

Message Set and Triggering Conditions for Road Works Warning Service

Disclaimer:

This document provides a view on the introduction of cooperative ITS in Europe. This version reflects the AG-working group point of view and not necessarily the point of view of the AG umbrella organisations and its stakeholders. However it is the aim, after a consultation process with all members, to have this document agreed by all members.

Document History

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1. Scope and Introduction

1.1. Abstract

This document describes the DENM message specification and triggering conditions for the service Road Works Warning (RWW) for the following use cases:

- Mobile short-term Road Works
- Stationary short-term Road Works
- Stationary long-term Road Works

The specification was agreed between the front runners of C-ITS deployment participating in the Amsterdam Group.

2. References

| Standard | Version used in this document |
|---|-------------------------------|
| EN 302 637-3 | v1.2.2 |
| ETSI TS 102 894-2 | v1.2.1 |
| C2C-CC Distributed Congestion Control (DCC) for Day One | v1.0 |
| Draft C2C-CC Basic System Standards Profile | v1.0.5 |

3. Terms and Abbreviations

3.1. Road Works Safety Trailer / Vehicle

Germany: fahrbare Absperrtafel
Austria: Warnleitanhänger
Netherlands: Actiewagen and Vluchtstrookwagen

3.2. Pre-Warner

Germany: Vorwarntafel
Austria: Vorwarnung
Netherlands: there are different types of Pre-Warners used:

- Pre-Warning vehicle (Mobile VMS on trailer)
- Traffic Signaling system (the permanent system is used);
- Temporarily/mobile signaling system (trailer with mobile gantry)

3.3. Abbreviations

| | |
|-------|---|
| RWW | Road Works Warning |
| RWST | Road Works Safety Trailer |
| TMA | Truck Mounted Attenuator |
| MRS | Mobile Lane Signaling (Mobiele Rijstrook Signalering) |
| TCC | Traffic Control Centre |
| ITS | Intelligent Transport Systems |
| ITS-S | ITS-Station |
| VMS | Variable Message Sign |

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|----|--------------|
| DE | Data Element |
| DF | Data Frame |

4. Verbal forms for the expression of provisions

Extracted from Draft C2C-CC Basic System Standards Profile v1.0.4:

In this document the following verbal forms are used to indicate requirements:

- Shall
- Shall not

Recommendations shall be indicated by the verbal forms:

- Should
- Should not

Permissions shall be indicated by the verbal forms:

- May
- May not

Possibility and capability shall be indicated by the verbal forms:

- Can
- Cannot

Inevitability, used to describe behaviour of systems beyond of scope of this deliverable shall be indicated by:

- Will
- Will not

Facts shall be indicated by the verbal forms:

- Is
- Is not

5. General description of Road Works Warning Use Case

The Road Operator is responsible for executing Road Works on his network. The Road Works may be carried out by subcontractors or by the road operator organization itself. In principle three types of Road Works can be distinguished:

- Mobile short-term
- Stationary short-term
- Stationary long-term

Relevant guidelines for Road Works are:

- Germany: Richtlinien für die Sicherung von Arbeitsstellen an Straßen RSA-95
 - Straßenverkehrsordnung
 - Baustellenmanagementhandbuch Hessen Mobil [1, 2]
 - Phasenpläne Hessen Mobil [3]
- Netherlands: Werk in Uitvoering Pakket 96a/96b
 - Deelpublicatie 970: 'Beleid, proces en basisinformatie'
 - Deelpublicatie 514: 'Maatregelen op autosnelwegen'
 - Deelpublicatie 972: 'Maatregelen naast de rijbaan'
 - Deelpublicatie 973: 'Maatregelen op de rijbaan'
 - Deelpublicatie 974: 'Maatregelen op fietspaden en voetpaden'
 - Deelpublicatie 975: 'Maatregelen op kruispunten en rotondes'
 - Deelpublicatie 976: 'Omleidingen en tijdelijke bewegwijzering'
 - Deelpublicatie 515: 'Specificaties voor materiaal en materieel'
 - Deelpublicatie 990: 'Maatregelen bij spoorwegovergangen'
 - Deelpublicatie 991: 'Verkeersregelaars bij wegwerkzaamheden'
- Austria:
 - Straßenverkehrsordnung
 - RVS 05.05.42
 - RVS 05.05.43

The guidelines include the formal definition of the work zone layout. The documents contain general descriptions. Work plans for specific Road Works are taken from the guidelines mentioned above.

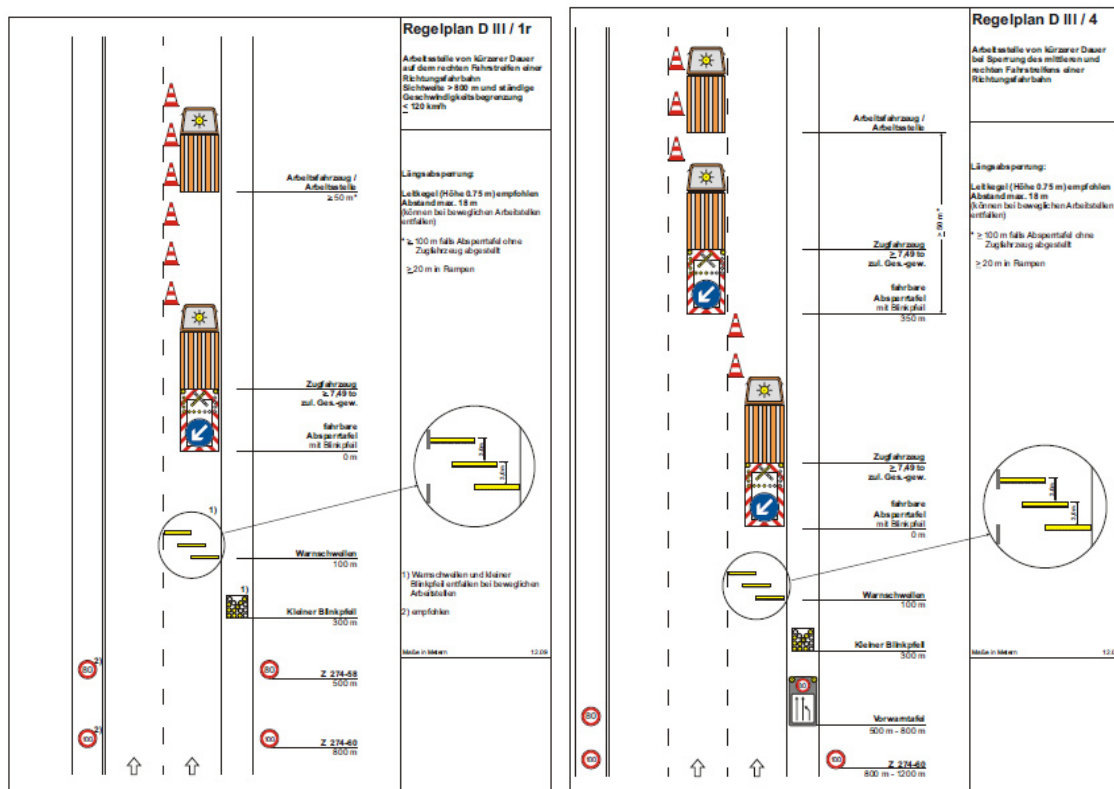
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5.1. Short-term Road Works

In general short-term Road Works are secured by a Road Works Safety Trailer and an optional Pre-Warner. In this version of the white paper, the Pre-Warner is assumed to be not equipped with C2X hardware. Therefore, details with regards to Pre-Warner C2X behavior are not considered. On day one, only the Road Works Safety Trailer can be safely assumed to transmit information about the Road Works to approaching vehicles / nomadic devices in the whole corridor.

The topology of short-term road works may include one or more lanes also including the hard-shoulder, which may be closed. For each blocked lane a separate trailer is positioned. The lanes can also be reformed. Such changes in the lane topology are indicated on the Pre-Warner.

Examples (from RSA-95):



5.1.1. Differentiation Stand-Alone vs. Basic RWW Service

As there will be no map available on the trailer and there will be no daily preparation of the trailers with details on upcoming road works and its parameters, the trailer has only a limited set of information available. However, trailers are connected to the back-office through cellular networks. Depending on the availability of cellular networks the trailer can get additional information from the back-office.

Therefore, two operation modes of the trailer in short term road works are defined as follows:

Stand-Alone Service: Only limited information is available (e.g. position of trailer, arrow position – for details see later chapters)

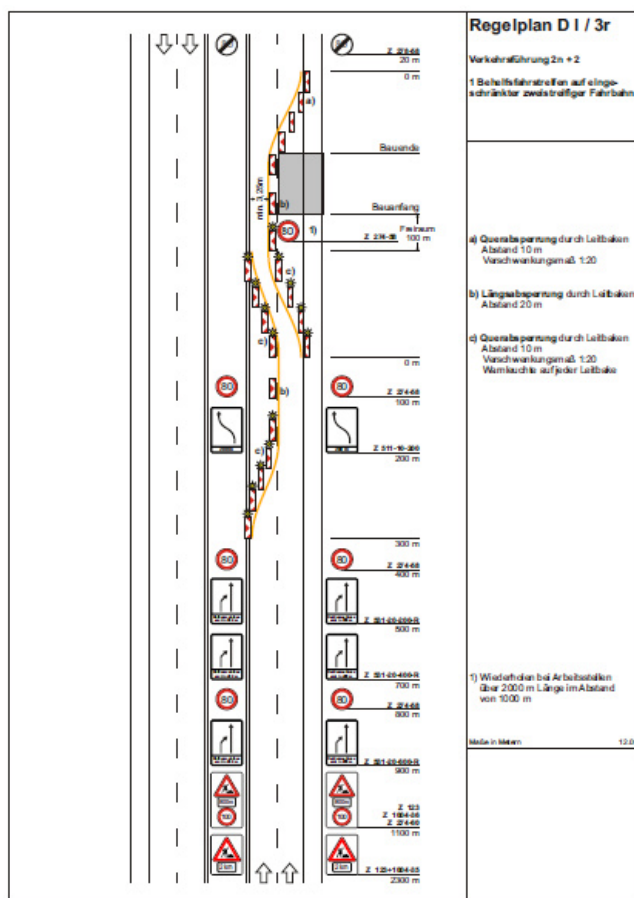
Basic Service: Stand-alone information plus additional information from backend (e.g. closed lane, type of Road Work – for details see later chapters)

5.2. Long-term Road Works

Long-term Road Works are not always secured by a Road Works Safety Trailer. Nevertheless, there will be one or more ITS-Stations transmitting information about the Road Works to approaching vehicles / nomadic devices.

Topology: one or more lanes incl. the hard-shoulder may be closed. Lanes might be deviated.

Example:



5.3. Mobile Road Works

Road Works can be moving activities like cutting grass or renewing lane markings. In this case, a slowly moving trailer is securing the mobile road works. Mobile Road Works are always short-term.

5.4. Stationary Road Works

Most Road Works are stationary i.e. are not moving. They have a fixed start and end point.

6. Message description (DENM profile) Road Works Warning

This chapter presents the DENM data fields as standardized in EN 302 637-3 (see Table 1) together with RWW alacarte container. It provides the specification and interpretation of the corresponding content for the existing data fields. In case there are differences in terms of preparation and interpretation of those data fields with respect to RWW type, those are then written in *italics*.

6.1. Data Fields used in all Use Cases

| Management Container | | UC |
|-----------------------|---|-------|
| Data Field | Description and Content | |
| referenceTime | referenceTime is set according to the definition in Annex B.39 of EN 302 637-3. It is the time when RWW DENM is initially generated by the DEN basic service at the facilities layer. In case of a repetition of a DENM the referenceTime shall not be changed. In case of an update, the referenceTime shall also be updated by the actual time value at the DEN basic service. This DE is common to all Road Work types. | 1,2,3 |
| actionID | actionID is set According to the protocol data setting rules defined in EN 302 637-3. actionID enables distinguishing among different events of the same ITS-S and other ITS-Ss. This DE is common to all Road Work types. | 1,2,3 |
| <i>detectionTime</i> | <i>Detection time is set according to the rules defined in EN 302 637-3, Annex B.10. It is the time at which Road Work starts at a functional level. It shall be refreshed for an update and a cancellation DENM as defined in sections 7.1, 7.2 and 7.3.</i> | 1,2,3 |
| <i>termination</i> | <i>This DF consists of the DE isNegation and isCancellation</i> | 1,2,3 |
| isNegation | The DE is not used for Road Works Warning for the Day One implementations. Therefore, it is set to FALSE. | - |
| <i>isCancellation</i> | <i>This flag is set to TRUE in case the function that detected the event determines that the event has ended, as defined in EN 302 637-3. The use of this flag may be avoided by setting sufficiently small validityDuration. Otherwise, the triggering conditions as defined in sections 7.1, 7.2 and 7.3 apply for sending isCancellation. The parameters repetitionDuration and validityDuration shall be kept the same as the original event message for an isCancellation message.</i> | 1,2,3 |

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| transmissionInterval | This DE is not used for Road Works Warning for the Day One implementations. | - | | | | | | | | | | | | | | |
|---------------------------------|--|------------|-------------|----------------|----------------|-------------------|-------------------------|--------------------|-------------|------------------------------|----------------------|---------------------------------|--------------------------|-------------------|-------------|-------|
| eventPosition | Geographical position of the detected event as defined in sections 7.1, 7.2 and 7.3. | 1,2,3 | | | | | | | | | | | | | | |
| relevanceDistance | Distance in which the Road Works Warning is relevant for the receiving ITS Station as defined in sections 7.1, 7.2 and 7.3. | 1,2,3 | | | | | | | | | | | | | | |
| relevanceTrafficDirection | Traffic direction along which the event information is relevant for the receiver. It is set to upStreamTraffic(1) for RWW. This DE is common to all Road Work types. | 1,2,3 | | | | | | | | | | | | | | |
| validityDuration | Time at which DENM should be deleted with an offset since detectionTime of the event as defined in sections 6.3, 7.1, 7.2 and 7.3. | 1,2,3 | | | | | | | | | | | | | | |
| stationType | Type of originating ITS Station as defined in sections 7.1, 7.2 and 7.3 | 1,2,3 | | | | | | | | | | | | | | |
| Situation Container | | | | | | | | | | | | | | | | |
| informationQuality | This DE is used as defined in EN 302 637-3 and it is determined and set as defined in Section 0. | 1,2,3 | | | | | | | | | | | | | | |
| eventType | <p>This DF is set using the DE causeCode as defined in ETSI TS 102 894-2, which is composed of two data types, the causeCode and the subCauseCode.</p> <p>For RWW the causeCode is set to 3.</p> <p>Current RWW implementations foresee 3 Road Work types, which can be indicated with a subCauseCode as follows. For subCauseCode the following mapping of the DENM / CDD to the Road Works Warning Use Case is used:</p> <table><tr><th>DENM / CDD</th><th>White Paper</th></tr><tr><td>unavailable(0)</td><td>0: unavailable</td></tr><tr><td>majorRoadworks(1)</td><td>1: long-term stationary</td></tr><tr><td>roadMarkingWork(2)</td><td>2: not used</td></tr><tr><td>slowMovingRoadMaintenance(3)</td><td>3: short term mobile</td></tr><tr><td>shortTermStationaryRoadworks(4)</td><td>4: short term stationary</td></tr><tr><td>streetCleaning(5)</td><td>5: not used</td></tr></table> | DENM / CDD | White Paper | unavailable(0) | 0: unavailable | majorRoadworks(1) | 1: long-term stationary | roadMarkingWork(2) | 2: not used | slowMovingRoadMaintenance(3) | 3: short term mobile | shortTermStationaryRoadworks(4) | 4: short term stationary | streetCleaning(5) | 5: not used | 1,2,3 |
| DENM / CDD | White Paper | | | | | | | | | | | | | | | |
| unavailable(0) | 0: unavailable | | | | | | | | | | | | | | | |
| majorRoadworks(1) | 1: long-term stationary | | | | | | | | | | | | | | | |
| roadMarkingWork(2) | 2: not used | | | | | | | | | | | | | | | |
| slowMovingRoadMaintenance(3) | 3: short term mobile | | | | | | | | | | | | | | | |
| shortTermStationaryRoadworks(4) | 4: short term stationary | | | | | | | | | | | | | | | |
| streetCleaning(5) | 5: not used | | | | | | | | | | | | | | | |

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| | winterService(6) | |
| | <i>Differences in terms of triggering conditions and the interpretations of the individual data elements are defined in sections 7.1, 7.2 and 7.3.</i> | |
| linkedCause | This DF is not used for Road Works Warning for the Day One implementations. | - |
| eventHistory | <p><i>This DF contains a list of event points, which represent the dimension of a plain event. This DF is used to model the segments of a Road Works as defined in sections 7.1, 7.2 and 7.3.</i></p> <p><i>In case that the road works site is longer than 1000m, the eventHistory is filled so that it still covers the end of the road works site, this might result in a gap between the eventPosition (start of road works) and the first point of eventHistory.</i></p> | 1b,2b,3 |
| Location Container | | |
| eventSpeed | <i>This DF is the actual speed of the Road Works trailer. It is determined and set as defined in sections 7.1, 7.2 and 7.3.</i> | 1 |
| EventPositionHeading | <i>This DF defines the heading direction of Road Works with regards to North (In degrees) as defined in sections 7.1, 7.2 and 7.3.</i> | 1 |
| traces | <p><i>Set of consecutive positions leading to the Road Works position according to definition in Annex B.52 of EN 302 637-3</i></p> <p><i>Traces will only be available on the accuracy level of a carriage way and might have an offset to the actual event position</i></p> <p><i>This DF is determined and set as defined in sections 7.1, 7.2 and 7.3.</i></p> | 1,2,3 |
| roadType | This DE is not used for Road Works Warning for the Day One implementations. | - |
| RWW Alacarte Container | | |
| lightBarSirenInUse | This DE is not used for Road Works Warning for the Day One implementations. | - |
| closedLanes | <i>This DF is Optional and indicates the closure of one or several lanes as defined in EN 302 637-3. In case of no connection with</i> | 1b,2b, |

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| | | |
|-------------------------|--|---------|
| | <p><i>the Traffic Control Centre this information is not available on the Road Works Safety Trailer. In case of a connection to Traffic Control Centre, this information might be available.</i></p> <p><i>Note: This DF is always set to closedLanes.HardShoulderStatus = "closed" when DENM alacarte Road Works Warning container is used to describe the pre-warner.</i></p> <p><i>This DF is determined and set as defined in sections 7.1, 7.2 and 7.3.</i></p> | 3 |
| restriction | This DF is not used for Road Works Warning for the Day One implementations. Information about restriction is to be transmitted using IVS messages. | - |
| speedLimit | <p><i>This DE is optional and describes applicable speed limits in the Road Works.</i></p> <p><i>This DE is determined and set as defined in sections 7.1, 7.2 and 7.3.</i></p> | 1b,2b,3 |
| incidentIndication | This DE is not used for Road Works Warning for the Day One implementations. | - |
| recommendedPath | This DF is not used for Road Works Warning for the Day One implementations. | - |
| startingPointSpeedLimit | <p><i>This DF is optional and depicts the starting point of speed limits applicable in the Road Works. This DF allows to set a different starting point for the speed limit than for the Road Works event.</i></p> <p><i>This DF is determined and set as defined in sections 7.1, 7.2 and 7.3.</i></p> | 1b,2b,3 |
| trafficFlowRule | <p><i>This DF is optional and indicates on which side vehicles may pass the Road Works Safety Trailer (depending on the arrow sign configuration on the trailer).</i></p> <p><i>Note: This DF is not used for Road Works Warning DENMs referring to the pre-warner.</i></p> <p><i>This DF is determined and set as defined in sections 7.1, 7.2 and 7.3.</i></p> | 1,2,3 |
| referenceDenms | <p><i>This DF is optional and is used to link different DENM messages that describe the same Road Works Warning event.</i></p> <p><i>This DF is determined and set as defined in sections 7.1, 7.2 and</i></p> | 1b,2b,3 |

| | | |
|--|------|--|
| | 7.3. | |
|--|------|--|

Table 1 DENM as standardized in EN 302 637-3 and corresponding content

Some implementations of road works not only use the Road Works Warning alacarte container. Those national specific examples are not part of the general description in the subsequent chapters and are described in detail in chapter 8.

6.2. Information Quality

The value of the data element informationQuality in the DENM depends on the way the event is detected and validated. This might be different for each RWW type depending on the actual situation on the field.

Following options are determined as indicators for the quality of transmitted information:

- a) eventPosition: planned position (by road operator)
- b) eventPosition: simple GNSS
- c) eventPosition: differential GNSS
- d) *eventPosition: validated position (e.g. map-matching)*
- e) traces: planned position (by road operator)
- f) traces: simple GNSS
- g) traces: differential GNSS
- h) *traces: validated positions (e.g. map-matching)*

The informationQuality value shall be set according to the following criteria:

| Class | Criteria |
|-------|------------------------------------|
| 0 | Not defined |
| 1 | a AND e (planned by road operator) |
| 2 | b AND f (simple GNSS) |
| 3 | c AND g (differential GNSS) |
| 4 | d AND h (validated positions) |
| 5 | Not defined |
| 6 | Not defined |
| 7 | Not defined |

6.3. Repetition Interval

The value for the repetitionInterval shall be set in accordance with the applicable Decentralized Congestion Control (DCC) algorithm. Values shall be in the range between 0,1 and 0.5sec. In the future the repetition interval of the warning messages should fulfill the following two constraints:

- The interval has to be low enough such that the receivers can receive the packet with a sufficiently high probability at defined distances. Both the distance as well as the probability level

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depends on functional requirements. In case of RWW, a distance of 500 meters with a Successful Transmission Ratio of 90% per second is required.

- Trying to send more messages than Decentralized Congestion Control (DCC) Algorithm allows would unnecessarily overload the system. Therefore, the repetition interval should be high enough to avoid producing messages that cannot be sent on time. The DCC rules for day one implementations can be found in "C2C-CC Decentralized Congestion Control (DCC) for Day One". For Traffic Class (TC) 1, repetition interval (T_{rx}) has been defined to be between 95ms and 250ms, depending on the channel load. Therefore, also the repetition interval should be chosen within this window.

In order to calculate the required message frequency, the repetition interval algorithm, which is defined below, shall be used

- after new event detection (excluding updates),
- in case of a 20% change in the estimated parameter " e_E " (see below $SQ_{t,AB}$), relative to the current estimation of " e " and
- in case of an absolute change in the measured channel load value by 5%.

Calculation of the Repetition Interval:

1. Calculate estimated signal quality at 500 meters distance to the originator ITS-S (road works safety trailer). Since ETSI G5 is based on broadcasting; the ITS-S does not have the possibility to know the exact receiver signal quality. Therefore, it shall be assumed that the channel behavior is symmetric. The signal quality at the receiver side shall be estimated as follows:

$$SQ_{t,AB} = AG_B + TP_{t,AB} - v * \log_{10}(d_{t,AB}) - w + e_E,$$

where $SQ_{t,AB}$ is the estimated signal quality in dBm at time t and at point B, which is 500 meters away from the sender at point A. AG is the antenna gain (in dBm) of the sender, TP is the transmission power (dBm), $d_{t,AB}$ is the distance between points A and B in meters (for RWW this variable is set to 500 meters), e_E is the average error calculated for the specific environment, whose calculation is explained in the next subsection. " v " and " w " are constants. As default, " v " shall be set to 20.3759 and " w " shall be set to 58.66 dBm.

2. Estimate the successful transmission probability using the following formula:

$$P_r = \frac{1}{1 + e^{a+b SQ + c CL}},$$

where P_r is the successful transmission probability (defined within the interval [0,1]), CL is the channel load measured at the time of transmission (defined within the interval [0,1]), SQ is the estimated signal quality as defined at Step 1 and " a ", " b " and " c " are respective coefficients. As default " a " shall be set to -18.4879, " b " to -0.20341 and " c " to 5.94928.

3. Calculate the required message frequency f using the following formula:

$$f = \frac{\log(1-P_y)}{\log(1-P_r)},$$

where P_y is the target probability (defined within the interval [0,1]).

4. Set the repetition interval to larger of $1/f$ or T_{TX} as defined by the DCC algorithm. In case the calculated repetition interval is larger than T_{TX} , alternatively, the transmit power can be increased and required repetition interval can be recalculated as described above.

Calculation of the error “eE”:

1. The parameter e_E shall be calculated by using the historical information about the received packets sent by approaching vehicles.
 - i) An estimation error shall be calculated using $SQ_{t,AB}$ at most once per second for the last packet, which is received from a distance of 500 ± 200 meters from the ITS-S and also which is within the relevance area. In case less packets are received than once per second, estimation error shall be calculated for each received packet.
 - ii) The antenna gain of the sender vehicle should be assumed to be zero.
 - iii) In case the received packet is a TC_0 packet, the transmission power of the sender shall be assumed to be 25dBm. In case of other traffic classes, the transmit power should be assumed to be 23dBm, as defined by “C2C-CC Decentralized Congestion Control (DCC) for Day One”.
 - iv) e_E should be calculated as the moving average of the last 100 estimation errors.

7. Triggering Conditions Road Works Warning

The individual countries have different procedures for setting up, running and finally removing Road Works equipment. Although partially similar guidelines for the layouts of the Road Works are used (for details see Richtlinie zur Sicherung von Arbeitsstellen RSA-95, Werk in Uitvoering Pakket 96a/96b, RVS), the process to accomplish those layouts as well as to remove all required equipment for a specific layout are only partially fixed in guidelines. A detailed description of the processes can be found in Annex A. For this reason, it was agreed between Road Operators to use already existing unambiguous triggers of a non C-ITS Road Works, as summarized in Table 2.

| | start sending DENM | update DENM | stop sending DENM |
|---|---|---|---|
| stand-alone mode of short-term road works | ... is triggered by: <ul style="list-style-type: none"> - signboard of RWST is opened or attenuator (TMA) is lowered - pre-warner is activated → DENM is sent as soon as sign board is visible or flashers are on. Alternatively the stand-alone mode is started when the system is in basic mode and the connection to the traffic control centre is lost | ... is triggered by: <ul style="list-style-type: none"> - change of position¹ - change of arrow sign configuration → DENM is updated when content changes DENM is updated if (validityDuration – (currentTime – referenceTime) < 2 sec) DF that trigger the update are modified | ... is triggered by: <ul style="list-style-type: none"> - signboard of RWST is closed or attenuator (TMA) is lifted - pre-warner is de-activated → DENM is no longer sent as soon as sign board is no longer visible / flashers are off Alternatively the stand-alone mode is stopped and basic mode is started when the RWST is connected to the traffic control centre and receives enhanced information |
| basic mode of short-term road works | ... is triggered by: <ul style="list-style-type: none"> - connection established between RWST and traffic control centre → DENM is sent as soon as enhanced information from the traffic control centre is available. | ... is triggered by: <ul style="list-style-type: none"> - change of position¹ - change of arrow sign configuration - updated information from the traffic control centre → DENM is updated when content changes DENM is updated if (validityDuration – (currentTime – referenceTime) < 2 sec) DF that trigger the update are modified | ... is triggered by: <ul style="list-style-type: none"> - signboard of RWST is closed or attenuator (TMA) is lifted - pre-warner / MRS is de-activated → DENM is no longer sent as soon as sign board is no longer visible / flashers are off Alternatively the basic mode is stopped and stand-alone mode is started when the connection to the traffic control centre is lost |
| stationary long-term | <i>Use Case is not implemented on Day 1</i> | <i>Use case is not implemented on Day 1</i> | <i>Use case is not implemented on Day 1</i> |

¹ details on conditions for actually updating the DENM based on position changes can be found in chapter 7.1.1.3, 7.1.2.3, 7.2.1.3, 7.2.2.3

Table 2 Summary of Triggering Conditions for Road Works Warning

Note:

In general the Road Work Safety Trailer is used to set up and close down short-term road works. Therefore it is possible that although the respective road works is a stationary short-term road works the trailer is moving during the set up and close down phase. As described above the DENM is triggered based on Road Works Safety Trailer innate processes. Hence DENM updates may be triggered by changed position or changed arrow signs in a stationary road works. Example descriptions of the whole activity including set up and close down can be found in Reference [3] page 27 to 36. The subCauseCode which only can be set based on information available from the traffic control centre is not affected when the DENM is updated.

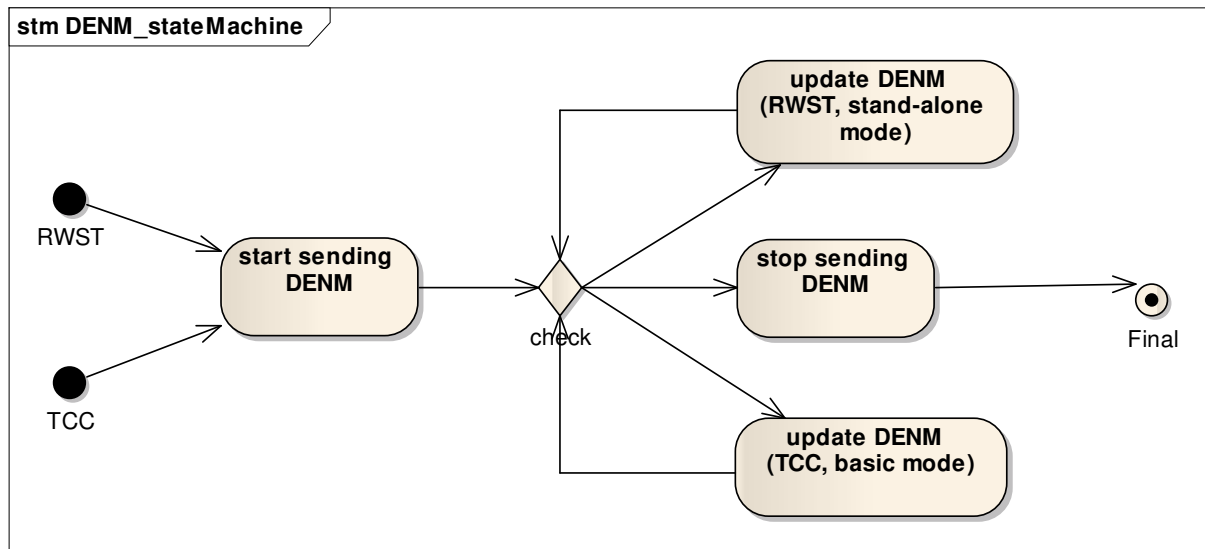


Figure 1 State machine visualizing the description from Table 2

7.1. Definition of Data Elements for Short-Term Mobile Road Works

7.1.1. Stand-Alone Service

7.1.1.1. Triggering Conditions

Road Works Warning Message shall be triggered when sign board on the Road Works Safety Trailer is opened or when the attenuator of the Truck Mounted Attenuator is lowered. In case that a pre-warner is used, the activation of the pre-warner shall serve as a Triggering Condition.

The setup of other visible (physical = signs, flash lights) warnings for the Road Works may serve as an additional Triggering Condition.

Alternatively the stand-alone mode is started when the system is in basic mode and the connection to the traffic control centre is lost.

7.1.1.2. Termination Conditions

Sending of the Road Works Warning Message shall stop / end when sign board on the Road Works Safety Trailer is closed or when the attenuator of the Truck Mounted Attenuator is lifted. In case that a pre-warner is used, the de-activation of the pre-warner shall serve as Triggering Condition.

In case other visible (physical = signs, flash lights) warnings for the Road Works have been used as a Triggering Condition, shutting down those shall trigger a termination, in case none of the triggering conditions are active as defined in 7.1.1.1.

Alternatively the stand-alone mode is stopped and basic mode is started when the Road Works Safety Trailer is connected to the traffic control centre and receives enhanced information

7.1.1.3. Update

An update of the Road Works Warning Message is sent in case that the position of the Road Works Safety Trailer changes at least by 4 meters².

If the arrow-sign configuration changes an update of the Road Works Warning Message shall be sent.

In case of a change in one of the data fields of RWW alacarte container, an update shall be sent.

An update of the Road Works Warning Message shall be sent if (validityDuration – (currentTime – referenceTime) < 2 sec).

7.1.1.4. Repetition

The repetition rate shall be set as defined in Section 6.3.

7.1.1.5. Traffic Class

² value set according to Profile document v 1.0.4 CAM – FAC13:
The MAX_DDISTANCE representing the delta distance (in meters) between two generation rules checks shall use a value of 4 m.

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This value shall be set to 1.

7.1.1.6. Information Quality

This value shall be set as defined in Section 6.2.

7.1.1.7. Message Parameters

| Management Container | |
|-------------------------|--|
| relevanceDistance | lessThan5km |
| eventPosition | This DF is set to the actual position of the RWW vehicle/trailer (Data type ReferencePosition in WGS 84 as defined by ETSI TS 102 894-2). |
| validityDuration | 1s |
| stationType | roadSideUnit(15) |
| Situation Container | |
| eventType | causeCode: 3 (Road Works) subCauseCode: 0 (unavailable) |
| eventHistory | This DF is set to the maximum length of the vehicle / trailer combination. |
| Location Container | |
| eventSpeed | This DF is set to the current speed of road works |
| EventPositionHeading | This DF is set to the heading direction of Road Works |
| traces | Point of the traces come from the positioning module of the trailer |
| RWW Alacarte Container | |
| closedLanes | This DF is not available in standalone service. For use with pre-warner see Fehler! Verweisquelle konnte nicht gefunden werden.. |
| speedLimit | This DF is not available in standalone service. |
| startingPointSpeedLimit | This DF is not available in standalone service, |
| trafficFlowRule | This DF is set to passToRight(2) (both arrow signs to the right) or passToLeft(3) (sheet metal sign to the left). For use with pre-warner see Fehler! Verweisquelle konnte nicht gefunden werden.. |

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| | |
|----------------|---|
| referenceDenms | This DF is not available in standalone service. |
|----------------|---|

7.1.2. Basic Service

7.1.2.1. Triggering Conditions

7.1.2.2. Road Works Warning Message shall be triggered when a connection between Road Works Safety Trailer and traffic control centre is established and enhanced information from the traffic control centre is available on the Road Works Safety Trailer. Termination Conditions

Sending of the Road Works Warning Message shall stop / end when sign board on the Road Works Safety Trailer is closed or when the attenuator of the Truck Mounted Attenuator is lifted. In case that a pre-warner is used, the de-activation of the pre-warner shall serve as Triggering Condition.

In case other visible (physical = signs, flash lights) warnings for the Road Works have been used as a Triggering Condition, shutting down those shall trigger a termination, in case none of the triggering conditions are active as defined in 7.1.2.1.

Alternatively the basic mode is stopped and stand-alone mode is started when the connection to the traffic control centre is lost.

7.1.2.3. Update

An update of the Road Works Warning Message is sent in case that the position of the Road Works Safety Trailer changes at least by 4 meters³.

If the arrow-sign configuration changes an update of the Road Works Warning Message shall be sent.

In case of a change in one of the data fields of RWW alacarte container, an update shall be sent.

In case that updated information from the Traffic Control Centre is available on the trailer, the updated information shall be broadcasted.

An update of the Road Works Warning Message shall be sent if $(\text{validityDuration} - (\text{currentTime} - \text{referenceTime})) < 2 \text{ sec}$.

7.1.2.4. Repetition

The repetition rate shall be set as defined in Section 6.3.

7.1.2.5. Traffic Class

This value shall be set to 1.

³ value set according to Profile document v 1.0.4 CAM – FAC13:
The MAX_DDISTANCE representing the delta distance (in meters) between two generation rules checks shall use a value of 4 m.

7.1.2.6. Information Quality

This value shall be set as defined in chapter 0

7.1.2.7. Message Parameters

| Management Container | |
|-------------------------|---|
| relevanceDistance | lessThan5km |
| eventPosition | This DF is set to the actual position of a RWW vehicle/trailer (Data type ReferencePosition in WGS 84 as defined by ETSI TS 102 894-2). |
| validityDuration | 1s |
| stationType | roadSideUnit(15) |
| Situation Container | |
| eventType | causeCode: 3 (Road Works) subCauseCode: 3 (short-term mobile) |
| eventHistory | This DF is set to describe the Road Works segment. |
| Location Container | |
| eventSpeed | This DF is set to the current speed of road works |
| EventPositionHeading | This DF is set to the heading direction of Road Works |
| traces | Points of the traces come from the positioning module of the trailer OR Points of the traces come from a road works management database Options can be combined. |
| RWW Alacarte Container | |
| closedLanes | This DF is optionally available from the TCC. For use with pre-warner see Fehler! Verweisquelle konnte nicht gefunden werden.. |
| speedLimit | This DF is optionally set to the applicable speed limit. |
| startingPointSpeedLimit | This DF is optionally set to the starting position of the applicable speed limit. |
| trafficFlowRule | This DF is set to passToRight(2) (both arrow signs to the right) or passToLeft(3) (sheet metal sign to the left). For use with pre-warner see Fehler! Verweisquelle konnte nicht gefunden werden.. |

| | |
|---------------|--|
| referenceDems | This DF is filled by the traffic control centre. Each DENM includes a list with other DENM actionIDs belonging to the same Road Works event. |
|---------------|--|

7.2. Definition of Data Elements for Short-Term Stationary Road Works

7.2.1. Stand-Alone Service

7.2.1.1. Triggering Conditions

Sending of the Road Works Warning Message shall start when sign board on the Road Works Safety Trailer is opened or when the attenuator of the Truck Mounted Attenuator is lowered. In case that a pre-warner / MRS is used, the activation of the pre-warner / MRS shall serve as Triggering Condition.

The setup of other visible (physical = signs, flash lights) warnings for the Road Works may serve as an additional Triggering Condition.

Alternatively the stand-alone mode is started when the system is in basic mode and the connection to the traffic control centre is lost.

7.2.1.2. Termination Conditions

Sending of the Road Works Warning Message shall stop / end when sign board on the Road Works Safety Trailer is closed or when the attenuator of the Truck Mounted Attenuator is lifted. In case that a pre-warner / MRS is used, the de-activation of the pre-warner / MRS shall serve as Triggering Condition.

In case other visible (physical = signs, flash lights) warnings for the Road Works have been used as a Triggering Condition, shutting down those shall trigger a termination, in case none of the triggering conditions are active as defined in 7.2.1.1.

Alternatively the stand-alone mode is stopped and basic mode is started when the Road Works Safety Trailer is connected to the traffic control centre and receives enhanced information

7.2.1.3. Update

During the setting up and closing down procedures of the stationary Road Works there might be changes in the position and / or arrow sign configuration. An update of the Road Works Warning Message is sent in case that the arrow sign configuration of the Road Works Safety Trailer changes. Only with position changes of 4m an updated DENM shall be generated².

In case of a change in one of the data fields of RWW alacarte container, an update shall be sent.

An update of the Road Works Warning Message shall be sent if $(\text{validityDuration} - (\text{currentTime} - \text{referenceTime})) < 2 \text{ sec}$.

7.2.1.4. Repetition

The repetition rate shall be set as defined in Section 6.3.

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7.2.1.5. Traffic Class

This value shall be set to 1.

7.2.1.6. Information Quality

This value shall be set as defined in Section 6.2.

7.2.1.7. Message Parameters

| Management Container | |
|-------------------------|--|
| relevanceDistance | lessThan5km |
| eventPosition | This DF is set to the actual position of the RWW vehicle/trailer (Data type ReferencePosition in WGS 84 as defined by ETSI TS 102 894-2). |
| validityDuration | 60s |
| stationType | roadSideUnit(15) |
| Situation Container | |
| eventType | causeCode: 3 (Road Works) subCauseCode: 0 (unavailable) |
| eventHistory | This DF is set to the maximum length of the vehicle / trailer combination. |
| Location Container | |
| eventSpeed | This DF is set to the current speed of road works |
| EventPositionHeading | This DF is set to the heading direction of Road Works |
| traces | Point of the traces come from the positioning module of the trailer |
| RWW Alacarte Container | |
| closedLanes | This DF is not available in standalone service. For use with pre-warner see Fehler! Verweisquelle konnte nicht gefunden werden.. |
| speedLimit | This DF is not available in standalone service. |
| startingPointSpeedLimit | This DF is not available in standalone service, |
| trafficFlowRule | This DF is set to passToRight(2) (both arrow signs to the right) or passToLeft(3) (sheet metal sign to the left). For use with pre-warner see Fehler! Verweisquelle konnte nicht gefunden werden.. |
| referenceDenms | This DF is not available in standalone service. |

7.2.2. Basic Service

7.2.2.1. Triggering Conditions

Sending of the Road Works Warning Message shall start when a connection between Road Works Safety Trailer and traffic control centre is established and enhanced information from the traffic control centre is available on the Road Works Safety Trailer.

7.2.2.2. Termination Conditions

Sending of the Road Works Warning Message shall stop / end when sign board on the Road Works Safety Trailer is closed or when the attenuator of the Truck Mounted Attenuator is lifted. In case that a pre-warner / MRS is used, the de-activation of the pre-warner / MRS shall serve as Triggering Condition.

In case other visible (physical = signs, flash lights) warnings for the Road Works have been used as a Triggering Condition, shutting down those shall trigger a termination, in case none of the triggering conditions are active as defined in 7.2.2.1.

Alternatively the basic mode is stopped and stand-alone mode is started when the connection to the traffic control centre is lost.

7.2.2.3. Update

During the setting up and closing down procedures of the stationary Road Works there might be changes in the position and / or arrow sign configuration. An update of the Road Works Warning Message is sent in case that the arrow sign configuration of the Road Works Safety Trailer changes. Only with position changes of 4m an updated DENM shall be generated.

In case that updated information from the Traffic Control Centre is available on the trailer, the updated information is broadcasted.

An update of the Road Works Warning Message shall be sent if $(\text{validityDuration} - (\text{currentTime} - \text{referenceTime})) < 2 \text{ sec}$.

7.2.2.4. Repetition

The repetition rate shall be set as defined in Section 6.3.

7.2.2.5. Traffic Class

This value shall be set to 1.

7.2.2.6. Information Quality

This value shall be set as defined in chapter 0

7.2.2.7. Message Parameters

| Management Container | |
|-------------------------|---|
| relevanceDistance | lessThan5km |
| eventPosition | This DF is set to the actual position of the RWW vehicle/trailer (Data type ReferencePosition in WGS 84 as defined by ETSI TS 102 894-2). |
| validityDuration | 60s |
| stationType | roadSideUnit(15) |
| Situation Container | |
| eventType | causeCode: 3 (Road Works) subCauseCode: 4 (short-term stationary) |
| eventHistory | This DF is set to describe the Road Works segment. |
| Location Container | |
| eventSpeed | This DF is set to the current speed of road works |
| EventPositionHeading | This DF is set to the heading direction of Road Works |
| traces | Points of the traces come from the positioning module of the trailer OR Points of the traces come from a road works management database Options can be combined. |
| RWW Alacarte Container | |
| closedLanes | This DF is optionally available from the TCC For use with pre-warner see Fehler! Verweisquelle konnte nicht gefunden werden.. |
| speedLimit | This DF is optionally set to the applicable speed limit. |
| startingPointSpeedLimit | This DF is optionally set to the starting position of the applicable speed limit. |
| trafficFlowRule | This DF is set to passToRight(2) (both arrow signs to the right) or passToLeft(3) (sheet metal sign to the left). For use with pre-warner see Fehler! Verweisquelle konnte nicht gefunden werden.. |
| referenceDenms | This DF is filled by the traffic control centre. Each DENM includes a list with other DENM actionIDs belonging to the same Road Works event. |

7.3. Definition of Data Elements for Long-Term Stationary Road Works – currently out of scope

This scenario is currently out of scope and will be added in a later version of this document.

7.3.1. Triggering Conditions

7.3.2. Termination Conditions

7.3.3. Update

7.3.4. Repetition

The repetition rate is set as defined in Section 6.3.

7.3.5. Traffic Class

Traffic Class is set to 1.

7.3.6. Information Quality

This value shall be set as defined in chapter

7.3.7. Message Parameters

| Management Container | |
|----------------------|--|
| relevanceDistance | |
| eventPosition | <i>In scenarios without trailers and for long-term stationary RWW, the reference must be provided from a road works database in the Traffic Centre and should be validated (e.g. by manual measurement).</i> |
| validityDuration | <i>application layer needs to deal with long term road works > 24 hours</i> |
| Location Container | |
| eventSpeed | |
| EventPositionHeading | |
| traces | |

8. Example scenarios

This informative chapter shall help to understand the use of the previously specified Triggering Conditions (chapter 7). Typical examples for road works design are presented – the corresponding DENMs are included.

Disclaimer: the examples in the subsequent subchapters were developed by the respective countries and not the Amsterdam Group Task Force.

8.1. Short-Term mobile – stand alone

8.1.1. Netherlands

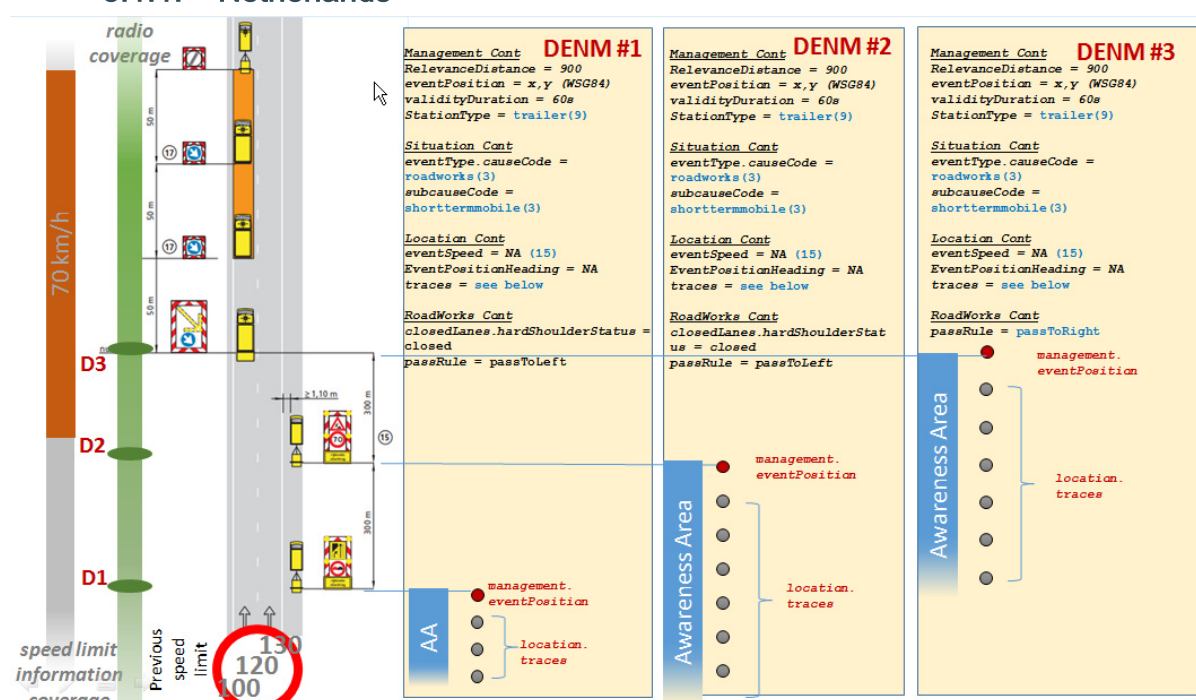


Figure 2 Dutch example for short-term mobile road works in stand-alone mode, trailer and pre-warner equipped.

For the Dutch messages the messages will include closedLanes and passToLeft/passToRight.

Both set of rules are included because;

- in The Netherlands a roadclosing pre-warner is always equipped with a “sheet metal sign” indicating which side traffic has to pass. This information has to be transmitted for legal reasons.
- In the Netherlands, many hard shoulders are used as driving lanes in peak hours (meaning there is no hard shoulder temporarily). For this reason there is always a possibility that there is traffic driving on the hard shoulder as a driver can have missed a sign indicating the hard shoulder isn’t in use as a driving lane. For this reason, messages on safety trailers placed on the hard shoulder should always transmit a passRule besides a hardShoulderStatus attribute.

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8.2. Short-Term mobile – basic service

8.2.1. Netherlands

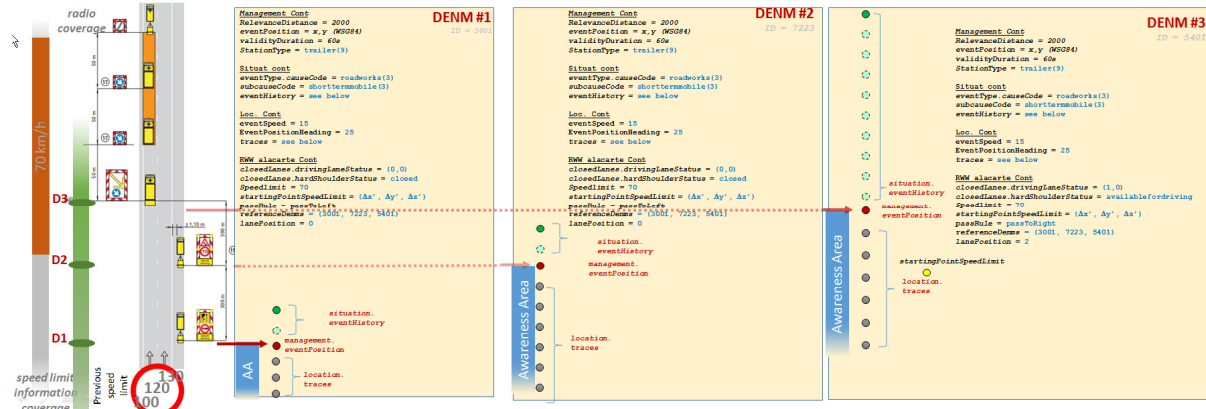


Figure 3 Dutch example for short-term mobile road works in basic mode, trailer and pre-warner equipped.

See comment in chapter 8.1.1

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8.3. Short-Term stationary – stand alone

8.3.1. Austria

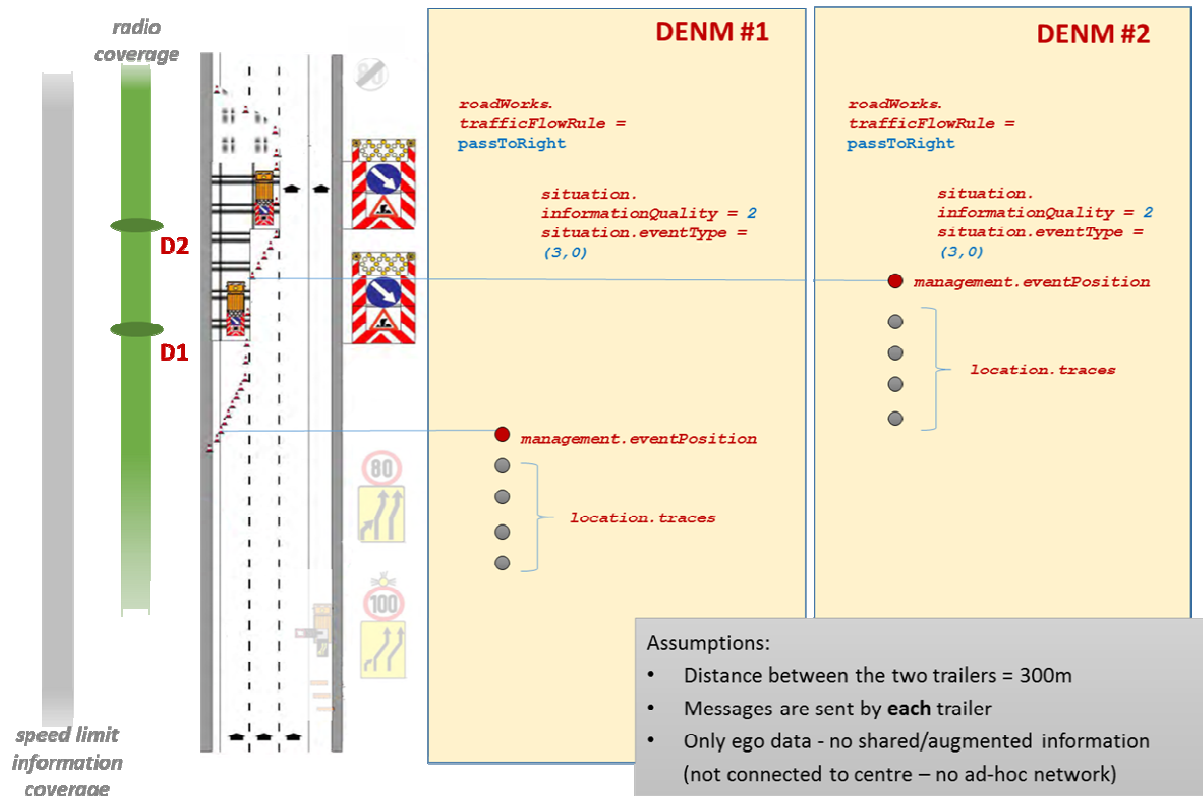


Figure 4 Austrian example for short-term stationary road works in standalone mode

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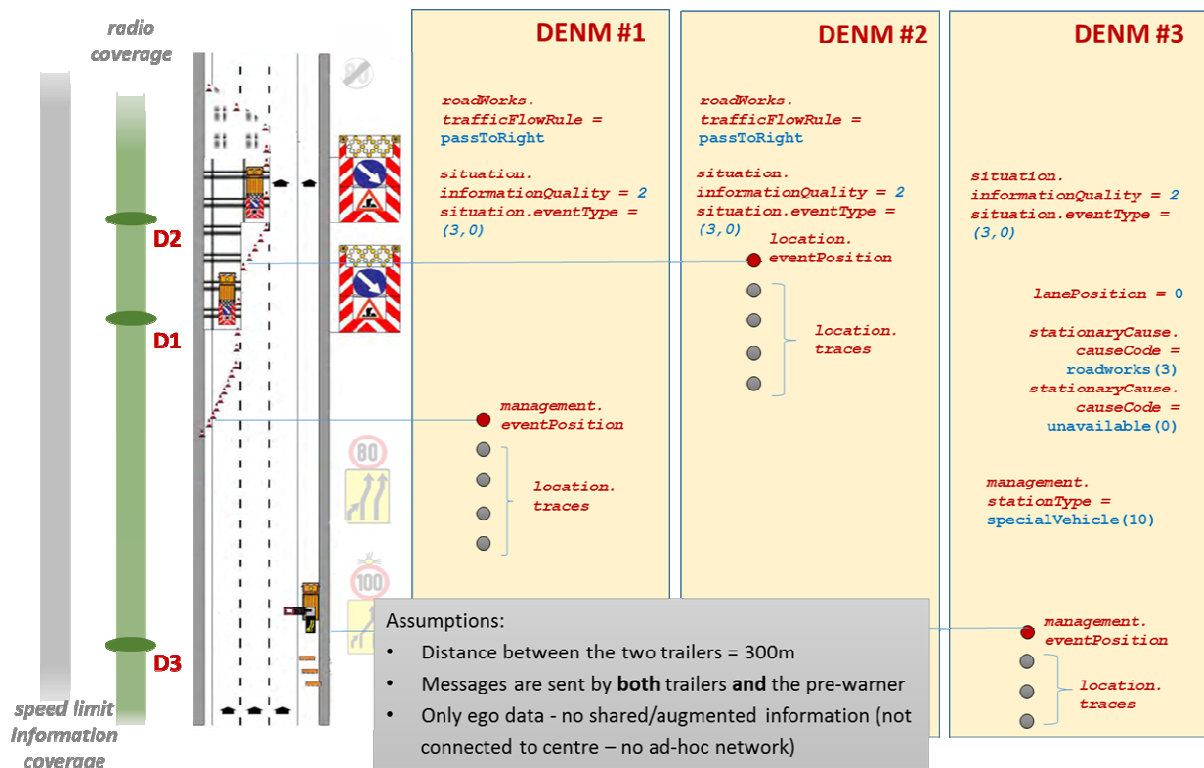


Figure 5 Austrian example for short-term stationary road works in standalone mode with equipped pre-warner

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8.3.2. Germany

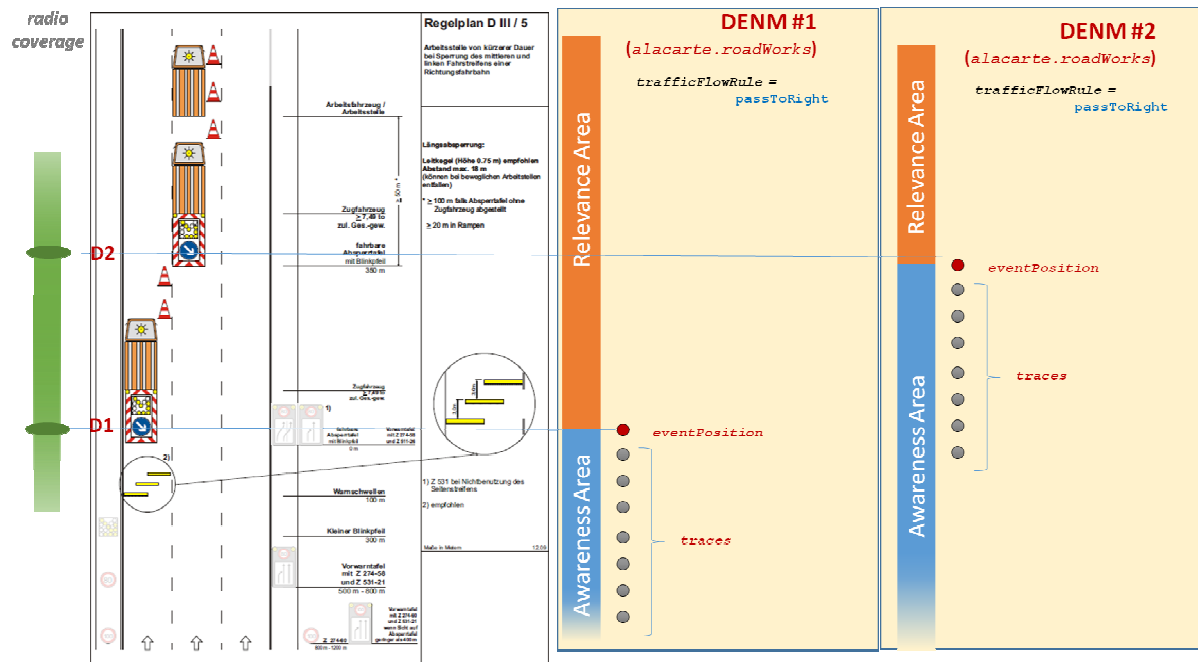


Figure 6 German example for short-term stationary road works in standalone mode

On Day 1 the pre-warner will not be equipped in Germany, therefore this example is not included in the current version of the document.

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8.3.3. Netherlands

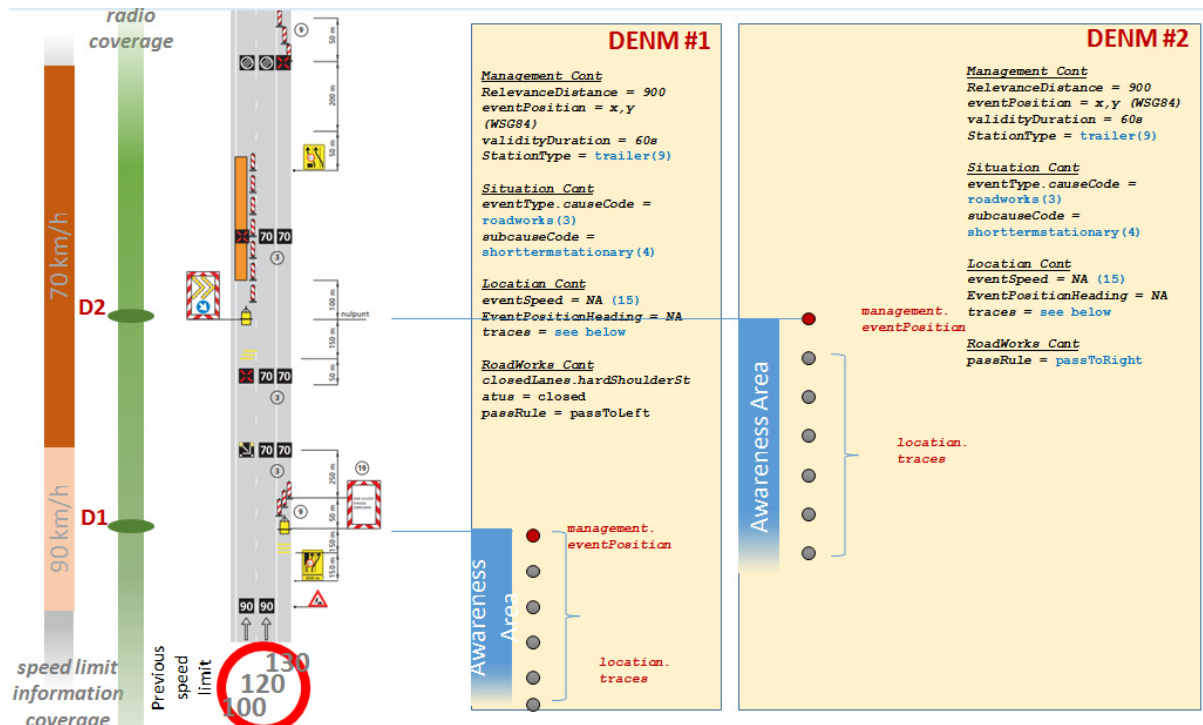


Figure 7 Dutch example for short-term stationary road works in stand-alone mode, trailer and pre-warner equipped. See comment in chapter 8.1.1

8.4. Short-Term stationary – basic service

8.4.1. Austria

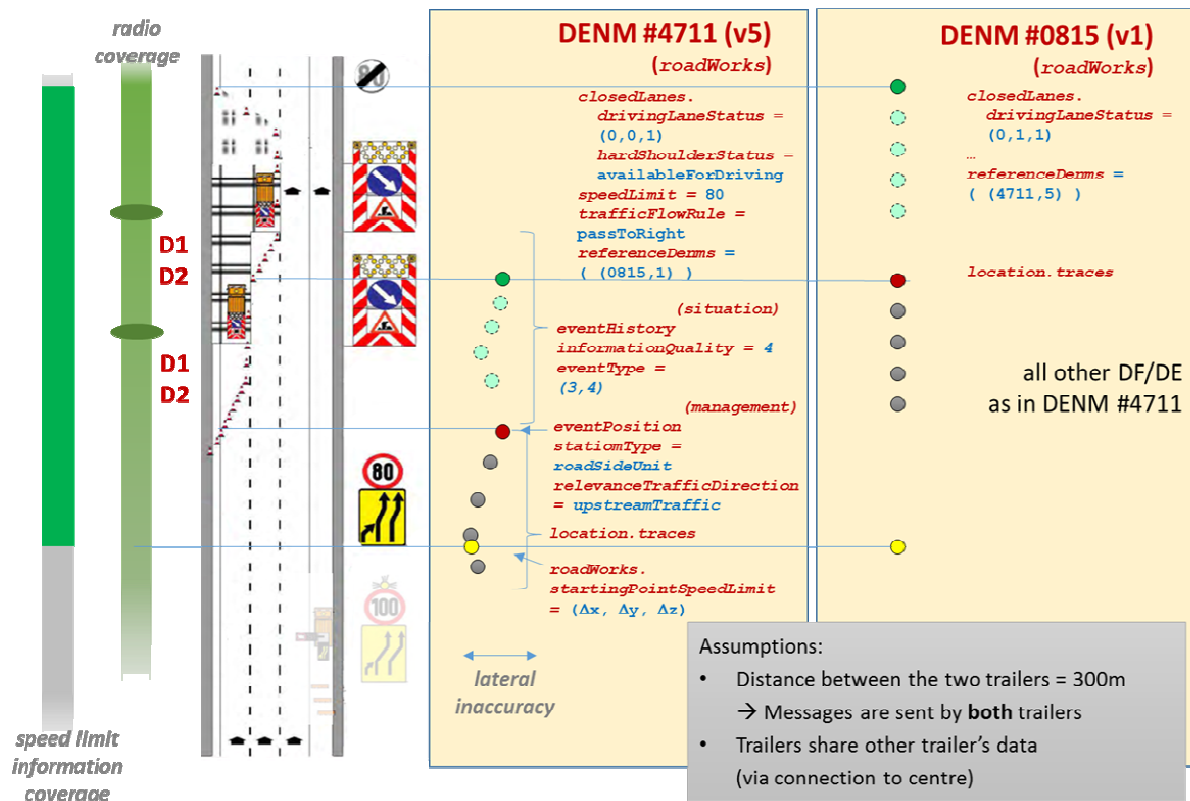


Figure 8 Austrian example for short-term stationary road works in basic service mode

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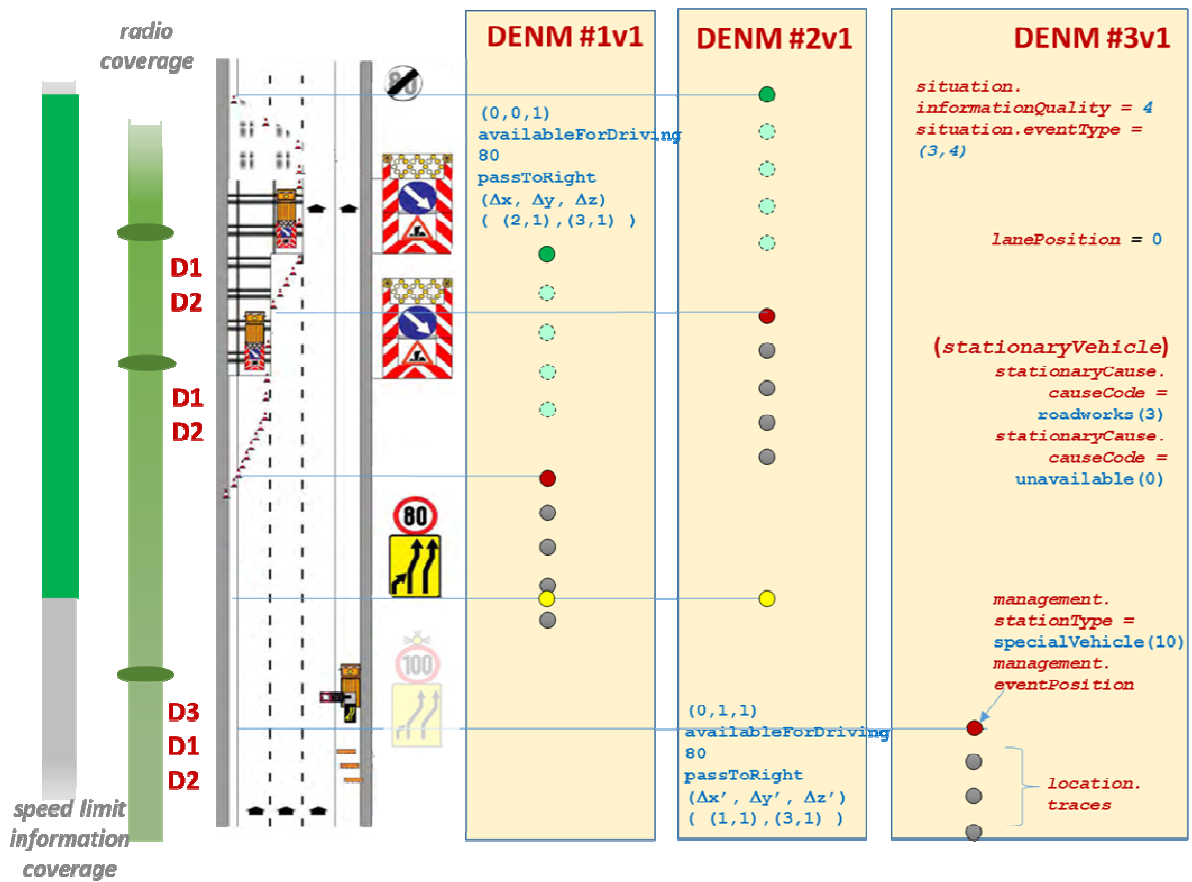


Figure 9 Austrian example for short-term stationary road works in basic service mode with equipped pre-warner

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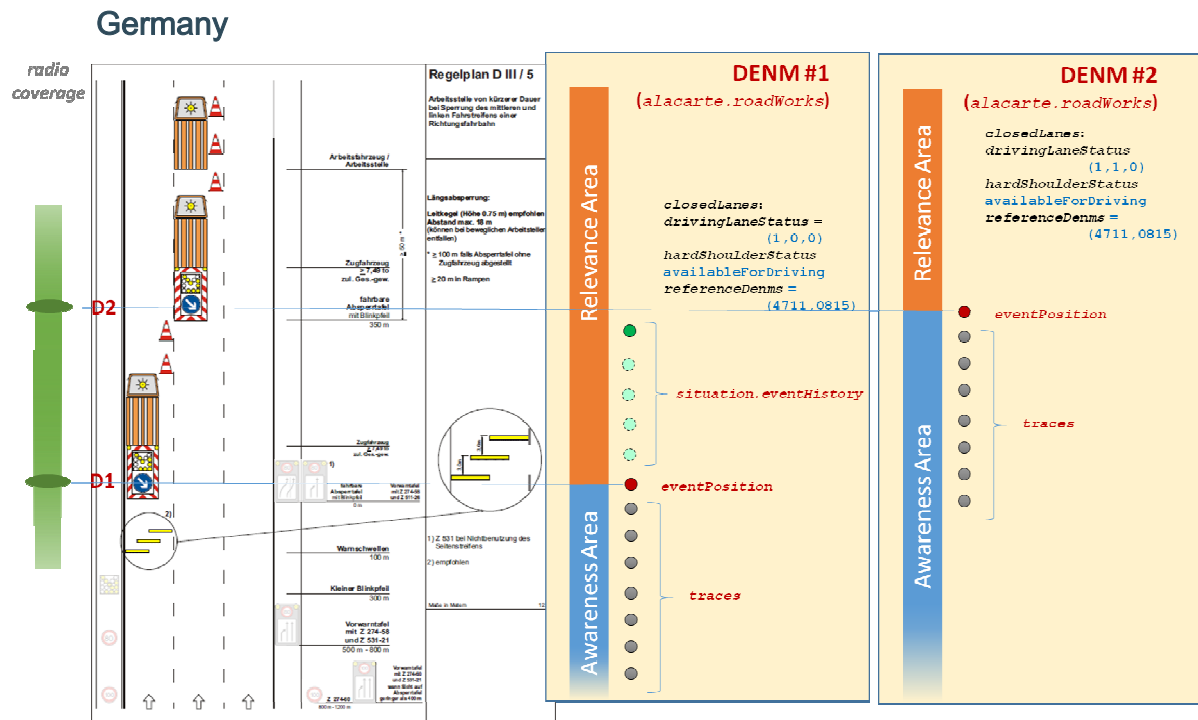


Figure 10 German example for short-term stationary road works in basic service mode

On Day 1 the pre-warner will not be equipped in Germany, therefore this example is not included in the current version of the document.

As long as the pre-warner is not equipped it is not possible to provide speed limit information.

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8.4.2. Netherlands

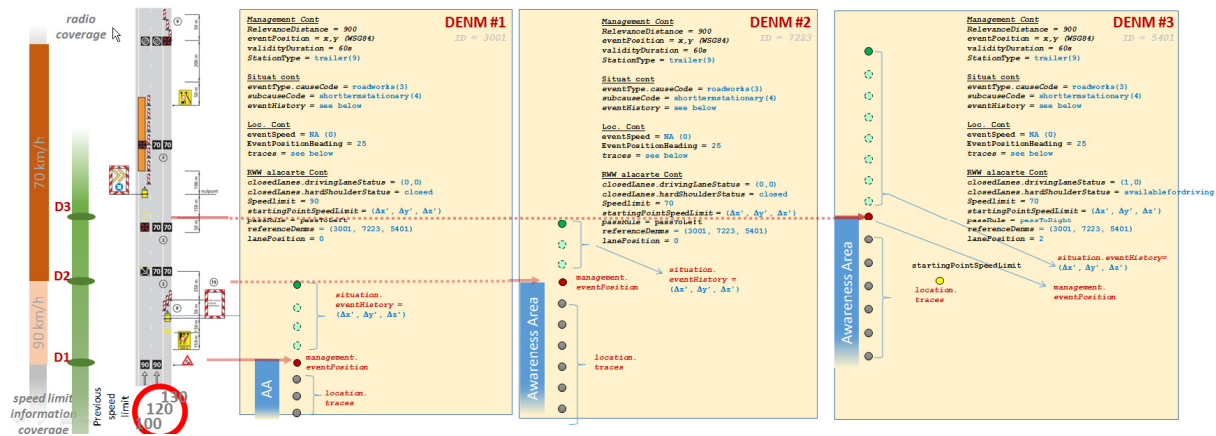


Figure 11 Dutch example for short-term stationary road works in basic mode, trailer and pre-warner equipped.

See comment in chapter 8.1.1

8.5. Long-term stationary

This scenario is currently out of scope and will be added in a later version of this document.

Annex A – Description / Reference documents of individual set up and shut down procedures of Road Works

Netherlands: see RoadWorkProcedures_NL_v3.pdf

Germany: see 20140326_AG_RWW_TriggeringConditions.docx

References

- [1] http://www.mobil.hessen.de/irj/servlet/prt/portal/prtroot/slimp.CMReader/HMWVL_15/HSV_V_Internet/med/8a8/8a814d34-5a20-1417-9cda-a2b417c0cf46,22222222-2222-2222-2222-222222222222
- [2] http://www.mobil.hessen.de/irj/servlet/prt/portal/prtroot/slimp.CMReader/HMWVL_15/HSV_V_Internet/med/679/67924d34-5a20-1417-9cda-a2b417c0cf46,22222222-2222-2222-2222-222222222222
- [3] http://www.mobil.hessen.de/irj/go/km/docs/Hessen/HMWVL/Laermschutzkarten/HE_VZP-Katalog_AKD.pdf