

Triggering Conditions and Data Quality Adverse Weather Conditions

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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1 Introduction

Other (informational)

RS_tcAdWe_184

This document describes the triggering conditions for adverse weather conditions for the following three use cases:

- adverse weather conditions - fog
- adverse weather conditions - precipitation
- adverse weather conditions - traction loss

2 Definitions

Definition

RS_tcAdWe_642

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

3 Requirement specifications

3.1 Adverse weather condition - fog

3.1.1 Description of use case

Other (informational)

RS_tcAdWe_185

This clause describes the triggering of V2V messages for the *Adverse Weather Condition - Fog* vehicle C-ITS service. A DENM shall be triggered, if fog interferes the driver at a particular extent.

Other (informational)

RS_tcAdWe_186

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

- 'adverse weather conditions — precipitation'.

Requirement (i)

RS_tcAdWe_93

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 or an update DENM. If the triggering conditions are not fulfilled, a DENM signal shall not be generated.

Tested by:

3.1.2 Triggering conditions

3.1.2.1 Preconditions

Requirement (i)

RS_tcAdWe_94

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

1. the vehicle speed is greater than 7 km/h;
2. the vehicle speed is less than 80 km/h (vehicle speed greater 80 km/h is not reasonable for reduced visibility).

Tested by:

3.1.2.2 Service-specific conditions

Requirement (i)

RS_tcAdWe_95

If the preconditions in RS_tcAdWe_94 and at least one of the following conditions are satisfied, the triggering conditions for these vehicle C-ITS services are fulfilled and the generation of a DENM shall be triggered:

- driver reaction and light status:
 - a) the driver enables the rear fog-light and the low-beam light is enabled. All these conditions shall be valid for more than 20 s (to minimise risk of misuse by driver, conditions have to be valid for a longer period);
 - b) the driver enables the rear fog-light, the low-beam light is enabled and the vehicle speed is less than 60 km/h. All these conditions shall be valid for a duration greater than 20 s;

- visibility range measurement device:
 - c) the visibility due to fog is less than 80 m +/-40 m tolerance for more than 5 s (the obscured view has to be detected for a reasonable period. The period is shorter than for conditions a) and b) due to more reliable information);
 - d) the visibility due to fog is less than 80 m +/-40 m tolerance and the vehicle speed is less than 60 km/h (if the vehicle is in a non-urban area, this speed could be an indication of reduced visibility) for more than 5 s.

Tested by:

3.1.2.3 Information quality

Requirement (i)

RS_tcAdWe_103

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 ‘adverse weather condition — fog’

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

Tested by:

Requirement (i)

RS_tcAdWe_104

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:

3.1.3 Termination conditions

Requirement (i)

RS_tcAdWe_105

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

Tested by:

3.1.3.1 Cancellation

Requirement (i)

RS_tcAdWe_106

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

Tested by:

3.1.3.2 Negation

Requirement (i)

RS_tcAdWe_107

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

Tested by:

3.1.4 Update

Requirement (i)

RS_tcAdWe_108

The appropriate update procedure for a DENM shall be evaluated every 0.1 s and determined based on the following conditions:

- (a) At least one of the conditions of requirement RS_tcAdWe_95 in clause 3.1.2.2 is fulfilled.
- (b) A period with a duration greater than or equal to a minimum update interval of 10 s passed since the last new or update DENM.
- (c) Either
 - the vehicle's position has changed equal to or more than 100 m with respect to the currently transmitted DENM *eventPosition* or
 - the vehicle's heading has changed equal to or more than 4 ° with respect to the currently transmitted DENM *eventHeading*

If condition (a) and condition (b) and/or (c) are fulfilled, an update DENM shall be generated, with the following constraints:

- The information of the detected event shall be assigned to the DENM data fields of the updated DENM according to RS_tcAdWe_187 in clause 3.1.7.1.
- The *eventHistory* shall be generated or refreshed for the updated DENM according to RS_BSP_544 considering the thresholds
 - pDenmEventHistoryGenMaxDeltaTime set to 60,
 - pDenmEventHistoryGenMaxDeltaDistance set to 100, and
 - pDenmEventHistoryGenMaxDeltaHeading set to 4.

If condition (a) is not fulfilled, the DENM shall be also immediately updated considering the above constraints. Thereafter, no further updates shall be generated.

If neither of the condition (b) nor (c) is fulfilled, no updated DENM shall be generated.

If an updated DENM shall be generated, but the generation is not possible, e.g. due to loss of positioning information, no further updates shall be generated. A new DENM might be generated once the service is available again and respective triggering conditions are fulfilled.

Note: Condition (b) is intended to ensure up to date information by frequent update DENMs

Note: Condition (c) is intended to ensure an update DENM when the vehicle has moved to a

location where a new *eventHistory* point would help representing the shape of the underlying road, e.g. a sharp curve. This condition is comparable to conditions b) and c) of RS_BSP_544.

Tested by:

3.1.5 Repetition duration and repetition interval

Requirement (i)

RS_tcAdWe_113

DENMs that are new or have been updated, shall be repeated for a *repetitionDuration* of 180 s with a *repetitionInterval* of 4 s. 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: The *validityDuration* is set to 300 s. Therefore, one can prevent a gap of DENMs if the *repetitionDuration* of the original DENM has expired and the update has not yet been received.

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_tcAdWe_114

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

Tested by:

3.1.7 Message parameters

3.1.7.1 DENM

Requirement (i)

RS_tcAdWe_187

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

Table 4: DENM data elements of ‘adverse weather condition — fog’

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. The timestamp reflects the beginning of the detection of the current event. Shall be set in accordance with [TS 102 894-2].
	Shall be refreshed for an update DENM and set to the detection time of the current event.
<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) Note: for new and update DENMs, the <i>relevanceDistance</i> is the minimum distance within which a receiving vehicle must be aware of the event. For update DENMs, it is to be considered as the distance to any <i>eventHistory</i> 's <i>eventPoint</i> .		
<i>relevanceTrafficDirection</i>	allTrafficDirections(0)		
<i>validityDuration</i>	300 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_tcAdWe_103. Shall be refreshed for every update DENM and set to the informationQuality of the current event point.		
<i>causeCode</i>	adverseWeatherCondition-Visibility(18)		
<i>subCauseCode</i>	fog(1)		
<i>eventHistory</i>	This element shall be refreshed for updated DENMs according to RS_BSP_544.		
Location container			
<i>traces</i>	<i>PathHistory</i> of the originating vehicle C-ITS station with reference to the current event point. Shall be set in accordance with [TS 102 894-2]. Shall be refreshed for an update DENM.		
<i>roadType</i>	<i>RoadType</i> of the road on which the detecting vehicle C-ITS station is situated. Shall be refreshed for an update DENM. Shall be set in accordance with [TS 102 894-2] in combination with the following rules:		
	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-NoStructuralSeparation ToOppositeLanes(2)
	Non-urban	Yes	nonUrban- WithStructuralSeparation ToOppositeLanes(3)
	Non-urban	Unknown	nonUrban-NoStructuralSeparation ToOppositeLanes(2)
	If the information about the urban/non-urban status cannot be determined, the data element shall be omitted.		

Tested by:

3.1.7.2 CAM

Requirement (i)

RS_tcAdWe_116

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

Tested by:

3.1.8 Network and transport layer

Requirement (i)

RS_tcAdWe_117

The interface parameter destination area in IF.DEN.1 [EN 302 637-3] shall be a circular shape with center point C and radius R.

For new DENMs, C shall be set as the *eventPosition* and R as the *relevanceDistance*.

For update DENMs

- C shall be located at the middle point along the union of segments connecting the DENM *eventPosition* and all subsequent *eventHistory*'s event points, and
- R shall be calculated as the sum of a value *d* and the *relevanceDistance*. The value *d* shall be calculated as the Euclidean distance separating C from the farthest *eventHistory*'s event point.

Note: for new and update DENMs, the *relevanceDistance* is always the minimum distance a receiving vehicle must be aware of the event after entering the destination area. As for update DENMs the event has been detected along the *eventHistory*, the *relevanceDistance* shall be the minimum distance that a receiving vehicle must possibly drive from the border of the destination area to any *eventHistory*'s eventPoint. For this reason, for update DENM the radius R adds the *relevanceDistance* to *d*, which ensures that a receiving vehicle has enough time margin to react from the moment it enters the destination area before reaching the area where the event has been detected (see figure below).

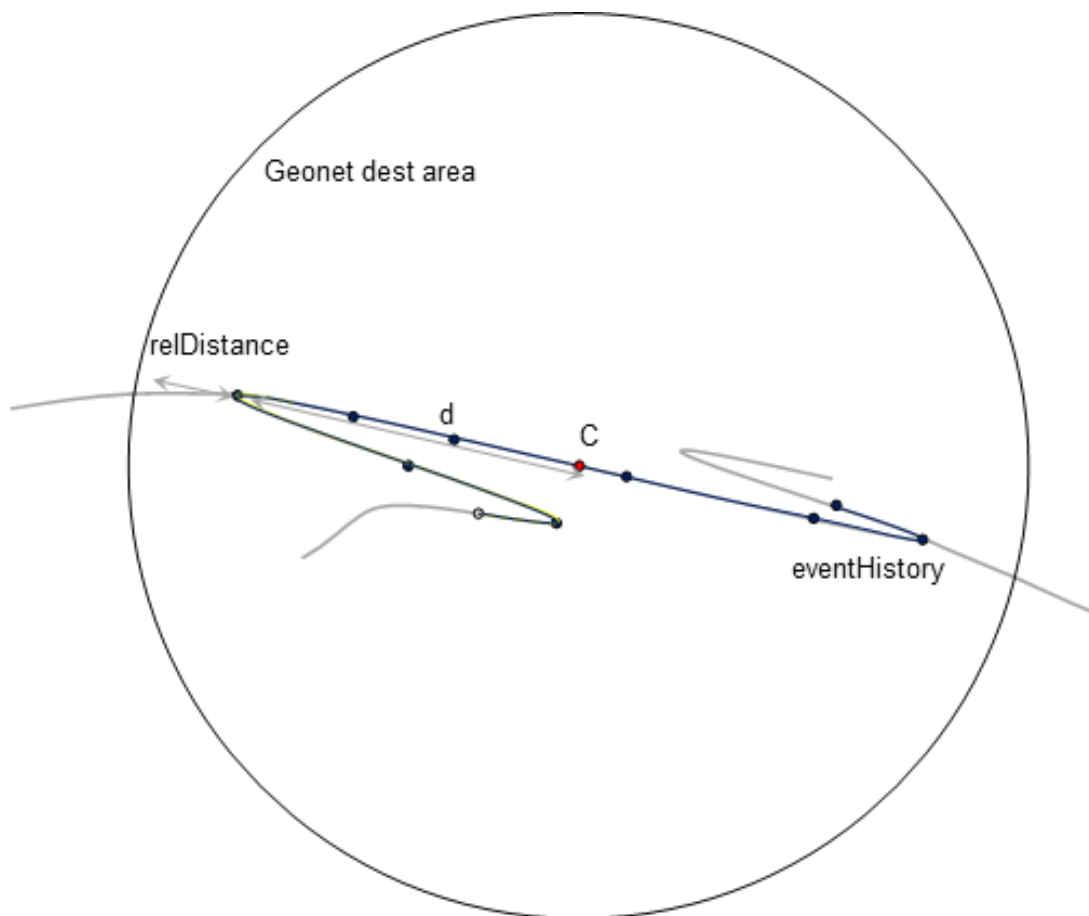


Figure 1: eventHistory and Geonet destination area

Tested by:

3.1.9 Security layer

Requirement (i)

RS_tcAdWe_119

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 Adverse weather condition - precipitation

3.2.1 Description of vehicle C-ITS service

Other (informational)

RS_tcAdWe_191

This clause describes the triggering of V2V messages for the *Adverse Weather Condition - Precipitation* vehicle C-ITS service. A DENM shall be triggered, if precipitation interferes the driver at a particular extent.

Other (informational)

RS_tcAdWe_192

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

triggering conditions:

- 'adverse weather conditions — fog'.

Requirement (i)**RS_tcAdWe_121**

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 or an update DENM. If the triggering conditions are not fulfilled, a DENM signal shall not be generated.

Tested by:

3.2.2 Triggering conditions

3.2.2.1 Preconditions

Requirement (i)**RS_tcAdWe_122**

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

- the vehicle speed is greater than 7 km/h;
- the vehicle speed is less than 80 km/h;
- the windshield washer function is not active.

Tested by:

3.2.2.2 Service-specific conditions

Requirement (i)**RS_tcAdWe_123**

If the preconditions in RS_tcAdWe_122 and at least one of the following conditions are satisfied, the triggering conditions for these vehicle C-ITS services are fulfilled and the generation of a DENM shall be triggered.

- wiper level and light status:
 - a) the wiper operates at its maximum speed level. The low-beam light is enabled. All these conditions shall be valid for more than 20 s;
 - b) the wiper operates at its maximum speed level and the vehicle speed is less than 60 km/h. The low-beam light is enabled. All these conditions shall be valid for more than 20 s;
- rain measurement device, wiper level and light status:
 - c) the quantity of rainfall is at least 90 % of the maximum output of the measurement device and the wiper operates at its maximum speed level. The low-beam light is enabled. All of this needs to be valid for more than 20 s;
 - d) the quantity of rainfall is at least 90 % of the maximum output of the measurement device and the wiper operates at its maximum speed level. The low-beam light is enabled and the vehicle speed is less than 60 km/h. All these conditions shall be valid for more than 20 s.

Tested by:

3.2.2.3 Information quality

Requirement (i)

RS_tcAdWe_130

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 ‘adverse weather condition — precipitation’

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

Tested by:

Requirement (i)

RS_tcAdWe_131

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:

3.2.3 Termination conditions

Requirement (i)

RS_tcAdWe_132

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

Tested by:

3.2.3.1 Cancellation

Requirement (i)

RS_tcAdWe_133

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

Tested by:

3.2.3.2 Negation

Requirement (i)

RS_tcAdWe_134

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

Tested by:

3.2.4 Update

Requirement (i)

RS_tcAdWe_135

The appropriate update procedure for a DENM shall be evaluated every 0.1 s and determined based on the following conditions:

- (a) At least one of the conditions of requirement RS_tcAdWe_123 in clause 3.2.2.2 is fulfilled.
- (b) A period with a duration greater than or equal to a minimum update interval of 10 s passed since the last new or update DENM.
- (c) Either
 - the vehicle's position has changed equal to or more than 100 m with respect to the currently transmitted DENM *eventPosition* or
 - the vehicle's heading has changed equal to or more than 4 ° with respect to the currently transmitted DENM *eventHeading*

If condition (a) and condition (b) and/or (c) are fulfilled, an update DENM shall be generated, with the following constraints:

- The information of the detected event shall be assigned to the DENM data fields of the updated DENM according to RS_tcAdWe_193 in clause 3.2.7.1.
- The *eventHistory* shall be generated or refreshed for the updated DENM according to RS_BSP_544 considering the thresholds
 - pDenmEventHistoryGenMaxDeltaTime set to 60,
 - pDenmEventHistoryGenMaxDeltaDistance set to 100, and
 - pDenmEventHistoryGenMaxDeltaHeading set to 4.

If condition (a) is not fulfilled, the DENM shall be also immediately updated considering the above constraints. Thereafter, no further updates shall be generated.

If neither of the condition (b) nor (c) is fulfilled, no updated DENM shall be generated.

If an updated DENM shall be generated, but the generation is not possible, e.g. due to loss of positioning information, no further updates shall be generated. A new DENM might be generated once the service is available again and respective triggering conditions are fulfilled.

Note: Condition (b) is intended to ensure up to date information by frequent update DENMs

Note: Condition (c) is intended to ensure an update DENM when the vehicle has moved to a location where a new *eventHistory* point would help representing the shape of the underlying road, e.g. a sharp curve. This condition is comparable to conditions b) and c) of RS_BSP_544.

Tested by:

3.2.5 Repetition duration and repetition interval

Requirement (i)

RS_tcAdWe_140

DENMs that are new or have been updated, shall be repeated for a *repetitionDuration* of 180 s with a *repetitionInterval* of 4 s. Therefore, the interface parameters *Repetition duration* and *Repetition interval* between the application and the DEN basic service shall be set according to the above

values.

Note: The *validityDuration* is set to 300 s. Therefore, one can prevent a gap of DENMs if the *repetitionDuration* of the original DENM has expired and the update has not yet been received.

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_tcAdWe_141

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

Tested by:

3.2.7 Message parameters

3.2.7.1 DENM

Requirement (i)

RS_tcAdWe_193

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

Table 6: DENM data elements of ‘adverse weather condition — precipitation’

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. The timestamp reflects the beginning of the detection of the current event point. Shall be set in accordance with [TS 102 894-2].
	Shall be refreshed for an update DENM and set to the detection time of the current event point.
<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 and set to the position of the current event point.

<i>relevanceDistance</i>	lessThan1000m (4) Note: for new and update DENMs, the <i>relevanceDistance</i> is the minimum distance within which a receiving vehicle must be aware of the event. For update DENMs, it is to be considered as the distance to any <i>eventHistory</i> 's <i>eventPoint</i> .		
<i>relevanceTrafficDirection</i>	allTrafficDirections(0)		
<i>validityDuration</i>	300 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_tcAdWe_130. Shall be refreshed for every update DENM and set to the informationQuality of the current event point.		
<i>causeCode</i>	adverseWeatherCondition-Precipitation(19)		
<i>subCauseCode</i>	unavailable(0)		
<i>eventHistory</i>	This element shall be refreshed for updated DENMs according to RS_BSP_544.		
Location container			
<i>traces</i>	<i>PathHistory</i> of the originating vehicle C-ITS station with reference to the current event point. Shall be set in accordance with [TS 102 894-2]. Shall be refreshed for an update DENM.		
<i>roadType</i>	<i>RoadType</i> of the road on which the detecting vehicle C-ITS station is situated. Shall be refreshed for an update DENM and set to the roadType of the current event point. Shall be set in accordance with [TS 102 894-2] in combination with the following rules:		
	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- WithStructuralSeparation ToOppositeLanes(3)
	Non-urban	Unknown	nonUrban- NoStructuralSeparation ToOppositeLanes(2)
	If the information about the urban/non-urban status cannot be determined, the data element shall be omitted.		

Tested by:

3.2.7.2 CAM

Requirement (i)

RS_tcAdWe_143

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

Tested by:

3.2.8 Network and transport layer

Requirement (i)

RS_tcAdWe_144

The interface parameter destination area in IF.DEN.1 [EN 302 637-3] shall be a circular shape with center point C and radius R.

For new DENMs, C shall be set as the *eventPosition* and R as the *relevanceDistance*.

For update DENMs

- C shall be located at the middle point along the union of segments connecting the DENM *eventPosition* and all subsequent *eventHistory*'s event points, and
- R shall be calculated as the sum of a value *d* and the *relevanceDistance*. The value *d* shall be calculated as the Euclidean distance separating C from the farthest *eventHistory*'s event point.

Note: for new and update DENMs, the *relevanceDistance* is always the minimum distance a receiving vehicle must be aware of the event after entering the destination area. As for update DENMs the event has been detected along the *eventHistory*, the *relevanceDistance* shall be the minimum distance that a receiving vehicle must possibly drive from the border of the destination area to any *eventHistory*'s eventPoint. For this reason, for update DENM the radius R adds the *relevanceDistance* to *d*, which ensures that a receiving vehicle has enough time margin to react from the moment it enters the destination area before reaching the area where the event has been detected (see figure below).

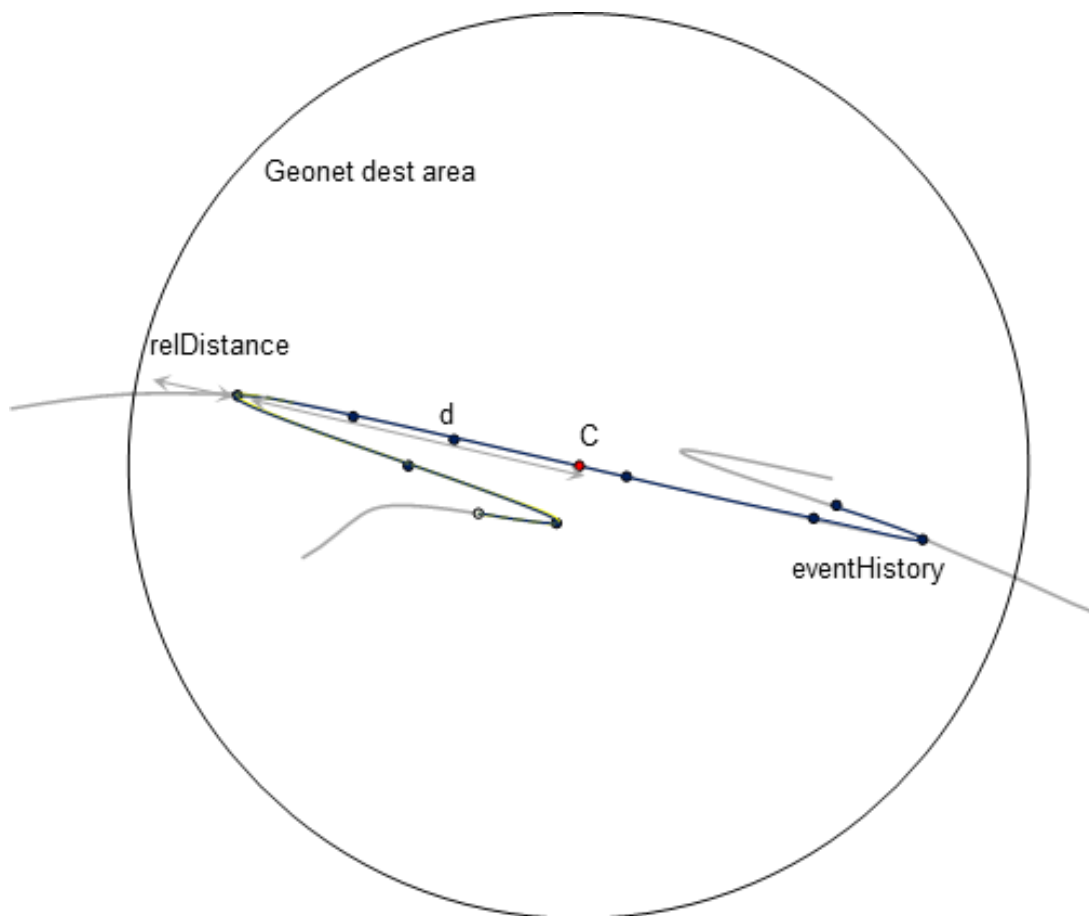


Figure 2: eventHistory and Geonet destination area

Tested by:

3.2.9 Security layer

Requirement (i)

RS_tcAdWe_146

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:

3.3 Adverse weather condition - traction loss

3.3.1 Description of vehicle C-ITS service

Other (informational)

RS_tcAdWe_197

This clause describes the triggering of V2V messages for the *Adverse Weather Condition - Traction Loss* vehicle C-ITS service. A DENM shall be triggered, if a traction loss caused by slipperiness is detected at a particular extent.

Other (informational)

RS_tcAdWe_198

The following use cases are related to the *Adverse Weather Condition - Traction Loss* use case, because they share similar triggering conditions:

- none

Requirement (i)**RS_tcAdWe_148**

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 or an update DENM. If the triggering conditions are not fulfilled, a DENM signal shall not be generated.

Tested by:

3.3.2 Triggering conditions

3.3.2.1 Preconditions

Requirement (i)**RS_tcAdWe_149**

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

- reverse gear is not enabled;
- no errors concerning engine, drive train and braking system are reported.

Tested by:

3.3.2.2 Service-specific conditions

Requirement (i)**RS_tcAdWe_150**

If the precondition in RS_tcAdWe_149 and at least one of the following conditions are satisfied, the triggering conditions for these vehicle C-ITS services are fulfilled and the generation of a DENM shall be triggered.

- on the basis of positive acceleration:
 - a) on the basis of Anti-Slip Regulation (ASR), throttle position, vehicle acceleration and vehicle speed. An ASR-request is active for at least 200 ms (as for other safety functions depending on ASR). The throttle position is pressed on average more than 30 % of the max value while ASR intervention is active. The (filtered) acceleration of the vehicle is less than 40 % of the vehicle acceleration on μ -High (dry asphalt 0,85) at the same start speed and driving manoeuvre (No detailed values have been put here to cover different drive configurations, e.g. two-wheel vs. four-wheel drive);
 - b) on the basis of ASR, throttle position, vehicle acceleration and vehicle speed. An ASR-request is active for at least 200 ms. The throttle position is pressed on average more than 30 % of the max value while ASR intervention is active. The (filtered) acceleration of the vehicle is less than 20 % of the vehicle acceleration on μ -High (dry asphalt 0,85) at the same start speed and driving manoeuvre;
 - c) on the basis of ASR, throttle position, vehicle acceleration and vehicle speed. An ASR-request is active for at least 200 ms. The throttle position is pressed on average more than 30 % of the max value while ASR intervention is active. The (filtered) acceleration of the vehicle is less than 10 % of the vehicle acceleration on μ -High (dry asphalt 0,85) at the same start speed and driving manoeuvre;
 - d) on the basis of ASR and throttle position. An ASR-request is active for at least

200 ms. The throttle position is pressed on average less than 30 % of the max value (so as not to cause an ASR intervention on ground with high friction value) while ASR intervention is active;

- on the basis of negative acceleration (deceleration):
 - e) on the basis of Anti-lock Braking System (ABS), braking pressure and deceleration. ABS intervention is active for more than 200 ms (according to other safety functions depending on ABS). Braking pressure is more than 20 % of maximum capable braking pressure. The (filtered) deceleration of the vehicle is less than 50 % of the vehicle deceleration on μ -high (dry asphalt 0,85) at the same start speed and driving manoeuvre;
 - f) on the basis of ABS, braking pressure and deceleration. ABS intervention is active for more than 200 ms. Braking pressure is more than 20 % of maximum capable braking pressure. The (filtered) deceleration of the vehicle is less than 25 % of the vehicle deceleration on μ -high (dry asphalt 0,85) at the same start speed and driving manoeuvre;
 - g) on the basis of ABS, braking pressure and deceleration. ABS intervention is active for more than 200 ms. Braking pressure is more than 20 % (so as not to cause an ABS intervention on ground with high friction value) of maximum capable braking pressure. The (filtered) deceleration of the vehicle is less than 10 % of the vehicle deceleration on μ -high (dry asphalt 0,85) at the same start speed and driving manoeuvre;
 - h) on the basis of ABS and braking pressure. ABS intervention is active for more than 200 ms. Braking pressure is less than 20 % of maximum capable braking pressure;
- on the basis of friction coefficient estimation:
 - i) the friction coefficient is less than 0,3 for at least 5 s (the friction coefficient of ice is $< 0,2$; for snow and loose chippings, it is approx. 0,4. The friction coefficient needs to be detected for a certain period);
 - j) the friction coefficient is less than 0,2 for at least 5 s.

Note: Throttle position refers also to an equivalent request by other driver input systems or automatic system like ACC.

Tested by:

Requirement (i)

RS_tcAdWe_162

For conditions (a)-(g), a minimum detection interval shall be waited from the detection time of the last triggered or updated DENM before the same event can be detected again and trigger a new DENM. In this way, an intermittent event will not trigger a series of DENMs at short timed intervals. The *Minimum Detection Interval* shall be 5 s.

Tested by:

3.3.2.3 Information quality

Requirement (i)

RS_tcAdWe_164

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 ‘adverse weather condition — traction loss’

Event detection	Value of InformationQuality
No TRCO compliant implementation	unknown(0)
Condition a) or e) is fulfilled	1
Condition b) fulfilled	2
Condition c) or f) is fulfilled	3
Condition g) fulfilled	4
Condition d) or h) fulfilled	5
Condition i) is fulfilled	6
Condition j) is fulfilled	7

Tested by:

Requirement (i)**RS_tcAdWe_165**

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:

3.3.3 Termination conditions**Requirement (i)****RS_tcAdWe_166**

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

Tested by:

3.3.3.1 Cancellation**Requirement (i)****RS_tcAdWe_167**

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

Tested by:

3.3.3.2 Negation**Requirement (i)****RS_tcAdWe_168**

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

Tested by:

3.3.4 Update

Requirement (i)

RS_tcAdWe_169

The appropriate update procedure for a DENM shall be evaluated every 0.1 s and determined based on the following conditions:

- (a) At least one of the conditions of requirement RS_tcAdWe_150 in clause 3.3.2.2 is fulfilled.
- (b) A period with a duration greater than or equal to a minimum update interval of 0.1 s passed since the last new or update DENM.
- (c) Either
 - the vehicle's position has changed equal to or more than 10 m with respect to the currently transmitted DENM *eventPosition* or
 - the vehicle's heading has changed equal to or more than 4 ° with respect to the currently transmitted DENM *eventHeading*

If condition (a) and condition (b) and/or (c) are fulfilled, an update DENM shall be generated, with the following constraints:

- The information of the detected event shall be assigned to the DENM data fields of the updated DENM according to RS_tcAdWe_177 in clause 3.3.7.1.
- The *eventHistory* shall be generated or refreshed for the updated DENM according to RS_BSP_544 considering the thresholds
 - pDenmEventHistoryGenMaxDeltaTime set to 1,
 - pDenmEventHistoryGenMaxDeltaDistance set to 10, and
 - pDenmEventHistoryGenMaxDeltaHeading set to 4.

If condition (a) is not fulfilled, the DENM shall be also immediately updated considering the above constraints. Thereafter, no further updates shall be generated.

If neither of the condition (b) nor (c) is fulfilled, no updated DENM shall be generated.

If an updated DENM shall be generated, but the generation is not possible, e.g. due to loss of positioning information, no further updates shall be generated. A new DENM might be generated once the service is available again and respective triggering conditions are fulfilled.

Note: Condition (b) is intended to ensure up to date information by frequent update DENMs

Note: Condition (c) is intended to ensure an update DENM when the vehicle has moved to a location where a new *eventHistory* point would help representing the shape of the underlying road, e.g. a sharp curve. This condition is comparable to conditions b) and c) of RS_BSP_544.

Tested by:

3.3.5 Repetition duration and repetition interval

Requirement (i)

RS_tcAdWe_174

By default, DENMs that are new or have been updated shall be repeated for a

repetitionDuration of 300 s with a *repetitionInterval* of 1 s. Therefore, the interface parameters Repetition duration and Repetition interval between the application and the DEN basic service shall be set in accordance to these values.

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

Tested by:

Requirement (i)

RS_tcAdWe_175

If the DENM is triggered in an urban area, which as determined by a digital map or an on-board sensor algorithm, it shall be repeated for a *repetitionDuration* of 180 s with a *repetitionInterval* of 4 s.

Note: The *validityDuration* is set to 600 s or 300 s, respectively. Therefore, one can prevent a gap of DENMs if the *repetitionDuration* of the original DENM has expired and the update has not yet been received.

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

Tested by:

3.3.6 Traffic class

Requirement (i)

RS_tcAdWe_176

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

Tested by:

3.3.7 Message parameters

3.3.7.1 DENM

Requirement (i)

RS_tcAdWe_177

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

Table 8: DENM data elements of ‘adverse weather condition — traction loss’

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. The timestamp reflects the beginning of the detection of the current event point. Shall be set in accordance with [TS 102 894-2].
	Shall be refreshed for an update DENM and set to the detection time of the current event point.

<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 and set to the position of the current event point.		
<i>relevanceDistance</i>	lessThan1000m (4) Note: for new and update DENMs, the <i>relevanceDistance</i> is the minimum distance within which a receiving vehicle must be aware of the event. For update DENMs, it is to be considered as the distance to any <i>eventHistory</i> 's <i>eventPoint</i> .		
<i>relevanceTrafficDirection</i>	allTrafficDirections(0)		
<i>validityDuration</i>	Default: 600 s In urban areas, as determined by digital map or on-board sensor algorithm: 300 s (If the vehicle has no information about the urban/non-urban status, the default value shall be used.)		
<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_tcAdWe_164. Shall be refreshed for every update DENM and set to the informationQuality of the current event point.		
<i>causeCode</i>	adverseWeatherCondition-Adhesion(6)		
<i>subCauseCode</i>	unavailable(0)		
<i>eventHistory</i>	This element shall be refreshed for updated DENMs according to RS_BSP_544.		
Location container			
<i>traces</i>	<i>PathHistory</i> of the originating vehicle C-ITS station with reference to the current event point. Shall be set in accordance with [TS 102 894-2]. Shall be refreshed for an update DENM.		
<i>roadType</i>	<i>RoadType</i> of the road the detecting vehicle C-ITS station is situated on.		
	Shall be refreshed for an update DENM and set to the <i>roadType</i> of the current event point.		
	Shall be set in accordance with [TS 102 894-2] in combination with the following rules:		
	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)
If the information about the urban/non-urban status cannot be determined, the data element shall be omitted.			

Tested by:

3.3.7.2 CAM

Requirement (i)

RS_tcAdWe_178

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

Tested by:

3.3.8 Network and transport layer

Requirement (i)

RS_tcAdWe_179

The interface parameter destination area in IF.DEN.1 [EN 302 637-3] shall be a circular shape with center point C and radius R.

For new DENMs, C shall be set as the *eventPosition* and R as the *relevanceDistance*.

For update DENMs

- C shall be located at the middle point along the union of segments connecting the DENM *eventPosition* and all subsequent *eventHistory*'s event points, and
- R shall be calculated as the sum of a value *d* and the *relevanceDistance*. The value *d* shall be calculated as the Euclidean distance separating C from the farthest *eventHistory*'s event point.

Note: for new and update DENMs, the *relevanceDistance* is always the minimum distance a receiving vehicle must be aware of the event after entering the destination area. As for update DENMs the event has been detected along the *eventHistory*, the *relevanceDistance* shall be the minimum distance that a receiving vehicle must possibly drive from the border of the destination area to any *eventHistory*'s eventPoint. For this reason, for update DENM the radius R adds the *relevanceDistance* to *d*, which ensures that a receiving vehicle has enough time margin to react from the moment it enters the destination area before reaching the area where the event has been detected (see figure below).

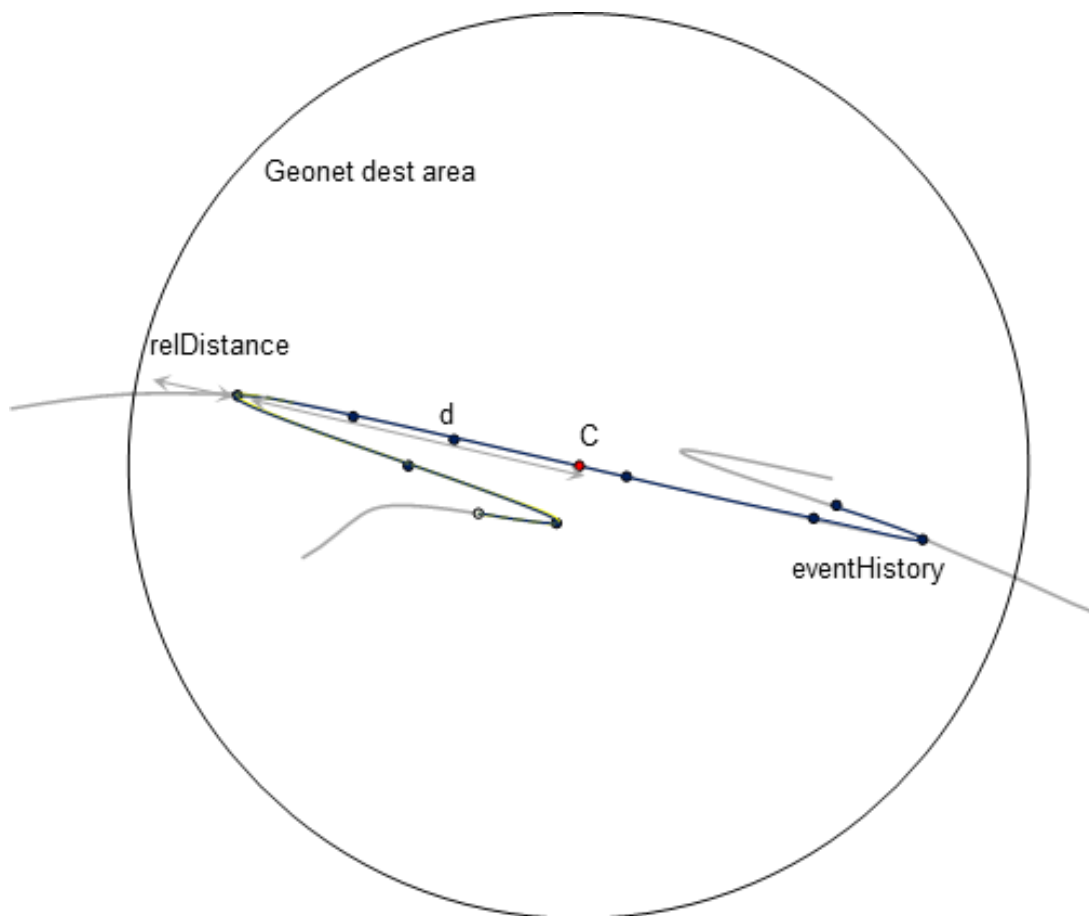


Figure 3: eventHistory and Geonet destination area

Tested by:

3.3.9 Security layer

Requirement (i)

RS_tcAdWe_181

When the triggering conditions as described in clause 3.3.2 apply, the application shall request the blocking of the AT changeover as defined in RS_BSP_184.

Tested by:
