
Triggering Conditions and Data Quality Adverse Weather Conditions

CAR 2 CAR Communication Consortium



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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). Today, the Consortium comprises 88 members, with 18 vehicle manufacturers, 39 equipment suppliers and 31 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 works in close cooperation with the European and international standardisation organisations such as ETSI and CEN.

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Table 2: Changes since last version

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1 Introduction

1.1 Abstract

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 Triggering conditions

2.1 Adverse Weather Condition

2.1.1 Adverse Weather Condition - Fog

2.1.1.1 Description of Use Case

Other (informational)

RS_tcAdWe_185

This section describes the triggering of V2V messages for the *Adverse Weather Condition - Fog* use case. A DENM shall be triggered, if fog interferes the driver at a particular extent.

Requirement

RS_tcAdWe_93

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

Tested by:

2.1.1.2 Relations to other Use Cases

Other (informational)

RS_tcAdWe_186

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

- Adverse Weather Conditions - Precipitation

2.1.1.3 Triggering Conditions

2.1.1.3.1 Preconditions

Requirement

RS_tcAdWe_94

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

1. The vehicle velocity is greater than 7 km/h.
2. The vehicle velocity is less than 80 km/h (vehicle velocity greater 80 km/h is not reasonable for reduced visibility. Speed according to filtered vehicle bus signal).

Tested by:

2.1.1.3.2 Use Case Specific Conditions

Requirement

RS_tcAdWe_95

Once at least one of the following conditions is satisfied, the triggering conditions for this use case 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 of this needs to be valid for a duration greater than 20 seconds (to minimize 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 velocity is less than 60 km/h. All of this needs to be valid for a duration greater than 20 seconds.

- Visibility Range Measurement Device:

c) The visibility due to fog is less than 80 meters +- 40 meters tolerance for a duration greater than 5 seconds (the obscured view has to be detected for a reasonable time period. Compared to the conditions a) and b), the time period is shorter due to a more reliable information).

d) The visibility due to fog is less than 80 meters +- 40 meters tolerance and the vehicle velocity is less than 60 km/h (if the vehicle is in non-urban area this speed could be an indication for reduced visibility) for a duration greater than 5 seconds.

Tested by:

Requirement

RS_tcAdWe_100

If the conditions b) or d) are evaluated, the vehicle speed shall be determined by the vehicle bus signal, not by GNSS. The filtered vehicle speed (with respect to sensor noise due to wheel ticks) shall be used.

Tested by:

Requirement

RS_tcAdWe_101

A new or update DENM shall not be generated within the *Detection Blocking Time*. The *Detection Blocking Time* is launched after the event is detected and a respective DENM has been triggered. In this way, a single event is not able to trigger a series of DENMs. For the Visibility Range Measurement Device (condition c and d) the *Detection Blocking Time* shall be 15 seconds. For the other conditions there shall be no *Detection Blocking Time*.

Tested by:

Requirement

RS_tcAdWe_102

In order to ensure consistent functional behaviour for the different triggering conditions a)-d) and the *Detection Blocking Time*, the *Minimum Detection Interval* between two detected events shall be 20 s.

Tested by:

2.1.1.3.3 Information Quality

Requirement

RS_tcAdWe_103

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)
Condition a) is fulfilled	1
Condition b) is fulfilled	2

Condition c) is fulfilled	3
Condition d) is fulfilled	4

Table 3: Information quality of "Adverse Weather Condition - Fog"

Tested by:

Requirement **RS_tcAdWe_104**

If the Triggering Conditions change in 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:

2.1.1.4 Termination Conditions

Requirement **RS_tcAdWe_105**

A termination of the use case shall not be considered.

Tested by:

2.1.1.4.1 Cancellation

Requirement **RS_tcAdWe_106**

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

Tested by:

2.1.1.4.2 Negation

Requirement **RS_tcAdWe_107**

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

Tested by:

2.1.1.5 Update

Requirement **RS_tcAdWe_108**

The following rules shall be applied for the update procedure:

If case 1 occurs the generation of an update DENM shall be triggered. If case 2 or case 3 occurs no update DENM shall be triggered, instead the generation of a new DENM shall be triggered.

Case 1: At least one of the use case specific conditions is fulfilled after the *Minimum Detection Interval*, specified in chapter 2.1.1.3.2. The *validityDuration* of the former DENM is not expired. Neither the value of the data element *DeltaLatitude* nor the value of the data element *DeltaLongitude*, representing the distance between the current detected event and the former detected event, exceeds the threshold that can be covered by the data elements *DeltaLatitude*

and *DeltaLongitude* (in current specification of [TS 102 894-2]: 13107 microdegrees):

An update DENM shall be generated. The information of the former DENM data elements (*eventPosition*, *eventDeltaTime*, *informationQuality*) have to be stored in the *eventHistory* by an additional *eventPoint*.

The event points shall be ordered in ascending order with respect to their lifetime with the most recent *eventPoint* at the first position. Event points in the *eventHistory* with lifetimes that exceed the *validityDuration* (see chapter 2.1.1.8.1) shall be deleted from the *eventHistory* for the update DENM. If the distance covered by the *eventHistory* exceeds the threshold that is allowed by the security, the oldest event points shall be deleted from the *eventHistory*.

The information of the current detected event have to be assigned to the DENM data fields of the updated DENM (e.g. *detectionTime* or *informationQuality*, see chapter 2.1.1.8.1).

NOTE: If lifetimes of event points exceed the *validityDuration* after the update DENM has been generated, it is up to the receiver to handle these event points.

Case 2: At least one of the use case specific conditions is fulfilled after the *Minimum Detection Interval*, specified in chapter 2.1.1.3.2. The *validityDuration* of the former DENM is not expired. Either the value of the data element *DeltaLatitude* or the value of the data element *DeltaLongitude*, representing the distance between the current detected event and the former detected event, exceeds the threshold that can be covered by the data elements *DeltaLatitude* and *DeltaLongitude* (in current specification of [TS 102 894-2]: 13107 microdegrees):

No update DENM shall be generated, but an additional new DENM shall be generated. The information of the current detected event have to be assigned to the DENM data fields of the additional new DENM (e.g. *detectionTime* or *informationQuality*, see chapter 2.1.1.8.1). The former DENM shall be continued to be transmitted as long as the *repetitionDuration* (see chapter 2.1.1.6) of the former DENM does not expire.

Case 3: At least one of the use case specific conditions is fulfilled after the *Minimum Detection Interval*, specified in chapter 2.1.1.3.2. The *validityDuration* of the former DENM is expired:

No update DENM shall be generated, but a new DENM according to the currently detected event shall be generated.

NOTE: In this case, the transmission of the former DENM has already been terminated, because the *repetitionDuration* (see chapter 2.1.1.6) of the former DENM is expired.

NOTE: If the use case specific conditions are not fulfilled after the *Minimum Detection Interval* (specified in chapter 2.1.1.3.2), the generation of an update DENM is not necessary. If a former DENM is still active, the transmission has to be continued as long as the *repetitionDuration* of the former DENM is not expired.

Tested by:

2.1.1.6 Repetition Duration and Repetition Interval

Requirement

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 according to the values above.

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

NOTE: The case of managing two DENMs with the same *causeCode* from the same ITS originator shall be handled by the receiving ITS station.

Tested by:

2.1.1.7 Traffic class

Requirement

RS_tcAdWe_114

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

Tested by:

2.1.1.8 Message Parameter

2.1.1.8.1 DENM

Requirement

RS_tcAdWe_187

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

Data Field	Value
Management Container	
<i>actionID</i>	Identifier of a DENM. Shall be set according to [TS 102 894-2].
<i>detectionTime</i>	<p><i>Timestamppts</i>-Timestamp at which the event is detected by the originating ITS-S. Timestamp is according to the beginning of the detection of the current event. Shall be set according to [TS 102 894-2].</p> <p>Shall be refreshed for an update DENM and set to the detection time of the current event.</p>
<i>referenceTime</i>	<i>Timestamppts</i> -Timestamp at which a new DENM or an update DENM is generated. Shall be set according to [TS 102 894-2].
<i>termination</i>	Shall not be set, because neither negation nor cancellation shall be used in this use case.
<i>eventPosition</i>	<p><i>ReferencePosition</i>. Shall be set according to [TS 102 894-2].</p> <p>Shall be refreshed for an update DENM.</p>
<i>relevanceDistance</i>	<ul style="list-style-type: none"> New DENM: lessThan1000m(4) Update DENM: lessThan5km(5) (By using updates, the distance covered by the eventHistory becomes longer. To address all relevant ITS stations, the relevanceDistance is longer in this case.)
<i>relevanceTrafficDirection</i>	allTrafficDirections(0)
<i>validityDuration</i>	300 seconds
<i>stationType</i>	The type of the originating ITS-S. Shall be set according to [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>	unavailable(0) or fog(1)		
<i>eventHistory</i>	This element shall only be used for update DENMs (see section 2.1.1.5.).		
Location Container			
<i>traces</i>	<p><i>PathHistory</i> of the originating ITS-S with reference to the current event point. Shall be set according to [TS 102 894-2]. Shall be refreshed for an update DENM.</p>		
<i>roadType</i>	<p><i>RoadType</i> of the road the detecting ITS-S is situated on. Shall be refreshed for an update DENM. Shall be set according to [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.			

Table 4: DENM data elements of "Adverse Weather Condition - Fog"

Tested by:

2.1.1.8.2 CAM

Requirement

RS_tcAdWe_116

CAM adaption shall not be used for this use case.

Tested by:

2.1.1.9 Networking and Transport Layer

Requirement

RS_tcAdWe_117

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*.

Tested by:

2.1.1.10 Security Layer

Requirement

RS_tcAdWe_119

If the triggering conditions as described in chapter 2.1.1.3 apply, an AT change shall be blocked for new and update DENMs for 15 minutes. Corresponding new and update DENMs shall be sent with the same authorization ticket.

Tested by:

Requirement

RS_tcAdWe_120

If a authorization ticket change appears and there is an active DENM transmission (new or update DENM), the transmission shall be stopped. In addition, the *EventHistory* and the *PathHistory* have to be deleted. Afterwards, the regular DENM generation process shall continue. Therefore, a new DENM shall be generated if the triggering conditions (see chapter 2.1.1.3) are satisfied. After the new DENM, update DENMs shall be used in the regular way (see chapter 2.1.1.5).

Tested by:

2.1.1.11 Scenarios

Other (informational)

RS_tcAdWe_188

This section 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 use case:

Count	Description	Status
	tbd	
	tbd	

Table 5: Adverse Weather Condition - Fog Scenarios

2.1.2 Adverse Weather Condition - Precipitation

2.1.2.1 Description of Use Case

Other (informational)

RS_tcAdWe_191

This section describes the triggering of V2V messages for the *Adverse Weather Condition - Precipitation* use case. A DENM shall be triggered, if precipitation interferes the driver at a particular extent.

Requirement**RS_tcAdWe_121**

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 fulfilled, a DENM signal shall not be generated.

Tested by:

2.1.2.2 Relations to other Use Cases**Other (informational)****RS_tcAdWe_192**

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

- Adverse Weather Conditions - Fog

2.1.2.3 Triggering Conditions**2.1.2.3.1 Preconditions****Requirement****RS_tcAdWe_122**

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

- The vehicle velocity is greater than 7 km/h (speed according to filtered vehicle bus signal).
- The vehicle velocity is less than 80 km/h (speed according to filtered vehicle bus signal).
- Front wash is not active.

Tested by:

2.1.2.3.2 Use Case Specific Conditions**Requirement****RS_tcAdWe_123**

Once at least one of the following conditions is satisfied, the triggering conditions for this use case are fulfilled and the generation of a DENM shall be triggered.

- Wiper Level and Light Status:
 - a) The wiper level is at maximum state. The low beam light is enabled. All of this needs to be valid for a duration greater than 20 seconds.
 - b) The wiper level is at maximum state and the vehicle velocity is less than 60 km/h (speed according to filtered vehicle bus signal). The low beam light is enabled. All of this needs to be valid for a duration greater than 20 seconds.
- Rain Measurement Device, Wiper Level and Light Status:
 - c) The quantity of rainfall is at minimum 90 % of the maximum output of the measurement device and the wiper level is at maximum state. The low beam light is enabled. All of this needs to be valid for a duration greater than 20 seconds.
 - d) The quantity of rainfall is at minimum 90 % of the maximum output of the measurement device and the wiper level is at maximum state. The low beam light is enabled and the vehicle velocity is less than 60 km/h (speed according to filtered vehicle bus signal). All of this needs to be valid for a duration greater than 20 seconds.

Tested by:

Requirement

RS_tcAdWe_128

If the conditions b) or d) are evaluated, the vehicle speed shall be determined by the vehicle bus signal, not by GNSS. The filtered vehicle speed (with respect to sensor noise due to wheel ticks) shall be used.

Tested by:

Requirement

RS_tcAdWe_129

Due to the algorithm, the *Minimum Detection Interval* between two detected events shall be 20 s.

Tested by:

2.1.2.3.3 Information Quality

Requirement

RS_tcAdWe_130

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)
Condition a) is fulfilled	1
Condition b) is fulfilled	2
Condition c) is fulfilled	3
Condition d) is fulfilled	4

Table 6: Information quality of "Adverse Weather Condition - Precipitation"

Tested by:

Requirement

RS_tcAdWe_131

If the Triggering Conditions change in 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:

2.1.2.4 Termination Conditions

Requirement

RS_tcAdWe_132

A termination of the use case shall not be considered.

Tested by:

2.1.2.4.1 Cancellation

Requirement

RS_tcAdWe_133

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

Tested by:

2.1.2.4.2 Negation

Requirement

RS_tcAdWe_134

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

Tested by:

2.1.2.5 Update

Requirement

RS_tcAdWe_135

The following rules shall be applied for the update procedure:

If case 1 occurs the generation of an update DENM shall be triggered. If case 2 or case 3 occurs no update DENM shall be triggered, instead the generation of a new DENM shall be triggered.

Case 1: At least one of the use case specific conditions is fulfilled after the *Minimum Detection Interval*, specified in chapter 2.1.2.3.2. The *validityDuration* of the former DENM is not expired. Neither the value of the data element *DeltaLatitude* nor the value of the data element *DeltaLongitude*, representing the distance between the current detected event and the former detected event, exceeds the threshold that can be covered by the data elements *DeltaLatitude* and *DeltaLongitude* (in current specification of [TS 102 894-2]: 13107 microdegrees):

An update DENM shall be generated. The information of the former DENM data elements (*eventPosition*, *eventDeltaTime*, *informationQuality*) have to be stored in the *eventHistory* by an additional *eventPoint*.

The event points shall be ordered in ascending order with respect to their lifetime with the most recent *eventPoint* at the first position. Event points in the *eventHistory* with lifetimes that exceed the *validityDuration* (see chapter 2.1.2.8.1) shall be deleted from the *eventHistory* for the update DENM. If the distance covered by the *eventHistory* exceeds the threshold that is allowed by the security, the oldest event points shall be deleted from the *eventHistory*.

The information of the current detected event have to be assigned to the DENM data fields of the updated DENM (e.g. *detectionTime* or *informationQuality*, see chapter 2.1.2.8.1).

NOTE: If lifetimes of event points exceed the *validityDuration* after the update DENM has been generated, it is up to the receiver to handle these event points.

Case 2: At least one of the use case specific conditions is fulfilled after the *Minimum Detection Interval*, specified in chapter 2.1.2.3.2. The *validityDuration* of the former DENM is not expired. Either the value of the data element *DeltaLatitude* or the value of the data element *DeltaLongitude*, representing the distance between the current detected event and the former detected event, exceeds the threshold that can be covered by the data elements *DeltaLatitude* and *DeltaLongitude* (in current specification of [TS 102 894-2]: 13107 microdegrees):

No update DENM shall be generated, but an additional new DENM shall be generated. The information of the current detected event have to be assigned to the DENM data fields of the additional new DENM (e.g. *detectionTime* or *informationQuality*, see chapter 2.1.2.8.1). The former DENM shall be continued to be transmitted as long as the *repetitionDuration* (see

chapter 2.1.2.6) of the former DENM does not expire.

Case 3: At least one of the use case specific conditions is fulfilled after the *Minimum Detection Interval*, specified in chapter 2.1.2.3.2. The *validityDuration* of the former DENM is expired:

No update DENM shall be generated, but a new DENM according to the currently detected event shall be generated.

NOTE: In this case, the transmission of the former DENM has already been terminated, because the *repetitionDuration* (see chapter 2.1.2.6) of the former DENM is expired.

NOTE: If the use case specific conditions are not fulfilled after the *Minimum Detection Interval* (specified in chapter 2.1.2.3.2), the generation of an update DENM is not necessary. If a former DENM is still active, the transmission has to be continued as long as the *repetitionDuration* of the former DENM is not expired.

Tested by:

2.1.2.6 Repetition Duration and Repetition Interval

Requirement

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 values above.

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

NOTE: The case of managing two DENMs with the same *causeCode* from the same ITS originator shall be handled by the receiving ITS station.

Tested by:

2.1.2.7 Traffic class

Requirement

RS_tcAdWe_141

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

Tested by:

2.1.2.8 Message Parameter

2.1.2.8.1 DENM

Requirement

RS_tcAdWe_193

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

Data Field	Value
Management Container	
<i>actionID</i>	Identifier of a DENM. Shall be set according to [TS 102 894-2].

<i>detectionTime</i>	<i>Timestamp</i> ts-Timestamp at which the event is detected by the originating ITS-S. Timestamp is according to the beginning of the detection of the current event point. Shall be set according to [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 according to [TS 102 894-2].		
<i>termination</i>	Shall not be set, because neither negation nor cancellation shall be used in this use case.		
<i>eventPosition</i>	<i>ReferencePosition</i> . Shall be set according to [TS 102 894-2].		
	Shall be refreshed for an update DENM and set to the position of the current event point.		
<i>relevanceDistance</i>	<ul style="list-style-type: none"> • New DENM: lessThan1000m(4) • Update DENM: lessThan5km(5) (By using updates, the distance covered by the <i>eventHistory</i> becomes longer. To address all relevant ITS stations, the <i>relevanceDistance</i> is longer in this case.) 		
<i>relevanceTrafficDirection</i>	allTrafficDirections(0)		
<i>validityDuration</i>	300 seconds		
<i>stationType</i>	The type of the originating ITS-S. Shall be set according to [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), heavyRain(1) or heavySnowfall(2)		
<i>eventHistory</i>	This element shall only be used for update DENMs (see section 2.1.2.5.).		
Location Container			
<i>traces</i>	<i>PathHistory</i> of the originating ITS-S with reference to the current event point.		
	Shall be set according to [TS 102 894-2]. Shall be refreshed for an update DENM.		
<i>roadType</i>	<i>RoadType</i> of the road the detecting ITS-S is situated on.		
	Shall be refreshed for an update DENM and set to the roadType of the current event point. Shall be set according to [TS 102 894-2] in combination with the following rules:		
	Urban / Non-Urban	Structural Separation	Data Element

	Urban	No	urban-NoStructuralSeparation ToOppositeLanes(0)
	Urban	Yes	urban-WithStructuralSeparation ToOppositeLanes(1)
	Urban	unknown	urban-NoStructuralSeparation ToOppositeLanes(0)
	Non-Urban	No	nonUrban-NoStructuralSeparation ToOppositeLanes(2)
	Non-Urban	Yes	nonUrban-WithStructuralSeparation ToOppositeLanes(3)
	Non-Urban	Unknown	nonUrban-NoStructuralSeparation ToOppositeLanes(2)
	Otherwise, if the information about the urban/non-urban status cannot be determined, the data element shall be omitted.		

Table 7: DENM data elements of "Adverse Weather Condition - Precipitation"

Tested by:

2.1.2.8.2 CAM

Requirement

RS_tcAdWe_143

CAM adaption shall not be used for this use case.

Tested by:

2.1.2.9 Networking and Transport Layer

Requirement

RS_tcAdWe_144

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*.

Tested by:

2.1.2.10 Security Layer

Requirement

RS_tcAdWe_146

If the triggering conditions as described in chapter 2.1.2.3 apply, an AT change shall be blocked for new and update DENMs for 15 minutes. Corresponding new and update DENMs shall be sent with the same authorization ticket.

Tested by:

Requirement

RS_tcAdWe_147

If an authorization ticket change appears and there is an active DENM transmission (new or update DENM), the transmission shall be stopped. In addition, the *EventHistory* and the

PathHistory have to be deleted. Afterwards, the regular DENM generation process shall continue. Therefore, a new DENM shall be generated if the triggering conditions (see chapter 2.1.2.3) are satisfied. After the new DENM, update DENMs shall be used in the regular way (see chapter 2.1.2.5).

Tested by:

2.1.2.11 Scenarios

Other (informational)

RS_tcAdWe_194

This section 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 use case:

Count	Description	Status
	tbd	
	tbd	

Table 8: Adverse Weather Condition - Precepitation Scenarios

2.1.3 Adverse Weather Condition - Traction Loss

2.1.3.1 Description of Use Case

Other (informational)

RS_tcAdWe_197

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

Requirement

RS_tcAdWe_148

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

Tested by:

2.1.3.2 Relations to other Use Cases

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

2.1.3.3 Triggering Conditions

2.1.3.3.1 Preconditions

Requirement

RS_tcAdWe_149

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

initialized:

- Reverse gear is not enabled.
- No errors concerning engine, drive train and braking system are reported.

Tested by:

2.1.3.3.2 Use Case Specific Conditions

Requirement

RS_tcAdWe_150

Once at least one of the following conditions is satisfied, the triggering conditions for this use case are fulfilled and the generation of a DENM shall be triggered.

- Positive acceleration:
 - a) ASR, acceleration pedal, vehicle acceleration and vehicle velocity:

An ASR-request must be active for at least 200 ms (according to other safety functions depending on ASR). The acceleration pedal is pressed in average more than 30 % while ASR intervention is active. The acceleration of the vehicle (acceleration according to filtered vehicle bus signal) is less than 40 % of the vehicle acceleration on μ -High (dry asphalt 0.85) at the same start speed and driving maneuver (No detailed values have been put here to incorporate different drive concepts, e.g. two-wheel drive vs. four-wheel drive).
 - b) ASR, acceleration pedal, vehicle acceleration and vehicle velocity:

An ASR-request must be active for at least 200 ms. The acceleration pedal is pressed in average more than 30 % while ASR intervention is active. The acceleration of the vehicle (acceleration according to filtered vehicle bus signal) is less than 20 % of the vehicle acceleration on μ -High (dry asphalt 0.85) at the same start speed and driving maneuver.
 - c) ASR, acceleration pedal, vehicle acceleration and vehicle velocity:

An ASR-request must be active for at least 200 ms. The acceleration pedal is pressed in average more than 30 % while ASR intervention is active. The acceleration of the vehicle (acceleration according to filtered vehicle bus signal) is less than 10 % of the vehicle acceleration on μ -High (dry asphalt 0.85) at the same start speed and driving maneuver.
 - d) ASR and acceleration pedal:

An ASR-request must be active for at least 200 ms. The acceleration pedal is pressed in average less than 30 % (ensure not to cause an ASR intervention on ground with high friction value) while ASR intervention is active.
- Negative acceleration (deceleration):
 - e) 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 deceleration of the vehicle (deceleration according to filtered vehicle bus signal) is less than 50 % of the vehicle deceleration on μ -high (dry asphalt 0.85) at the same start speed and driving maneuver.
 - f) 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 deceleration of the vehicle (deceleration according to filtered vehicle bus signal) is less than 25 % of the vehicle

deceleration on μ -high (dry asphalt 0.85) at the same start speed and driving maneuver.

g) ABS, Braking pressure and Deceleration:

ABS intervention is active for more than 200 ms. Braking pressure is more than 20 % (ensure not to cause an ABS intervention on ground with high friction value) of maximum capable braking pressure. The deceleration of the vehicle (deceleration according to filtered vehicle bus signal) is less than 10 % of the vehicle deceleration on μ -high (dry asphalt 0.85) at the same start speed and driving maneuver.

h) ABS and braking pressure:

ABS intervention is active for more than 200 ms. Braking pressure is less than 20 % of maximum capable braking pressure.

- Friction coefficient estimation:

- i) The friction coefficient is less than 0.3 for at least 5 seconds (the friction coefficient of ice is < 0.2 , the friction coefficient for snow and loose chipping is app. 0.4. The friction coefficient needs to be detected for a certain time period).

- j) The friction coefficient is less than 0.2 for at least 5 seconds.

Tested by:

Requirement

RS_tcAdWe_161

If the conditions a) to c) or e) to g) are evaluated, the vehicle acceleration/deceleration shall be determined by the vehicle bus signal, not by GNSS analysis.

Tested by:

Requirement

RS_tcAdWe_162

A new or update DENM shall not be generated within the *Detection Blocking Time*. The *Detection Blocking Time* is launched after the event is detected and a respective DENM has been triggered. This way, a single event is not able to trigger a series of DENMs. For friction coefficient estimation (condition i) and j)) the *Detection Blocking Time* shall be 15 seconds. For the other conditions the *Detection Blocking Time* shall be 20 s.

Tested by:

Requirement

RS_tcAdWe_163

In order to ensure consistent functional behavior for the different triggering conditions a)-d) and the *Detection Blocking Time*, the *Minimum Detection Interval* between two detected events shall be 20 s.

Tested by:

2.1.3.3.3 Information Quality

Requirement

RS_tcAdWe_164

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)
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

Table 9: Information quality of "Adverse Weather Condition - Traction Loss"

Tested by:

Requirement

RS_tcAdWe_165

If the Triggering Conditions change in 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:

2.1.3.4 Termination Conditions

Requirement

RS_tcAdWe_166

A termination of the use case shall not be considered.

Tested by:

2.1.3.4.1 Cancellation

Requirement

RS_tcAdWe_167

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

Tested by:

2.1.3.4.2 Negation

Requirement

RS_tcAdWe_168

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

Tested by:

2.1.3.5 Update

Requirement

RS_tcAdWe_169

The following rules shall be applied for the update procedure:

If case 1 occurs, the generation of an update DENM shall be triggered. If case 2 or case 3 occurs no update DENM shall be triggered, instead the generation of a new DENM shall be triggered.

Case 1: At least one of the use case specific conditions is fulfilled after the *Minimum Detection Interval*, specified in chapter 2.1.3.3.2. The *validityDuration* of the former DENM is not expired. Neither the value of the data element *DeltaLatitude* nor the value of the data element *DeltaLongitude*, representing the distance between the current detected event and the former detected event, exceeds the threshold that can be covered by the data elements *DeltaLatitude* and *DeltaLongitude* (in current specification of [TS 102 894-2]: 13107 microdegrees):

An update DENM shall be generated. The information of the former DENM data elements (*eventPosition*, *eventDeltaTime*, *informationQuality*) have to be stored in the *eventHistory* by an additional *eventPoint*.

The event points shall be ordered in ascending order with respect to their lifetime with the most recent *eventPoint* at the first position. Event points in the *eventHistory* with lifetimes that exceed the *validityDuration* (see chapter 2.1.3.8.1) shall be deleted from the *eventHistory* for the update DENM. If the distance covered by the *eventHistory* exceeds the threshold that is allowed by the security, the oldest event points shall be deleted from the *eventHistory*.

The information of the current detected event have to be assigned to the DENM data fields of the updated DENM (e.g. *detectionTime* or *informationQuality*, see chapter 2.1.3.8.1).

NOTE: If lifetimes of event points exceed the *validityDuration* after the update DENM has been generated, it is up to the receiver to handle these event points.

Case 2: At least one of the use case specific conditions is fulfilled after the *Minimum Detection Interval*, specified in chapter 2.1.3.3.2. The *validityDuration* of the former DENM is not expired. Either the value of the data element *DeltaLatitude* or the value of the data element *DeltaLongitude*, representing the distance between the current detected event and the former detected event, exceeds the threshold that can be covered by the data elements *DeltaLatitude* and *DeltaLongitude* (in current specification of [TS 102 894-2]: 13107 microdegrees):

No update DENM shall be generated, but an additional new DENM shall be generated. The information of the current detected event have to be assigned to the DENM data fields of the additional new DENM (e.g. *detectionTime* or *informationQuality*, see chapter 2.1.3.8.1). The former DENM shall be continued to be transmitted as long as the *repetitionDuration* (see chapter 2.1.3.6) of the former DENM does not expire.

Case 3: At least one of the use case specific conditions is fulfilled after the *Minimum Detection Interval*, specified in chapter 2.1.3.3.2. The *validityDuration* of the former DENM is expired:

No update DENM shall be generated, but a new DENM according to the currently detected event shall be generated.

NOTE: In this case, the transmission of the former DENM has already been terminated, because the *repetitionDuration* (see chapter 2.1.3.6) of the former DENM is expired.

NOTE: If the use case specific conditions are not fulfilled after the *Minimum Detection Interval* (specified in chapter 2.1.3.3.2), the generation of an update DENM is not necessary. If a former DENM is still active, the transmission has to be continued as long as the *repetitionDuration* of the former DENM is not expired.

Tested by:

2.1.3.6 Repetition Duration and Repetition Interval

Requirement

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.

Tested by:

Requirement

RS_tcAdWe_175

If the DENM is triggered in an urban area, which shall be determined by a digital map or an onboard sensor algorithm, the DENM 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 values above.

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 is expired and the update has not been received yet.

NOTE: The case of managing two DENMs with the same *causeCode* from the same ITS originator shall be handled by the receiving ITS station.

Tested by:

2.1.3.7 Traffic class

Requirement

RS_tcAdWe_176

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

Tested by:

2.1.3.8 Message Parameter

2.1.3.8.1 DENM

Requirement

RS_tcAdWe_177

Table 10 specifies the data elements of the DENM that shall be set.

Data Field	Value
Management Container	
<i>actionID</i>	Identifier of a DENM. Shall be set according to [TS 102 894-2].
<i>detectionTime</i>	<i>Timestampts</i> -Timestamp at which the event is detected by the originating ITS-S. Timestamp is according to the beginning of the detection of the current event point. Shall be set according to [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> pts-Timestamp at which a new DENM or an update DENM is generated. Shall be set according to [TS 102 894-2].		
<i>termination</i>	Shall not be set, because neither negation nor cancellation shall be used in this use case.		
<i>eventPosition</i>	<i>ReferencePosition</i> . Shall be set according to [TS 102 894-2].		
	Shall be refreshed for an update DENM and set to the position of the current event point.		
<i>relevanceDistance</i>	<ul style="list-style-type: none"> • New DENM: lessThan1000m(4) • Update DENM: lessThan5km(5) (By using updates, the distance covered by the <i>eventHistory</i> becomes longer. To address all relevant ITS stations, the <i>relevanceDistance</i> is longer in this case.) 		
<i>relevanceTrafficDirection</i>	allTrafficDirections(0)		
<i>validityDuration</i>	Default: 600 s In urban area, determined by digital map or onboard 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 ITS-S. Shall be set according to [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 only be used for update DENMs (see section 2.1.3.5.).		
Location Container			
<i>traces</i>	<i>PathHistory</i> of the originating ITS-S with reference to the current event point. Shall be set according to [TS 102 894-2]. Shall be refreshed for an update DENM.		
<i>roadType</i>	<i>RoadType</i> of the road the detecting ITS-S 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 according to [TS 102 894-2] in combination with the following rules:		
	Urban / Non-Urban	Structural Separation	Data Element

	Urban	No	urban-NoStructuralSeparation ToOppositeLanes(0)
	Urban	Yes	urban-WithStructuralSeparation ToOppositeLanes(1)
	Urban	unknown	urban-NoStructuralSeparation ToOppositeLanes(0)
	Non-Urban	No	nonUrban-NoStructuralSeparation ToOppositeLanes(2)
	Non-Urban	Yes	nonUrban-WithStructuralSeparation ToOppositeLanes(3)
	Non-Urban	Unknown	nonUrban-NoStructuralSeparation ToOppositeLanes(2)
Otherwise, if the information about the urban/non-urban status cannot be determined, the data element shall be omitted.			

Table 10: DENM data elements of "Adverse Weather Condition - Traction Loss"

Tested by:

2.1.3.8.2 CAM

Requirement

RS_tcAdWe_178

CAM adaption shall not be used for this use case.

Tested by:

2.1.3.9 Networking and Transport Layer

Requirement

RS_tcAdWe_179

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*.

Tested by:

2.1.3.10 Security Layer

Requirement

RS_tcAdWe_181

If the triggering conditions as described in chapter 2.1.3.3 apply, an AT change shall be blocked for new and update DENMs for 15 minutes. Corresponding new and update DENMs shall be sent with the same authorization ticket.

Tested by:

Requirement

RS_tcAdWe_182

If an authorization ticket change appears and there is an active DENM transmission (new or update DENM), the transmission shall be stopped. In addition, the *EventHistory* and the

PathHistory have to be deleted. Afterwards, the regular DENM generation process shall continue. Therefore, a new DENM shall be generated if the triggering conditions (see chapter 2.1.3.3) are satisfied. After the new DENM, update DENMs shall be used in the regular way (see chapter 2.1.3.5).

Tested by:

2.1.3.11 Scenarios

Other (informational)

RS_tcAdWe_206

This section 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 use case:

Count	Description	Status
	tbd	
	tbd	

Table 11: Adverse Weather Condition - Traction Loss Scenarios

3 Appendix

3.1 List of abbreviations

Other (informational)

RS_tcAdWe_209

ABS	Anti-lock Braking System
ASN.1	Abstract Syntax Notation One
ASR	Anti-Slip Regulation
AT	Authorization Ticket
AUT	Automatic Transmission
CAM	Cooperative Awareness Message
C2C-CC	Car to 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
ITS	Intelligent Transport System
ITS-S	ITS Station
KAF	Keep-Alive Forwarding
TC	Triggering Conditions
TTC	Time To Collision
V2V	Vehicle to Vehicle

Table 12: Abbreviations