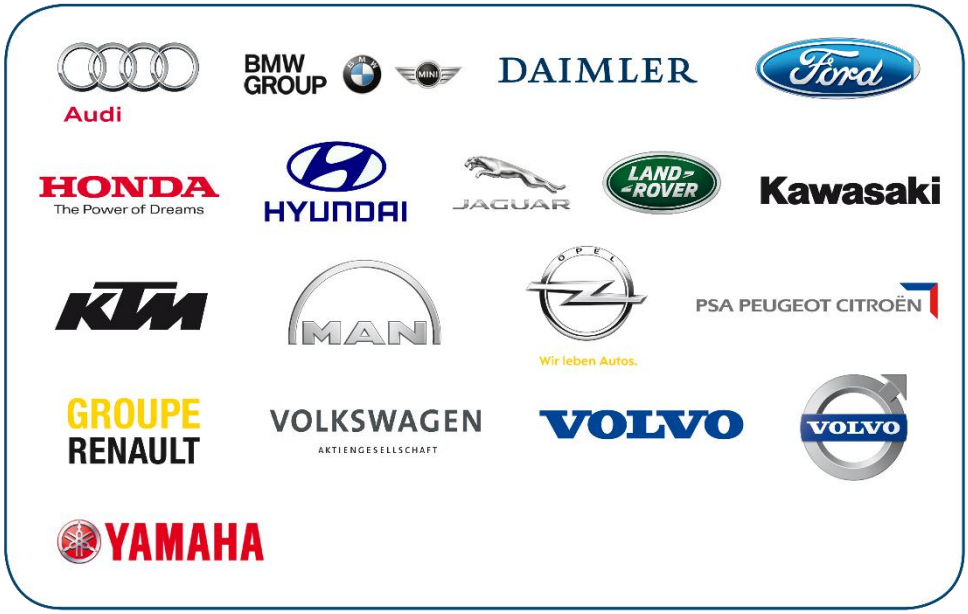
Triggering Conditions and Data Quality

CAR 2 CAR Communication Consortium

Exchange of IRCs

Partners of the C2C-CC



Document information

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Table 1: Document information

Changes since last version

Title:					
Explanatory notes:					
3	2	01.12.2015	Reworked according to Change Management process and released as part of CAR 2 CAR Release 1.1.0	Volkswagen AG	
3	1	28.04.2014	Update after CAM/DENM/CDD Enap Phase	Sebastian Engel	
3	0	07.02.2014	Fixed layout and minor type errors	Jan Buchholz	
2	1	11.12.2013	Update after WG App review	Jan Buchholz	
2	0	10.10.2013	Update after Audi/VW review	Sebastian Engel	
1	3	13.08.2013	Update after VW review	Jan Buchholz	
1	2	08.08.2013	Update after internal review	Jan Buchholz	
1	1	11.07.2013	Review Comments from WG-APP inserted	Gerhard Fischer	
1	0	10.06.2013	First release after initial creation and review phase.	Jan Buchholz	
Issue	**Rev.**	**Date**	**Changes**	**Edited by**	**Approved**

Table 2: Change history

Open Issues

None.

Content

List of tables

1 Introduction

1.1 Abstract

Requirement **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.

Details:

Detailed by:

Tested by:

Other (informational) **RS_tcIRC_138**

The triggering conditions are divided into the following two use cases:

- Exchange of IRCs - Request IRC
- Exchange of IRCs - Response IRC

2 Triggering conditions

2.1 Exchange of IRCs

2.1.1 Exchange of IRCs - Request IRC

2.1.1.1 Description of Use Case

Other (informational) **RS_tcIRC_140**

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

Requirement **RS_tcIRC_10**

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

Details:

Detailed by:

Tested by:

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.

2.1.1.2 Relations to other Use Cases

Other (informational) **RS_tcIRC_141**

The following use cases are related to the *Exchange of IRCs – Request IRC* use case, because they share similar triggering conditions:

- Exchange of IRCs - Response IRC

2.1.1.3 Triggering Conditions

2.1.1.3.1 Preconditions

Requirement **RS_tcIRC_157**

No precondition shall be satisfied for this use case.

Details:

Detailed by:

Tested by:

2.1.1.3.2 Use Case Specific Conditions

Requirement **RS_tcIRC_13**

Once both of the following conditions are satisfied, the triggering conditions for this use case 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 is greater than 20 km/h.

NOTE: Calculating the TTC only based on the GNSS position, delivered from state of the art GNSS-receivers, is not accurate enough for this use case.

Details:

Detailed by:

Tested by:

2.1.1.3.3 Information Quality

Requirement **RS_tcIRC_14**

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

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

Table 3: Information quality of "Exchange of IRCs - Request IRC"

Details:

Detailed by:

Tested by:

2.1.1.4 Termination Conditions

Requirement **RS_tcIRC_15**

A termination of the use case shall not be considered.

Details:

Detailed by:

Tested by:

2.1.1.4.1 Cancellation

Requirement **RS_tcIRC_16**

A cancellation DENM shall not be used for this use case.

Details:

Detailed by:

Tested by:

2.1.1.4.2 Negation

Requirement **RS_tcIRC_17**

A negation DENM shall not be used for this use case.

Details:

Detailed by:

Tested by:

2.1.1.5 Update

Requirement **RS_tcIRC_18**

An update DENM shall not be used for this use case.

Details:

Detailed by:

Tested by:

2.1.1.6 Repetition Duration and Repetition Interval

Requirement **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 according to the values above.

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 second (2 * (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 seen as a good compromise between channel load and ensuring the success of the transmission.

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

NOTE: The case of managing two DENMs with the same *causeCode* from the same originating ITS-S has to be handled by the receiving ITS-S.

Details:

Detailed by:

Tested by:

2.1.1.7 Traffic class

Requirement **RS_tcIRC_20**

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

Details:

Detailed by:

Tested by:

2.1.1.8 Message Parameter

2.1.1.8.1 DENM

Requirement **RS_tcIRC_21**

Table 4 specifies the data elements of the DENM that shall be set.

Data Field	Value
Management Container	
actionID	Identifier of a DENM.Shall be set according to [AD-3].
detectionTime	*TimestampIts*-Timestamp at which the event is detected by the originating ITS-S. Shall be set according to [AD-3].
referenceTime	*TimestampIts*-Timestamp at which a new DENM, an update DENM or a cancellation DENM is generated. Shall be set according to [AD-3].
termination	Shall not be set, because neither negation nor cancellation shall be used in this use case.
eventPosition	*ReferencePosition*. Shall be set according to [AD-3].

relevanceDistance	lessThan100m(1) NOTE: This shall also cover the worst case scenario of driving with nearly 250 km/h towards a dangerous end of queue (s = v*t = 69.4 m/s * 1.5 s = 104.2 m).
relevanceTrafficDirection	allTrafficDirections(0)
validityDuration	2 seconds NOTE: Shall be larger than TTC.
stationType	The type of the originating ITS-S. Shall be set according to [AD-3].
Situation Container	
informationQuality	See section 2.1.1.3.3
causeCode	collisionRisk(97)
subCauseCode	unavailable(0)
Location Container	
eventSpeed	Speed of the originating ITS-S. Shall be set according to [AD-3].
eventPositionHeading	Heading of the originating ITS-S. Shall be set according to [AD-3].
traces	*PathHistory* of the originating ITS-S. Shall be set according to [AD-3].
roadType	Shall be set according to [AD-3]. Otherwise, if the information about the urban/non-urban status cannot be determined, the data element shall be omitted.
Alacarte Container: ImpactReductionContainer	
heightLonCarrLeft	Height of left longitudinal carrier of the vehicle from base to top.Shall be set according to [AD-3].
heightLonCarrRight	Height of right longitudinal carrier of the vehicle from base to top. Shall be set according to [AD-3].
posLonCarrLeft	Longitudinal distance from the centre of vehicle front bumper to the front of the left longitudinal carrier of vehicle. Shall be set according to [AD-3].
posLonCarrRight	Longitudinal distance from the centre of vehicle front bumper to the front of the right longitudinal carrier of vehicle. Shall be set according to [AD-3].
positionOfPillars	Vehicle pillars refer to the vertical or near vertical support of vehicle, designated respectively as the A, B, C or D. Shall be set according to [AD-3].
posCentMass	Perpendicular distance from the centre of mass of an empty load vehicle to the front line of the vehicle bounding box. Shall be set according to [AD-3].
wheelBaseVehicle	Perpendicular distance between front and rear axle of the wheel base of vehicle. Shall be set according to [AD-3].
turningRadius	The smallest circular turn (i.e. U-turn) that the vehicle is capable of making. Shall be set according to [AD-3].
posFrontAx	Perpendicular distance between the vehicle front line of the bounding box and the front wheel axle. Shall be set according to [AD-3].
positionOfOccupants	BitString that indicates whether a passenger seat is occupied or whether the occupation status is detectable or not. Shall be set according to [AD-3].
vehicleMass	Mass of an empty loaded vehicle. Shall be set according to [AD-3].
requestResponseIndication	request(0)

Table 4: DENM data elements of "Exchange of IRCs - Request IRC"

Details:

Detailed by:

Tested by:

2.1.1.8.2 CAM

Requirement **RS_tcIRC_22**

CAM adaption shall not be used for this use case.

Details:

Detailed by:

Tested by:

2.1.1.9 Networking and Transport Layer

Requirement **RS_tcIRC_23**

For the Day One version of this application, the destination area is the same as the relevance area - in this case, a circle of radius *relevanceDistance*. Therefore, the interface parameter *DENM destination area* between the DEN basic service and the Networking & Transport layer shall be equal to a circular shape with radius equal to *relevanceDistance*.

Details:

Detailed by:

Tested by:

Requirement **RS_tcIRC_24**

The interface parameter *hopLimit* between the DEN basic service and the GeoNetworking/BTP shall be set to 1, according to [AD-4]. This indicates that the receiver shall not hop this message.

Details:

Detailed by:

Tested by:

2.1.1.10 Security Layer

Requirement **RS_tcIRC_25**

If the triggering conditions as described in chapter 2.1.1.3 apply, a pseudonym (ID) change shall be blocked as long as the *validityDuration* is not expired (see chapter 2.1.1.8.1).

Details:

Detailed by:

Tested by:

2.1.1.11 Scenarios

Other (informational) **RS_tcIRC_144**

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

Other (informational) **RS_tcIRC_142**

The following list encompasses scenarios which are regarded as relevant or irrelevant considering the present use case:

Count	Description	Status

	tbd.	
	tbd.	

Table 5: Exchange of IRC - Request IRC scenarios

2.1.1.12 Open Issues

Other (informational) **RS_tcIRC_145**

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

a) The following issue shall be incorporated into the profile document: “Keep-Alive-Forwarding shall not be used.”.

2.1.1.13 Feature Requests

Other (informational) **RS_tcIRC_146**

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

Other (informational) **RS_tcIRC_147**

The following list encompasses feature requests for upcoming document releases:

a) None.

2.1.2 Exchange of IRCs - Responce IRC

2.1.2.1 Description of Use Case

Other (informational) **RS_tcIRC_148**

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

Requirement **RS_tcIRC_27**

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

Details:

Detailed by:

Tested by:

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.

2.1.2.2 Relations to other Use Cases

Other (informational) **RS_tcIRC_150**

The following use cases are related to the *Exchange of IRCs – Response IRC* use case, because they share similar triggering conditions:

- Exchange of IRCs - Request IRC.

2.1.2.3 Triggering Conditions

2.1.2.3.1 Preconditions

Requirement **RS_tcIRC_28**

The following preconditions shall be satisfied every time before triggering of this use case is initialized:

1. An IRC as described in chapter 2.1.1.8.1 has been received.

Details:

Detailed by:

Tested by:

2.1.2.3.2 Use Case Specific Conditions

Requirement **RS_tcIRC_29**

Once both of the following conditions are satisfied, the triggering conditions for this use case are fulfilled and the generation of a DENM shall be triggered:

1) *requestResponseIndication* in the received IRC is set to request(0).

2) The perpendicular 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 the received IRC was actually a requested one, before responding with its own IRC. This can be done due to the *requestResponseIndication*. Additionally, only vehicles in the direct surrounding (within 100 m) respond to the request. This is to avoid needless load on the transmission channel by multiple transmitted IRCs.

Details:

Detailed by:

Tested by:

2.1.2.3.3 Information Quality

Requirement **RS_tcIRC_30**

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

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

Table 6: Information quality of "Exchange of IRCs - Response IRC"

Details:

Detailed by:

Tested by:

2.1.2.4 Termination Conditions

Requirement **RS_tcIRC_31**

A termination of the use case shall not be considered.

Details:

Detailed by:

Tested by:

2.1.2.4.1 Cancellation

Requirement **RS_tcIRC_32**

A cancellation DENM shall not be used for this use case.

Details:

Detailed by:

Tested by:

2.1.2.4.2 Negation

Requirement **RS_tcIRC_33**

A negation DENM shall not be used for this use case.

Details:

Detailed by:

Tested by:

2.1.2.5 Update

Requirement **RS_tcIRC_34**

An update DENM shall not be used for this use case.

Details:

Detailed by:

Tested by:

2.1.2.6 Repetition Duration and Repetition Interval

Requirement **RS_tcIRC_35**

New DENMs shall be repeated for a *repetitionDuration* of 300 ms 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 according to the values above.

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 second (2 * (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 seen as a good compromise between channel load and ensuring the success of the transmission.

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

NOTE: The case of managing two DENMs with the same *causeCode* from the same originating ITS-S has to be handled by the receiving ITS-S.

Details:

Detailed by:

Tested by:

2.1.2.7 Traffic class

Requirement **RS_tcIRC_36**

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

Details:

Detailed by:

Tested by:

2.1.2.8 Message Parameter

2.1.2.8.1 DENM

Requirement **RS_tcIRC_37**

Table 7 specifies the data elements of the DENM that shall be set.

Data Field	Value
Management Container	
actionID	Identifier of a DENM.Shall be set according to [AD-3].
detectionTime	*TimestampIts*-Timestamp at which the event is detected by the originating ITS-S. Shall be set according to [AD-3].
referenceTime	*TimestampIts*-Timestamp at which a new DENM, an update DENM or a cancellation DENM is generated. Shall be set according to [AD-3].
termination	Shall not be set, because neither negation nor cancellation shall be used in this use case.
eventPosition	*ReferencePosition*. Shall be set according to [AD-3].
relevanceDistance	lessThan100m(1)
relevanceTrafficDirection	allTrafficDirections(0)
validityDuration	2 seconds
stationType	The type of the originating ITS-S. Shall be set according to [AD-3].
Situation Container	
informationQuality	See section 2.1.2.3.3
causeCode	collisionRisk(97)
subCauseCode	unavailable(0)
Location Container	
eventSpeed	Speed of the originating ITS-S. Shall be set according to [AD-3].
eventPositionHeading	Heading of the originating ITS-S. Shall be set according to [AD-3].
traces	*PathHistroy* of the originating ITS-S. Shall be set according to [AD-3].
roadType	Shall be set according to [AD-3]. Otherwise, if the information about the urban/non-urban status cannot be determined, the data element shall be omitted.
Alacarte Container: ImpactReductionContainer	
heightLonCarrLeft	Height of left longitudinal carrier of the vehicle from base to top. Shall be set according to [AD-3].
heightLonCarrRight	Height of right longitudinal carrier of the vehicle from base to top. Shall be set according to [AD-3].
posLonCarrLeft	Longitudinal distance from the centre of vehicle front bumper to the front of the left longitudinal carrier of vehicle. Shall be set according to [AD-3].
posLonCarrRight	Longitudinal distance from the centre of vehicle front bumper to the front of the right longitudinal carrier of vehicle. Shall be set according to [AD-3].
positionOfPillars	Vehicle pillars refer to the vertical or near vertical support of vehicle, designated respectively as the A, B, C or D. Shall be set according to [AD-3].
posCentMass	Perpendicular distance from the centre of mass of an empty load vehicle to the front line of the vehicle bounding box. Shall be set according to [AD-3].

wheelBaseVehicle	Perpendicular distance between front and rear axle of the wheel base of vehicle. Shall be set according to [AD-3].
turningRadius	The smallest circular turn (i.e. U-turn) that the vehicle is capable of making. Shall be set according to [AD-3].
posFrontAx	Perpendicular distance between the vehicle front line of the bounding box and the front wheel axle. Shall be set according to [AD-3].
positionOfOccupants	BitString that indicates whether a passenger seat is occupied or whether the occupation status is detectable or not. Shall be set according to [AD-3].
vehicleMass	Mass of an empty loaded vehicle. Shall be set according to [AD-3].
requestResponseIndication	response(1)

Table 7: DENM data elements of "Exchange of IRCs - Response IRC"

Details:

Detailed by:

Tested by:

2.1.2.8.2 CAM

Requirement **RS_tcIRC_38**

CAM adaption shall not be used for this use case.

Details:

Detailed by:

Tested by:

2.1.2.9 Networking and Transport Layer

Requirement **RS_tcIRC_39**

For the Day One version of this application, the destination area is the same as the relevance area - in this case, a circle of radius *relevanceDistance*. Therefore, the interface parameter *DENM destination area* between the DEN basic service and the Networking and Transport layer shall be equal to a circular shape with radius equal to *relevanceDistance*.

Details:

Detailed by:

Tested by:

Requirement **RS_tcIRC_40**

The interface parameter *hopLimit* between the DEN basic service and the GeoNetworking/BTP shall be set to 1, according to [AD-4]. This indicates that the receiver shall not hop this message.

Details:

Detailed by:

Tested by:

2.1.2.10 Security Layer

Requirement **RS_tcIRC_115**

If the triggering conditions as described in chapter 2.1.2.3 apply, a pseudonym (ID) change shall be blocked as long as the *validityDuration* is not expired (see chapter 2.1.2.8.1).

Details:

Detailed by:

Tested by:

2.1.2.11 Scenarios

Other (informational) **RS_tcIRC_152**

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

Other (informational) **RS_tcIRC_151**

The following list encompasses scenarios which are regarded as relevant or irrelevant considering the present use case:

Count	Description	Status
	tbd.	
	tbd.	

Table 8: Exchange of IRC - Response IRC scenarios

2.1.2.12 Open issues

Other (informational) **RS_tcIRC_154**

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

Other (informational) **RS_tcIRC_153**

The following list encompasses open issues, which are not comprehensively discussed:

a) The following issue shall be incorporated into the profile document: “Keep-Alive-Forwarding shall not be used.”.

3 Appendix

3.1 List of abbreviations

Other (informational) **RS_tcIRC_119**

ABS	Anti-lock Breaking System
ASN.1	Abstract Syntax Notation One
ASR	Anti-Slide Regulation
AUT	Automatic Transmission
CAM	Cooperative Awareness Message
C2C-CC	CAR 2 CAR Communication Consortium
CDD	Common Data Dictionary
DEN	Decentralized Environmental Notification
DENM	DEN Message
ECE	Economic Commission for Europe
ETSI	European Telecommunications Standards Institute
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IRC	Impact Reduction Container
ITS	Intelligent Transport System
ITS-S	ITS Station
TC	Triggering Conditions
TTC	Time To Collision
V2V	Vehicle to Vehicle

Table 9: List of abbreviations

3.2 Applicable documents

Other (informational) **RS_tcIRC_124**

[AD-1] Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service

Draft ETSI EN 302 637-3 V1.2.7 (2014-07)

[AD-2] Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service
Draft ETSI EN 302 637-2 V1.3.5 (2014-06)

[AD-3] Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary;

ETSI TS 102 894 - 2 V1.1.2 (2014-07)

[AD-4] Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality

Draft ETSI EN 302 636-4-1 V1.0.2 (2013-09)

Table 10: Applicable documents

3.3 Related documents

RS_tcIRC_158

[RD-1]

Table 11: Related documents