

Triggering Conditions and Data Quality Exchange of IRCs

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 2: Changes since last release

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1 Introduction

Other (informational)

RS_tcIRC_8

This document describes the triggering conditions for a critical driving situation where the Impact Reduction Containers (IRCs) of potential collision opponents shall be exchanged.

Other (informational)

RS_tcIRC_138

The triggering conditions are divided into the following two vehicle C-ITS services:

- exchange of IRCs – request IRC
- exchange of IRCs – response IRC

2 Definitions

Definition

RS_tcIRC_642

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

3 Requirement specifications

3.1 Exchange of IRCs – request IRC

3.1.1 Description of vehicle C-ITS service

Other (informational)**RS_tcIRC_140**

This clause describes the triggering of V2V messages for a critical driving situation where a crash between two vehicles is highly likely or unavoidable. This phase is called PreCrash phase.

Other (informational)**RS_tcIRC_11**

In general, a request of an IRC is distinguished from a response to an IRC. In the request sending case, the ego vehicle is recognizing a potential collision and is therefore sending its own IRC, to get the IRC of the collision opponent in response.

Other (informational)**RS_tcIRC_141**

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

- 'exchange of IRCs – response IRC';

Requirement (i)**RS_tcIRC_10**

A DENM signal shall be sent to the stack only if the triggering conditions described in this clause are evaluated as valid. Such a signal prompts the stack to generate a new DENM. If the triggering conditions are not met, a DENM signal shall not be generated.

Tested by:

3.1.2 Triggering conditions

3.1.2.1 Preconditions

Requirement (i)**RS_tcIRC_157**

No specific preconditions apply to this vehicle C-ITS service.

Tested by:

3.1.2.2 Service-specific conditions

Requirement (i)**RS_tcIRC_13**

If both 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:

- 1) the 'time to collision' (TTC) calculated by an on-board measurement device algorithm is < 1.5 s. The acceptable tolerance for the calculated TTC value is 10 %;
- 2) the relative speed between two potential collision opponents exceeds 20 km/h.

Note: It is assumed that the generation of a new DENM is only triggered once when the conditions become fulfilled.

Tested by:

Requirement (i) **RS_tcIRC_151**

The use case shall not be triggered again as long as a previously detected use case is not terminated. In the case of a change of the critical object, the previous detection shall be terminated and the use case shall be triggered again immediately (with a new DENM and thus new ActionID).

Tested by:

3.1.2.3 Information quality

Requirement (i) **RS_tcIRC_14**

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 3: Information quality of ‘exchange of IRCs – request IRC’

Event detection	Value of InformationQuality
No TRCO-compliant implementation	unknown(0)
Otherwise	1

Tested by:

3.1.3 Termination conditions

Requirement (i) **RS_tcIRC_15**

A termination of the vehicle C-ITS service shall not be considered.

Tested by:

3.1.3.1 Cancellation

Requirement (i) **RS_tcIRC_16**

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

Tested by:

3.1.3.2 Negation

Requirement (i) **RS_tcIRC_17**

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

Tested by:

3.1.4 Update

Requirement (i) **RS_tcIRC_18**

An update DENM shall not be used for this vehicle C-ITS service.

Tested by:

3.1.5 Repetition duration and repetition interval

Requirement (i)

RS_tcIRC_19

New DENMs shall be repeated for a *repetitionDuration* of 300 ms (100 ms three times in a row) with a *repetitionInterval* of 100 ms. Therefore, the interface parameters *Repetition duration* and *Repetition interval* between the application and the DEN basic service shall be set in accordance with the above values.

Note: As it is not guaranteed that a sent IRC will reach the receiver (e.g. because of channel load, temporarily out of range, etc.), the sender sends the IRC three times in a row. This is equivalent to a *repetitionDuration* of 300 ms.

Note: The estimated duration for transmitting (application to application) an IRC (repetition not included) over automotive WLAN is 200 – 300 ms. If only the third attempt is received (worst case), in both cases (request and response), the information will be available for both vehicles after 1 s (2 x (300 ms + 100 ms (@10 Hz) + 100 ms (@10 Hz))). Therefore, the trigger parameter $TTC < 1,5$ s is sufficient. Sending the IRC three times in a row is considered a good compromise between channel load and ensuring successful transmission.

Note: Only the first DENM will be sent without Decentralized Congestion Control (DCC) constraints. The second and third DENMs may be affected by DCC (based on current channel load).

Note: Where two DENMs with the same *causeCode* originate from the same vehicle C-ITS station, the case shall be managed by the receiving C-ITS station.

Tested by:

3.1.6 Traffic class

Requirement (i)

RS_tcIRC_20

New DENMs shall be set to *traffic class* 0.

Tested by:

3.1.7 Message parameters

3.1.7.1 DENM

Requirement (i)

RS_tcIRC_21

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

Table 4: DENM data elements of ‘exchange of IRCs – request IRC’

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].

<i>referenceTime</i>	<i>Timestamp</i> ts-timestamp at which a new 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].
<i>relevanceDistance</i>	lessThan100m(1) Note: This shall also cover the worst case scenario of driving at nearly 250 km/h towards a dangerous end of queue ($s = v \times t = 69,4 \text{ m/s} \times 1,5 \text{ s} = 104,2 \text{ m}$).
<i>relevanceTrafficDirection</i>	allTrafficDirections(0)
<i>validityDuration</i>	2 s Note: Shall be larger than TTC.
<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_tclRC_14.
<i>causeCode</i>	collisionRisk(97)
<i>subCauseCode</i>	unavailable(0)
Location container	
<i>eventSpeed</i>	Speed of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>eventPositionHeading</i>	Heading of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>Traces</i>	<i>PathHistory</i> of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>roadType</i>	Shall be set in accordance with [TS 102 894-2]. If the information about the urban/non-urban status cannot be determined, the data element shall be omitted.
Alacarte container: ImpactReductionContainer	
<i>heightLonCarrLeft</i>	Height of left longitudinal carrier of the vehicle from base to top. Shall be set in accordance with [TS 102 894-2].
<i>heightLonCarrRight</i>	Height of right longitudinal carrier of the vehicle from base to top. Shall be set in accordance with [TS 102 894-2].
<i>posLonCarrLeft</i>	Longitudinal distance from the centre of vehicle front bumper to the front of the left longitudinal carrier of vehicle. Shall be set in accordance with [TS 102 894-2].
<i>posLonCarrRight</i>	Longitudinal distance from the centre of vehicle front bumper to the front of the right longitudinal carrier of vehicle. Shall be set in accordance with [TS 102 894-2].

<i>positionOfPillars</i>	Vehicle pillars refer to the vertical or near vertical support of vehicle, designated respectively as A, B, C or D. Shall be set in accordance with [TS 102 894-2].
<i>posCentMass</i>	Perpendicular distance from the centre of mass of an empty load vehicle to the front line of the vehicle bounding box. Shall be set in accordance with [TS 102 894-2].
<i>wheelBaseVehicle</i>	Perpendicular distance between front and rear axle of the wheel base of vehicle. Shall be set in accordance with [TS 102 894-2].
<i>turningRadius</i>	The smallest circular turn (i.e. U-turn) that the vehicle is capable of making. Shall be set in accordance with [TS 102 894-2].
<i>posFrontAx</i>	Perpendicular distance between the vehicle front line of the bounding box and the front wheel axle. Shall be set in accordance with [TS 102 894-2].
<i>positionOfOccupants</i>	BitString that indicates whether a passenger seat is occupied or whether the occupation status is detectable or not. Shall be set in accordance with [TS 102 894-2].
<i>vehicleMass</i>	Mass of an empty loaded vehicle. Shall be set in accordance with [TS 102 894-2].
<i>requestResponseIndication</i>	request(0)

Tested by:

3.1.7.2 CAM

Requirement (i)

RS_tcIRC_22

CAM adaption shall not be used for this vehicle C-ITS service.

Tested by:

3.1.8 Network and transport layer

Requirement (i)

RS_tcIRC_23

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:

3.1.9 Security layer

Requirement (i)

RS_tcIRC_25

When the triggering conditions as described in clause 3.1.2 apply, the application shall request the blocking of the AT changeover as defined in RS_BSP_184.

Tested by:

3.2 Exchange of IRCs – response IRC

3.2.1 Description of vehicle C-ITS service

Other (informational)

RS_tcIRC_148

This clause describes the triggering of V2V messages after having received an IRC from a potential collision opponent.

Other (informational)

RS_tcIRC_149

In general, a request of an IRC is distinguished from a response to an IRC. In the response sending case, the vehicle has received an IRC of a potential opponent and is therefore sending its own IRC, to provide the requesting vehicle the information it was requesting.

Other (informational)

RS_tcIRC_150

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

- 'exchange of IRCs – request IRC'.

Requirement (i)

RS_tcIRC_27

A DENM signal shall be sent to the stack only if the triggering conditions described in this clause are evaluated as valid. Such a signal prompts the stack to generate a new DENM. If the triggering conditions are not met, a DENM signal shall not be generated.

Tested by:

3.2.2 Triggering conditions

3.2.2.1 Preconditions

Requirement (i)

RS_tcIRC_28

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

1. an IRC as described in RS_tcIRC_21 has been received.

Tested by:

3.2.2.2 Service-specific conditions

Requirement (i)

RS_tcIRC_29

If the precondition in RS_tcIRC_28 and both 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:

1. *requestResponseIndication* in the received IRC is set to request(0);
2. the distance between the requesting vehicle (event position in the IRC) and the ego vehicle (reference position as defined in CAM) is less than 100 m.

Note: When an IRC is received, the receiver has to check that it was actually requested before responding with its own IRC. This can be done on the basis of the *requestResponseIndication*. To avoid unnecessary load on the transmission channel from multiple transmitted IRCs, only vehicles in the immediate vicinity (within 100 m) respond to the request.

Tested by:

3.2.2.3 Information quality

Requirement (i)

RS_tcIRC_30

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 5: Information quality of ‘exchange of IRCs – response IRC’

Event detection	Value of InformationQuality
No TRCO-compliant implementation	unknown(0)
Otherwise	1

Tested by:

3.2.3 Termination conditions

Requirement (i)

RS_tcIRC_31

A termination of the vehicle C-ITS service shall not be considered.

Tested by:

3.2.3.1 Cancellation

Requirement (i)

RS_tcIRC_32

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

Tested by:

3.2.3.2 Negation

Requirement (i)

RS_tcIRC_33

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

Tested by:

3.2.4 Update

Requirement (i)

RS_tcIRC_34

An update DENM shall not be used for this vehicle C-ITS service.

Tested by:

3.2.5 Repetition duration and repetition interval

Requirement (i)

RS_tcIRC_35

New DENMs shall be repeated for a *repetitionDuration* of 300 ms (100 ms three times in a row) with a *repetitionInterval* of 100 ms. Therefore, the interface parameters *Repetition duration* and *Repetition interval* between the application and the DEN basic service shall be set in accordance with the above values.

Note: As it is not guaranteed that a sent IRC will reach the receiver (e.g. because of channel load, temporarily out of range, etc.), the sender sends the IRC three times in a row. This is equivalent to a *repetitionDuration* of 300 ms.

Note: The estimated duration for transmitting (application to application) an IRC (repetition not included) over automotive WLAN is 200 – 300 ms. If only the third attempt is received (worst case), in both cases (request and response), the information will be available for both vehicles after 1 s (2 x (300 ms + 100 ms (@10 Hz) + 100 ms (@10 Hz))). Therefore, the trigger parameter *TTC* < 1.5 s is sufficient. Sending the IRC three times in a row is considered a good compromise between channel load and ensuring successful transmission.

Note: Only the first DENM will be sent without DCC constraints. The second and third DENMs may be affected by DCC (based on current channel load).

Note: Where two DENMs with the same *causeCode* originate from the same vehicle C-ITS station, the case shall be managed by the receiving C-ITS station.

Tested by:

3.2.6 Traffic class

Requirement (i)

RS_tcIRC_36

New DENMs shall be set to *traffic class* 0.

Tested by:

3.2.7 Message parameters

3.2.7.1 DENM

Requirement (i)

RS_tcIRC_37

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

Table 6: DENM data elements of ‘exchange of IRCs – response IRC’

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].
<i>referenceTime</i>	<i>Timestamp</i> ts-timestamp at which a new 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].
<i>relevanceDistance</i>	lessThan100m(1)
<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
Situation container	
<i>informationQuality</i>	See RS_tcIRC_30.
<i>causeCode</i>	collisionRisk(97)
<i>subCauseCode</i>	unavailable(0)
Location container	
<i>eventSpeed</i>	Speed of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>eventPositionHeading</i>	Heading of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].
<i>traces</i>	<i>PathHistory of the originating vehicle C-ITS station. Shall be set in accordance with [TS 102 894-2].</i>
<i>roadType</i>	Shall be set in accordance with [TS 102 894-2]. If the information about the urban/non-urban status cannot be determined, the data element shall be omitted.
Alacarte container: ImpactReductionContainer	
<i>heightLonCarrLeft</i>	Height of left longitudinal carrier of the vehicle from base to top. Shall be set in accordance with [TS 102 894-2].
<i>heightLonCarrRight</i>	Height of right longitudinal carrier of the vehicle from base to top. Shall be set in accordance with [TS 102 894-2].
<i>posLonCarrLeft</i>	Longitudinal distance from the centre of vehicle front bumper to the front of the left longitudinal carrier of vehicle. Shall be set in accordance with [TS 102 894-2].
<i>posLonCarrRight</i>	Longitudinal distance from the centre of vehicle front bumper to the front of the right longitudinal carrier of vehicle. Shall be set in accordance with [TS 102 894-2].
<i>positionOfPillars</i>	Vehicle pillars refer to the vertical or near vertical support of vehicle, designated respectively as A, B, C or D. Shall be set in accordance with [TS 102 894-2].
<i>posCentMass</i>	Perpendicular distance from the centre of mass of an empty load vehicle to the front line of the vehicle bounding box. Shall be set in accordance with [TS 102 894-2].
<i>wheelBaseVehicle</i>	Perpendicular distance between front and rear axle of the wheel base of vehicle. Shall be set in accordance with [TS 102 894-2].
<i>turningRadius</i>	The smallest circular turn (i.e. U-turn) that the vehicle is capable of making. Shall be set in accordance with [TS 102 894-2].
<i>posFrontAx</i>	Perpendicular distance between the vehicle front line of the bounding box and the front wheel axle. Shall be set in accordance with [TS 102 894-2].

<i>positionOfOccupants</i>	BitString that indicates whether a passenger seat is occupied or whether the occupation status is detectable. Shall be set in accordance with [TS 102 894-2].
<i>vehicleMass</i>	Mass of an empty load vehicle. Shall be set in accordance with [TS 102 894-2].
<i>requestResponseIndication</i>	response(1)

Tested by:

3.2.7.2 CAM

Requirement (i)

RS_tcIRC_38

CAM adaption shall not be used for this vehicle C-ITS service.

Tested by:

3.2.8 Network and transport layer

Requirement (i)

RS_tcIRC_39

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:

3.2.9 Security layer

Requirement (i)

RS_tcIRC_115

When the triggering conditions as described in clause 3.2.2 apply, the application shall request the blocking of the AT changeover as defined in RS_BSP_184.

Tested by: