.3 Termination conditions

Requirement (i)

RS_tcSpVe_125

The vehicle C-ITS service shall be terminated when the light bar is no longer in use or the triggering conditions of ‘emergency, recovery, prioritized vehicle at a location’ are satisfied. At the termination of the vehicle C-ITS service, updating of DENMs shall be terminated.

Note: *vehicleRole* might be set to *default(0)* if the vehicle C-ITS service is not active.

Tested by:

4.1.3.1 Cancellation

Requirement (i)

RS_tcSpVe_126

A cancellation DENM shall not be used for this vehicle C-ITS service.

Tested by:

4.1.3.2 Negation

Requirement (i)

RS_tcSpVe_127

A negation DENM shall not be used for this vehicle C-ITS service.

Tested by:

4.1.4 Update

Requirement (i)

RS_tcSpVe_128

The generated DENM shall be updated every 250 ms if the triggering conditions are still satisfied. The data fields that are assigned new values are defined in RS_tcSpVe_131.

Tested by:

4.1.5 Repetition duration and repetition interval

Requirement (i)

RS_tcSpVe_129

A repetition of the DENM shall not be used for this vehicle C-ITS service.

Tested by:

4.1.6 Traffic class

Requirement (i)

RS_tcSpVe_130

New and update DENMs shall be set to *traffic class 1*.

Tested by:

4.1.7 Message parameters

4.1.7.1 DENM

Requirement (i)

RS_tcSpVe_131

The following table specifies the data elements of the DENM that shall be set.

Table 5: DENM data elements of ‘emergency, prioritized, or recovery vehicle approaching’

Data field	Value
Management container	
<i>actionID</i>	Identifier of a DENM. Shall be set in accordance with [TS 102 894-2].
<i>detectionTime</i>	<i>Timestamp</i> ts-timestamp at which the event is detected by the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2]. Shall be refreshed for an update DENM.
<i>referenceTime</i>	<i>Timestamp</i> ts-timestamp at which a new DENM or an update DENM is generated. Shall be set in accordance with [TS 102 894-2].
<i>termination</i>	Shall not be set, because neither negation nor cancellation are to be used in this vehicle C-ITS service.
<i>eventPosition</i>	<i>ReferencePosition</i> . Shall be set in accordance with [TS 102 894-2]. Shall be refreshed for an update DENM.
<i>relevanceDistance</i>	lessThan1000m(4)
<i>relevanceTrafficDirection</i>	allTrafficDirections(0)
<i>validityDuration</i>	2 s
<i>stationType</i>	The type of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
Situation container	
<i>informationQuality</i>	See RS_tcSpVe_123. Shall be refreshed for every update DENM.
<i>causeCode</i>	emergencyVehicleApproaching (95)
<i>subCauseCode</i>	emergency vehicle: emergencyVehicleApproaching(1) prioritized vehicle: prioritizedVehicleApproaching(2) Note: The vehicle C-ITS service of the moving recovery service, e.g. carrying a broken-down vehicle, is only indicated by the CAM via the data elements vehicleRole and lightBarSirenInUse.
Location container	
<i>eventSpeed</i>	Speed of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2]. Shall be refreshed for an update DENM.
<i>eventPositionHeading</i>	Heading of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2]. Shall be refreshed for an update DENM.

<i>traces</i>	<p><i>PathHistory</i> of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].</p> <p>Shall be refreshed for an update DENM.</p>		
<i>roadType</i>	<p><i>RoadType</i> of the road the detecting vehicle C-ITS station is situated on.</p> <p>Shall be refreshed for an update DENM.</p> <p>Shall be set in accordance with [TS 102 894-2] in combination with the following rules:</p>		
	Urban / non-urban	Structural separation	Data element
	Urban	No	urban-NoStructuralSeparationToOppositeLanes(0)
	Urban	Yes	urban-WithStructuralSeparationToOppositeLanes(1)
	Urban	Unknown	urban-NoStructuralSeparationToOppositeLanes(0)
	Non-urban	No	nonUrban-NoStructuralSeparationToOppositeLanes(2)
	Non-urban	Yes	nonUrban-WithStructuralSeparationToOppositeLanes(3)
	Non-urban	Unknown	nonUrban-NoStructuralSeparationToOppositeLanes(2)
<p>Otherwise, if the information about the urban/non-urban status cannot be determined, the data element shall be omitted.</p>			
Alacarte container			
<i>lanePosition</i>	<p>If the <i>lanePosition</i> is provided by an on-board sensor (e.g. radar, camera), the value shall be set in accordance with [TS 102 894-2]. Use of GNSS and a digital map to estimate the lane number is not legitimate for this version of the triggering condition.</p> <p>If the <i>lanePosition</i> is unknown, the data element shall be omitted.</p> <p>Shall be refreshed for an update DENM.</p>		

Tested by:

4.1.7.2 CAM

Requirement (i)

RS_tcSpVe_132

The *vehicleRole* may be initialised at a 'default' setting (*vehicleRole* of CAM set to *default(0)*). If at least one of the triggering conditions in RS_tcSpVe_120 is satisfied, the *vehicleRole* shall be set to:

- recovery vehicle: rescue(5);
- emergency vehicle: emergency(6) and
- prioritized vehicle: safetyCar(7).

Tested by:

Requirement (i)

RS_tcSpVe_133

The following table specifies the data elements of the CAM that shall be set if the vehicle C-ITS service is triggered.

Table 6: CAM data elements of ‘emergency, recovery, prioritized vehicle approaching’

Data field	Value
CoopAwareness	
<i>generationDeltaTime</i>	Time corresponding to the time of the reference position in the CAM, considered as time of CAM generation. Shall be set in accordance with [EN 302 637-2].
BasicContainer	
<i>stationType</i>	The type of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>referencePosition</i>	Position and position accuracy measured at the reference point of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
HighFrequencyContainer shall be set to BasicVehicleContainerHighFrequency	
<i>heading</i>	Heading direction of the originating vehicle C-ITS station in relation to true north. Shall be set in accordance with [TS 102 894-2].
<i>speed</i>	Driving speed of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>driveDirection</i>	Vehicle drive direction (forward or backward) of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>vehicleLength</i>	Length of vehicle. Shall be set in accordance with [TS 102 894-2].
<i>vehicleWidth</i>	Width of vehicle. Shall be set in accordance with [TS 102 894-2].
<i>longitudinalAcceleration</i>	Vehicle longitudinal acceleration of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>curvature</i>	Curvature of the vehicle trajectory and the accuracy. Shall be set in accordance with [TS 102 894-2].

<i>curvatureCalcMode</i>	Describes whether the yaw rate is used to calculate the curvature for a reported curvature value. Shall be set in accordance with [TS 102 894-2].
<i>yawRate</i>	Yaw rate of vehicle at a point in time. Shall be set in accordance with [TS 102 894-2].
LowFrequencyContainer shall be set to BasicVehicleContainerLowFrequency	
<i>vehicleRole</i>	<ul style="list-style-type: none"> recovery vehicle: rescue(5) emergency vehicle: emergency(6) prioritized vehicle: safetyCar(7)
<i>exteriorLights</i>	Describes the status of the exterior light switches of a vehicle. Shall be set in accordance with [TS 102 894-2].
<i>pathHistory</i>	Represents the vehicle's movement over a recent period and/or distance. Shall be set in accordance with [TS 102 894-2].
<ul style="list-style-type: none"> recovery vehicle: SpecialVehicleContainer shall be set to RescueContainer emergency vehicle: SpecialVehicleContainer shall be set to EmergencyContainer prioritized vehicle: SpecialVehicleContainer shall be set to SafetyCarContainer 	
<i>lightBarSirenInUse</i>	lightBarActivated bit shall be set to 1(onChange), if the usage of the light bar is detected; otherwise, it shall be set to 0. sirenActivated bit shall be set to 1, if usage of the siren is detected; otherwise, it shall be set to 0.
<i>emergencyPriority</i>	Is not required
<i>IncidentIndication</i>	In case of EmergencyContainer and SafetyCarContainer: <i>causeCode</i> and <i>subCauseCode</i> as specified in DENM (RS_tcSpVe_153) Note: the RescueContainer does not provide IncidentIndication.

Tested by:

4.1.8 Network and transport layer

Requirement (i)

RS_tcSpVe_134

The interface parameter destination area in IF.DEN.1 [ETSI EN 302 637-3] shall be equal to a circular shape with centre point equal to *eventPosition* and radius equal to *relevanceDistance*.

Tested by:

4.1.9 Security layer

Requirement (i)

RS_tcSpVe_136

When the triggering conditions as described in clause 4.1.2 apply, the application shall request the blocking of the AT changeover as defined in RS_BSP_184.

Tested by:

4.2 Special vehicle warning – emergency, recovery, prioritized vehicle at a location

4.2.1 Description of vehicle C-ITS service

Other (informational)

RS_tcSpVe_225

The intent of the emergency, recovery, prioritized vehicle use case is to warn drivers about the location of the involved vehicle during safeguarding (e.g. a traffic accident, incident or rescue and recovery work) so the other road users will be able to adjust their driving behaviour accordingly and in time. The equipped emergency, recovery, prioritized vehicle is sending a warning message when the vehicle is at a location with an activated light bar.

Requirement (i)

RS_tcSpVe_137

As soon as the vehicle C-ITS service is triggered, the emergency, recovery, prioritized vehicle at a location shall transmit a DENM and shall set data fields of CAM in accordance with the rules specified in the current clause.

Note: A parallel activation with the vehicle C-ITS service *emergency, recovery, prioritized vehicle approaching* has to be avoided, i.e. an emergency vehicle C-ITS station can be either triggered as an *emergency, recovery, prioritized vehicle approaching* or as a *emergency, recovery, prioritized vehicle at a location*.

Tested by:

Other (informational)

RS_tcSpVe_227

The following vehicle C-ITS services are related to this service, because they share similar triggering conditions:

- ‘special vehicle warning – emergency, recovery, prioritized vehicle approaching’;

4.2.2 Triggering conditions

4.2.2.1 Preconditions

Requirement (i)

RS_tcSpVe_138

The following preconditions shall be satisfied when this use case is triggered:

- the emergency, recovery, prioritized vehicle at a location vehicle C-ITS services are restricted to emergency, recovery, prioritized vehicles as prescribed in RS_tcSpVe_244.

Tested by:

Requirement (i)

RS_tcSpVe_139

The default vehicle C-ITS service for an emergency vehicle C-ITS station is ‘emergency, recovery, prioritized vehicle approaching. A change to the vehicle C-ITS service ‘*emergency, recovery, prioritized vehicle at a location*’ shall be triggered only under the conditions defined in clause 4.2.2.2.

Tested by:

4.2.2.2 Service-specific conditions

Requirement (i)**RS_tcSpVe_140**

If the vehicle speed is below $pAtLocationSpeed$ and the light bar is in use, a *locationTimer* shall be initialised with zero and started. If the light bar is no longer in use or the vehicle speed is above $pAtLocationSpeed$, the *locationTimer* shall be stopped and reset to zero.

Tested by:

Requirement (i)**RS_tcSpVe_240**

If the preconditions in RS_tcSpVe_138 and at least one of the following conditions are satisfied, the triggering conditions for this vehicle C-ITS service are fulfilled and the generation of a DENM shall be triggered:

- a) the light bar is in use and either the ignition is off or the run lock (engine relay that keeps the motor running while the key is removed) is activated;
- b) the light bar is in use and the vehicle's state suggests parking mode (parking brake activated in case of manual transmission cars, 'park' selected in case of automatic transmission cars, stand is being used in case of PTWs);
- c) the light bar is in use and the *locationTimer* is $pAtLocationTime$ or more.
- d) the light bar is in use and the status 'at a location' is triggered manually by operator

Tested by:

Requirement (i)**RS_tcSpVe_143**

The level of information quality can be improved by the following conditions:

- e) the status of at least one door, or the boot, is 'open';
 - e.1) in case of PTWs, the status of the locked storage space is 'open';
- f) The driver's seat is detected by one of the following techniques, as being 'not occupied':
 - a. passenger compartment camera;
 - b. state-of-the-art technique for seat occupation used in seatbelt reminder.

Tested by:

Requirement (i)**RS_tcSpVe_144**

If the vehicle C-ITS service is triggered due to fulfilment of condition a) or b), the *locationTimer* shall be stopped and set to $pAtLocationTime$. In the update phase, only the conditions shall be checked, but no timer shall be started.

Tested by:

Requirement (i)**RS_tcSpVe_247**

The position of the vehicle C-ITS station at the moment in time when the service was triggered shall be buffered, it is called *AtALocationPosition* in the following.

Tested by:

4.2.2.3 Information quality

Requirement (i)

RS_tcSpVe_145

The value of the data element *informationQuality* in the DENM depends on how the event is detected. The *informationQuality* value shall be set in accordance with the following table (highest possible value shall be used):

Table 7: Information quality of ‘emergency, recovery, prioritized vehicle at a location’

Event detection	Value of InformationQuality
No TRCO-compliant implementation	unknown(0)
Condition c) fulfilled	1
Condition b) fulfilled	2
At least one of conditions b) or c) fulfilled and condition e) fulfilled	3
At least one of conditions b) or c) fulfilled and condition f) fulfilled	4
Condition a) fulfilled	5
Condition d) fulfilled	6

Tested by:

Requirement (i)

RS_tcSpVe_146

If the triggering conditions change between two updates, the *informationQuality* shall not be changed until the next update. If the changed conditions are still fulfilled while the DENM is updated, the *informationQuality* shall be updated.

Tested by:

4.2.3 Termination conditions

Requirement (i)

RS_tcSpVe_147

This vehicle C-ITS service is terminated by a cancellation of the originating vehicle C-ITS station. At the termination of the vehicle C-ITS service, updating of DENMs shall be terminated.

Note: *vehicleRole* might be set to *default(0)* if the vehicle C-ITS service is not active.

Tested by:

4.2.3.1 Cancellation

Requirement (i)

RS_tcSpVe_148

If one of the following conditions is satisfied before the period set in the data element *validityDuration* has expired, the generation of a cancellation DENM shall be triggered:

- the distance between the current position of the vehicle C-ITS station and the buffered *AtALocationPosition* is greater than *pAtLocationRadius*;
- the lightbar is no longer in use

Note: cancellation by operation control software not intended, automatic deactivation preferred.

Tested by:

4.2.3.2 Negation

Requirement (i)

RS_tcSpVe_149

A negation DENM shall not be used for this vehicle C-ITS service.

Tested by:

4.2.4 Update

Requirement (i)

RS_tcSpVe_150

The generated DENM shall be updated every 1 s, if the triggering conditions are still satisfied. All data fields that are assigned new values are defined in RS_tcSpVe_153.

Tested by:

4.2.5 Repetition duration and repetition interval

Requirement (i)

RS_tcSpVe_151

A repetition of the DENM shall not be used for this vehicle C-ITS service.

Tested by:

4.2.6 Traffic class

Requirement (i)

RS_tcSpVe_152

New, update and cancellation DENMs shall be set to *traffic class* 1.

Tested by:

4.2.7 Message parameters

4.2.7.1 DENM

Requirement (i)

RS_tcSpVe_153

The following table specifies the data elements of the DENM that shall be set.

Table 8: DENM data elements of ‘emergency, recovery, prioritized vehicle at a location’

Data field	Value
Management container	
<i>actionID</i>	Identifier of a DENM. Shall be set in accordance with [TS 102 894-2].

<i>detectionTime</i>	<p><i>Timestamp</i>ts-timestamp at which the event is detected by the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].</p> <p>Shall be refreshed for an update DENM.</p>										
<i>referenceTime</i>	<p><i>Timestamp</i>ts-timestamp at which a new, update or cancellation DENM is generated. Shall be set in accordance with [TS 102 894-2].</p>										
<i>termination</i>	<p>Shall not be set in the case of new or update DENM. Shall be set to isCancellation(0) in the case of fulfilment of cancellation conditions; see RS_tcSpVe_148</p>										
<i>eventPosition</i>	<p><i>ReferencePosition</i>. Shall be set in accordance with [TS 102 894-2].</p> <p>Shall be refreshed for an update DENM.</p>										
<i>relevanceDistance</i>	lessThan5km(5)										
<i>relevanceTrafficDirection</i>	<p>If the roadType is known, the value shall be set as follows:</p> <table border="1"> <thead> <tr> <th>RoadType</th> <th>Direction</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>allTrafficDirections(0)</td> </tr> <tr> <td>1</td> <td>upstreamTraffic(1)</td> </tr> <tr> <td>2</td> <td>allTrafficDirections(0)</td> </tr> <tr> <td>3</td> <td>upstreamTraffic(1)</td> </tr> </tbody> </table> <p>Otherwise, the value shall be set to allTrafficDirections(0)</p>	RoadType	Direction	0	allTrafficDirections(0)	1	upstreamTraffic(1)	2	allTrafficDirections(0)	3	upstreamTraffic(1)
RoadType	Direction										
0	allTrafficDirections(0)										
1	upstreamTraffic(1)										
2	allTrafficDirections(0)										
3	upstreamTraffic(1)										
<i>validityDuration</i>	30 s										
<i>stationType</i>	The type of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].										
Situation container											
<i>informationQuality</i>	See RS_tcSpVe_145. Shall be refreshed for every update DENM.										
<i>causeCode</i>	rescueAndRecoveryWorkInProgress(15)										
<i>subCauseCode</i>	<ul style="list-style-type: none"> • recovery vehicle: unavailable(0) • emergency vehicle: emergencyVehicles(1) • prioritized vehicle: unavailable(0) <p>Note: At the time of document finalization, there is a change request in ETSI for additional subCauseCodes for recovery and prioritized vehicles.</p>										
Location container											
<i>eventSpeed</i>	<p>Speed of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].</p> <p>Shall be refreshed for an update DENM.</p>										
<i>eventPositionHeading</i>	<p>Heading of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].</p> <p>Shall be refreshed for an update DENM.</p>										

<i>traces</i>	<p><i>PathHistory</i> of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].</p> <p>Shall be refreshed for an update DENM.</p> <p>If the <i>PathDeltaTime</i> is used in the <i>PathPoints</i>, the <i>PathDeltaTime</i> of the first <i>PathPoint</i> (closest point to the <i>ReferencePosition</i>) shall be refreshed for an update DENM. All other <i>PathPoints</i> shall not be refreshed. If the <i>PathDeltaTime</i> of the first <i>PathPoint</i> exceeds the maximum value in accordance with [TS 102 894-2], the <i>PathDeltaTime</i> shall not be further refreshed.</p> <p>If the <i>PathDeltaTime</i> is not used in the <i>PathPoints</i>, the <i>PathHistory</i> shall not be refreshed for an update DENM.</p>		
<i>roadType</i>	<p><i>RoadType</i> of the road on which the detecting vehicle C-ITS station is situated.</p> <p>Shall be refreshed for an update DENM.</p> <p>Shall be set in accordance with [TS 102 894-2] in combination with the following rules:</p>		
	Urban / non-urban	Structural separation	Data element
	Urban	No	urban-NoStructuralSeparationToOppositeLanes(0)
	Urban	Yes	urban-WithStructuralSeparationToOppositeLanes(1)
	Urban	Unknown	urban-NoStructuralSeparationToOppositeLanes(0)
	Non-urban	No	nonUrban-NoStructuralSeparationToOppositeLanes(2)
	Non-urban	Yes	nonUrban-WithStructuralSeparationToOppositeLanes(3)
	Non-urban	Unknown	nonUrban-NoStructuralSeparationToOppositeLanes(2)
	Otherwise, if the information about the urban/non-urban status cannot be determined, the data element shall be omitted.		
Alacarte Container			
<i>lanePosition</i>	<p>If the <i>lanePosition</i> is provided by an onboard sensor (e.g. radar, camera), the value shall be set in accordance with [TS 102 894-2]. Use of GNSS and a digital map for the estimation of the lane number is not legitimate for this version of the triggering condition.</p>		

	If the lanePosition is unknown, the data element shall be omitted. Shall be refreshed for an update DENM.
Alacarte container: StationaryVehicleContainer	
<i>stationarySince</i>	Shall be set according to the duration in minutes of the detecting vehicle C-ITS station being 'at a location'. Shall be set in accordance with [TS 102 894-2]. Shall be refreshed for an update DENM.

Tested by:

4.2.7.2 CAM

Requirement (i)

RS_tcSpVe_154

The *vehicleRole* may be initialised at a 'default' setting (*vehicleRole* of CAM set to *default(0)*). If at least one of the triggering conditions defined in RS_tcSpVe_240 is satisfied the *vehicleRole* shall be set to:

- recovery vehicle: rescue(5);
- emergency vehicle: emergency(6) and
- prioritized vehicle: safetyCar(7).

Tested by:

Requirement (i)

RS_tcSpVe_155

The following table specifies the data elements of the CAM that shall be set if the vehicle C-ITS service is triggered.

Table 9: CAM data elements of 'emergency, recovery, prioritized vehicle at a location

Data field	Value
CoopAwareness	
<i>generationDeltaTime</i>	Time corresponding to the time of the reference position in the CAM, considered as time of CAM generation. Shall be set in accordance with [EN 302 637-2].
BasicContainer	
<i>stationType</i>	The type of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>referencePosition</i>	Position and position accuracy measured at the reference point of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
HighFrequencyContainer shall be set to BasicVehicleContainerHighFrequency NOTE: at the time of document finalization, PTW HighFrequencyContainer definition is still work in progress	

<i>heading</i>	Heading direction of the originating vehicle C-ITS station in relation to true north. Shall be set in accordance with [TS 102 894-2].
<i>speed</i>	Driving speed of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>driveDirection</i>	Vehicle drive direction (forward or backward) of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>vehicleLength</i>	Length of vehicle. Shall be set in accordance with [TS 102 894-2].
<i>vehicleWidth</i>	Width of vehicle. Shall be set in accordance with [TS 102 894-2].
<i>longitudinalAcceleration</i>	Vehicle longitudinal acceleration of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>curvature</i>	Curvature of the vehicle trajectory and the accuracy. Shall be set in accordance with [TS 102 894-2].
<i>curvatureCalcMode</i>	Describes whether the yaw rate is used to calculate the curvature for a reported curvature value. Shall be set in accordance with [TS 102 894-2].
<i>yawRate</i>	Yaw rate of vehicle at a point in time. Shall be set in accordance with [TS 102 894-2].
LowFrequencyContainer shall be set to BasicVehicleContainerLowFrequency	
<i>vehicleRole</i>	<ul style="list-style-type: none"> • recovery vehicle: rescue(5) • emergency vehicle: emergency(6) • prioritized vehicle: safetyCar(7)
<i>exteriorLights</i>	Describes the status of the exterior light switches of a vehicle. Shall be set in accordance with [TS 102 894-2].
<i>pathHistory</i>	Represents the vehicle's movement over a recent period and/or distance. Shall be set in accordance with [TS 102 894-2].
<ul style="list-style-type: none"> • recovery vehicle: SpecialVehicleContainer shall be set to RescueContainer • emergency vehicle: SpecialVehicleContainer shall be set to EmergencyContainer • prioritized vehicle: SpecialVehicleContainer shall be set to SafetyCarContainer 	
<i>lightBarSirenInUse</i>	lightBarActivated bit shall be set to 1(onChange), if the usage of the light bar is detected, otherwise, it shall be set to 0. sirenActivated bit shall be set to 1, if usage of the siren is detected, otherwise, it shall be set to 0.

<i>emergencyPriority</i>	Is not required
<i>IncidentIndication</i>	In case of EmergencyContainer and SafetyCarContainer: <i>causeCode</i> and <i>subCauseCode</i> as specified in DENM (RS_tcSpVe_153) Note: the RescueContainer does not provide <i>IncidentIndication</i> .

Tested by:

4.2.8 Network and transport layer

Requirement (i)

RS_tcSpVe_156

The interface parameter destination area in IF.DEN.1 [ETSI EN 302 637-3] shall be equal to a circular shape with centre point equal to *eventPosition* and radius equal to *relevanceDistance*.

Tested by:

4.2.9 Security layer

Requirement (i)

RS_tcSpVe_158

When the triggering conditions as described in clause 4.2.2 apply, the application shall request the blocking of the AT changeover as defined in RS_BSP_184.

Tested by:

5 Appendix

5.1 Scenarios

Other (informational)

RS_tcSpVe_232

This clause has an informational character and is not part of the requirement specification.

The following list encompasses scenarios which are regarded as relevant or irrelevant considering the present vehicle C-ITS service:

Count	Description	Status
SC_0	Urban/nonurban environment	Irrelevant
SC_1	Current road situation and conditions	Not directly relevant
SC_2	Traffic in the opposite driving direction.	Irrelevant
SC_3	The special vehicle drives to an emergency site using the light bar. The siren might be used.	Relevant
SC_4	The special vehicle stops at an emergency site in order to safeguard the situation. The intention of the special vehicle and the crew has to be detected. A change in the use-cases from 'in operation' to 'safeguarding' has to be detected.	Relevant
SC_5	The special vehicle leaves an emergency site. A change in the use-cases from 'at a location' to 'approaching' might be detected depending on situation.	Relevant
SC_6	The recovery service carries a broken vehicle using the light bar. This case is covered by usual CAMs. The recovery service is considered as a usual vehicle in road traffic.	Irrelevant

Table9: Scenarios