

SWP 2.1 Use Cases

Other DENM Applications

Hazardous Location Warnings / Events

WP 2 - System Definition

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Overview of changes

No.	Version	Status	Date	Type of Change
1	01.00	Released	2014-11-28	First Release
2	02.00	Released	2015-03-12	Second Release
3	03.00	Released	2015-07-15	Third Release
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Table 1: Document History

Reference to the status- and version administration:

Status:

In progress the document is currently in editing mode

Released the document has been checked and released by quality assurance, it can only be modified if the version number is updated.

Versions:

Takes place in two stages. Released documents receive the next higher integral version number.

00.01, 00.02 etc. Not released versions, with the status in progress

01, 02, etc. Released version with the status released

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1 Document Information

1.1 Scope

The aim of this document is to create an overview on how to create other DENM (Decentralized Environmental Notification Message) applications in ECo-AT – beside the Roadworks Warning application described in the RWW Use Case document – by using currently available infrastructure based content. The document will focus on Hazardous Location Warnings / Events and describe, in a first approach, which kinds of events are available and how they can be mapped into the DENM.

The overall emphasis of the document will be on Infrastructure based DENM events: event messages which originate in the TCC and are sent out to Vehicles (I2V). Nonetheless, the document will also deal with the reverse concept: event messages emanating from Vehicles, captured by the Infrastructure and forwarded to the TCC (V2I).

The document can be seen as a guideline how relevant traffic events, which are available at ASFINAGs TCC, can be mapped into adequate DEN messages. These messages could also be a way to comply with the demands of the ITS Directive (2010/40/EU) / Commission Delegated Regulation (EU) 886/2013 to provide safety related messages free of charge to users. On the other side, it also elaborates on how Vehicle DENMs can be captured and used in a TCC.

How messages are processed or interpreted in the vehicle depends on the application profiles, which are defined by the C2C-CC. The detailed specification and also the relevant triggering conditions of the application profiles are currently not publically available and are not in the scope of this document.

The document essentially serves three purposes:

1. It creates a common understanding of all project partners in ECo-AT regarding the objectives and the general course of activities in regard to the creation of other DENM applications / Hazardous Location Warnings / Events based on available infrastructure based content as well as the reception of Vehicle based DENM event.
2. It is the basis for further, more detailed specifications of the messages mapping and encoding to implement DENM based Hazardous Location Warnings / Events.
3. It is the basis for communication with the other Corridor partners in DE and NL in order to come to harmonized Corridor-wide specifications regarding Hazardous Location Warnings / Events based on DENM.

The ECo-AT use cases are based on – and will be kept aligned with – the automotive industry.

1.2 Definitions, Terms and Abbreviations

Abbreviation / Term	Definition
2G/3G/4G	Different generations of cellular communication systems, offering digital communication links for data exchange – typical systems assigned to these generations in Europe are GSM/GPRS, UMTS and LTE
AG	Amsterdam Group – co-operation of C2C-CC, CEDR, ASECAP & POLIS for European roll-out of Cooperative ITS
ALERT-C	Series of Standards used to code traffic information on the Traffic Message Channel (TMC) – Event Codes used by ASF-EMS are found in part 2 [ISO 14819]
ASF-EMS	ASFINAGs internal Event-Management-System which is the basis for the events sent out by the “Other DENM Applications - Hazardous Location Warnings / Events” use case
C-ITS	Cooperative ITS – C-ITS is a “subset of overall ITS that communicates and shares information between ITS stations to give advice or facilitate actions with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone systems” (ISO/TR 17465-1)
C-ITS-S	Central ITS station
C2C-CC	CAR 2 CAR Communication Consortium (C2C-CC) - a nonprofit, industry driven organisation initiated by European vehicle manufacturers, equipment suppliers, and research organisations to further the cause of cooperative Intelligent Transport Systems (C-ITS)
DENM	Decentralized Environmental Notification Message – as of [ETSI 302 637-3]
I2V	Infrastructure-to-Vehicle – describes the bidirectional information flow from infrastructure communication point R-ITS-S towards passing vehicles (V-ITS-S) and vice versa
ITS	Intelligent Transport Systems – systems that use information and communication technology to improve transport systems
MAP	Message to convey local, detailed network topology in specific areas, as specified in ISO/PDTS 19091
R-ITS-S	Roadside ITS station, mobile on vehicle or fixed at roadside
RWW	Road Works Warning – Day 1 I2V use case where a R-ITS-S delivers information about downstream road works to V-ITS-S

Abbreviation / Term	Definition
TCC	Traffic Control Centre
TMC	Traffic Message Channel - a technology for delivering traffic and travel information to motorists using the Radio Data System(RDS) on top of FM broadcasts
V-ITS-S	Vehicle ITS station (as of [ETSI 302 665]), i.e. on-board unit for C-ITS

Table 2: Definitions, Terms and Abbreviations

1.3 References

All references in this document can be found in the master table of references available in the “Eco-AT_SWP2.3_MasterTableOfReferences_v03.60.pdf” document.

2 Scenarios

Each use case can be broken down into so called “*scenarios*”. A scenario is a sequence of events within the C-ITS system that forms a mode of operation for the use case. Each use case contains at least one scenario, but can of course also consist of multiple scenarios, covering different ways of operation possible for the underlying C-ITS system.

In regard to the “Other DENM applications – Hazardous Location Warnings / Events” use case, the following scenarios are covered:

2.1 Sending event information from the TCC to the vehicles (Infrastructure based DENM events)

ALERT-C based event information in the TCC is sent to the C-ITS-S over IF1 (see [ECo-AT SWP2.3 system overview] for system architecture and interface nomenclature) using DATEX II. In the C-ITS-S, a mapping from the DATEX II content to DENM cause / sub cause codes is performed and corresponding DENMs are created. They are forwarded to geographically relevant R-ITS-S (using IF3) and sent out via ITS-G5 (as defined in [ETSI 202 663]) (IF4) at these locations. Vehicles driving through the coverage area of such an R-ITS-S receive these DENMs.

2.2 Sending event information from the vehicles to the TCC (Vehicle based DENM events)

Vehicles emit DENMs to warn C-ITS aware vehicles and infrastructure of dangers perceived based on certain triggering conditions. R-ITS-S at roadside receive such information if it is sent out within their coverage area. They filter out duplicates and send unique DENMs to the C-ITS-S (using IF3). There, the relevant event information (cause and sub cause codes) is extracted and mapped into corresponding DATEX II information sets to be sent to the TCC via IF1. The TCC can then decide to issue new events based on that information.

3 Infrastructure based DENM events

3.1 Road Operator's Perspective

ASFINAG operates and maintains the entire Austrian motorway and expressway network, comprising 2,183 km of roads. On most of the motorways, a sensor based traffic data collection and classification system is implemented. ASFINAG also operates an efficient traffic management system which uses sensors and measuring instruments along the route, responding to sudden events and regulating the flow of traffic via display gantries. Traffic and carriageway conditions, weather and local data (noise pollution and pollutants) are measured and used to derive flexible and appropriate information about speed limits, overtaking bans, warnings and other information. Some of this information is shown on the display gantries automatically; much is prepared and broadcast by human operators. Furthermore, ASFINAG has implemented a digital multicast video system, providing live streams from approximately 5900 cameras on the whole network. More than 4000 cameras are installed in Tunnels. All these systems can be considered as input sources for detecting roadside events.

Via cooperation with other traffic service providers in Austria, external traffic events are also available, covering both the ASFINAG network as well as the rest of Austria’s road network. This data – augmented with the abovementioned ASFINAG data – is the basis for the RDS-TMC broadcasting service in Austria.

In the future, C-ITS communication technologies will provide a further communication channel to directly alert road users about ongoing events by using the ITS-G5 radio channel. C-ITS communication standards currently provide several message format specifications: One of them is called DENM (Decentralized Environmental Notification Message).

Road operator data systems like the ones described above can be used to generate suitable content to be sent out by DENM applications, especially in regard to Hazardous Location Warning / Event. C-ITS can then provide a direct communication link for making that information available to the road users.

3.2 ASFINAG Event-Management

ASFINAG has recently implemented an internal Event-Management-System (ASF-EMS), which currently covers the events shown in Table 3. The first column shows the text as used in the ASF-EMS. The second column provides the English translation of the underlying ALERT-C code in the third column, as described in [ISO 14819]. The complete mapping information for both use case scenarios (from ALERT-C to DATEX II to ETSI DENM for events sent from the TCC to the vehicles / from ETSI DENM to DATEX II for events sent from vehicles to the TCC) can be found in [ECo-AT SWP3.1 DATEX II mapping]. It is in line with the encoding guidelines for safety related messages published by TISA [TPEG DATEX safety], even though the overlap with this specification is rather small, covering only seven events (ALERT-C codes 703, 923, 992, 1109, 1301, 1482, and 1701). The ECo-AT DATEX II profile [DATEX profile OtherDENM] has been updated to contain the approved extension for marking up safety related information in Release 3.6.

Important Note:

The event mapping presented here is based on the current version of the ASFINAG Event-Management-System, [ETSI 302 637-3] and [TPEG TEC] and can be used as a guideline to map ALERT-C events into DENM. The number of events may change over time, the principles will remain the same. The complete mapping information relevant for this use case can be found in the ECo-AT SWP3.1 DATEX II Mapping Tables [ECo-AT SWP3.1 DATEX II mapping] in the “DATEXII_Translation_OtherDENM_V03.60.xlsx” Excel spreadsheet.

Ereignisbeschreibung (ALERT-C, german)	Event description (ALERT-C, CEN english)	ALERT-C code
Verkehrsbehinderung	traffic problem	1
Höhenkontrolle wurde ausgelöst	over-height warning system triggered	11
wegen Bergungsarbeiten gesperrt	closed, rescue and recovery work in progress	16
Brücke gesperrt	bridge closed	24
Tunnel gesperrt	tunnel closed	25
Straße wird mehrfach gesperrt	road closed intermittently	28

Ereignisbeschreibung (ALERT-C, german)	Event description (ALERT-C, CEN english)	ALERT-C code
Stau	stationary traffic	101
1 km Stau	stationary traffic for 1 km	102
2 km Stau	stationary traffic for 2 km	103
4 km Stau	stationary traffic for 4 km	104
6 km Stau	stationary traffic for 6 km	105
10 km Stau	stationary traffic for 10 km	106
dichter Verkehr	slow traffic (with average speeds Q)	115
1 km dichter Verkehr	slow traffic for 1 km (with average speeds Q)	116
2 km dichter Verkehr	slow traffic for 2 km (with average speeds Q)	117
4 km dichter Verkehr	slow traffic for 4 km (with average speeds Q)	118
6 km dichter Verkehr	slow traffic for 6 km (with average speeds Q)	119
10 km dichter Verkehr	slow traffic for 10 km (with average speeds Q)	120
Unfall	(Q)accident(s)	201
Schwerer Unfall	(Q) serious accident(s)	202
Unfall mit (Q) Fahrzeugen	multi-vehicle accident (involving Q vehicles)	203
Unfall mit (Q) LKW	accident involving (a/Q) heavy lorr(y/ies)	204
Unfall mit Gefahrguttransporter	(Q) accident(s) involving hazardous materials	205
Verkehrsbehinderung durch (Q) verlorene Ladungen	(Q) shed load(s)	210
Verkehrsbehinderung durch (Q) defekte Fahrzeuge	(Q) broken down vehicle(s)	211
Verkehrsbehinderung durch (Q) defekte LKW	(Q) broken down heavy lorr(y/ies)	212
(Q) brennende Fahrzeuge	(Q) vehicle fire(s)	213
Unfall mit (Q) Bussen	accident involving (a/Q) bus(es)	335
Unfall, Folgeunfall	(Q) secondary accident(s)	345
Unfall im Baustellenbereich	(Q) accident(s) in roadworks area	351
Stau nach vorausgegangenem Unfall	Stationary traffic due to (Q) earlier accident(s)	379
dichter Verkehr nach vorausgegangenem Unfall	Slow traffic due to (Q) earlier accident(s)	383
Behinderungen durch Bergungsarbeiten	rescue and recovery work in progress	397
gesperrt	closed	401
Durchfahrt gesperrt für LKW	closed for heavy vehicles (over Q)	403
Durchfahrt gesperrt für Schwerlastverkehr	no through traffic for heavy lorries (over Q)	404
Einfahrt gesperrt	(Q) entry slip road(s) closed	471
Ausfahrt gesperrt	(Q) exit slip road(s) closed	474
Verbindungsfahrbahn gesperrt	connecting carriageway closed	478
Fahstreifen gesperrt	(Q) lane(s) closed	500
rechter Fahstreifen gesperrt	(Q) right lane(s) closed	501
mittlerer Fahstreifen gesperrt	(Q) centre lane(s) closed	502
linker Fahstreifen gesperrt	(Q) left lane(s) closed	503
Pannestreifen gesperrt	emergency lane closed	637
Instandhaltungsarbeiten	(Q sets of) maintenance work	703
Brückenarbeiten	bridge maintenance work (at Q bridges)	707
Baustelle, Stau	(Q sets of) roadworks. Stationary traffic	710
Baustelle, 1 km Stau	(Q sets of) roadworks. Stationary traffic for 1 km	711
Baustelle, 2 km Stau	(Q sets of) roadworks. Stationary traffic for 2 km	712
Baustelle, 4 km Stau	(Q sets of) roadworks. Stationary traffic for 4 km	713
Baustelle, 6 km Stau	(Q sets of) roadworks. Stationary traffic for 6 km	714
Baustelle, 10 km Stau	(Q sets of) roadworks. Stationary traffic for 10 km	715
Baustelle, dichter Verkehr	(Q sets of) roadworks. Slow traffic	724
Baustelle, 1 km dichter Verkehr	(Q sets of) roadworks. Slow traffic for 1 km	725
Baustelle, 2 km dichter Verkehr	(Q sets of) roadworks. Slow traffic for 2 km	726
Baustelle, 4 km dichter Verkehr	(Q sets of) roadworks. Slow traffic for 4 km	727
Baustelle, 6 km dichter Verkehr	(Q sets of) roadworks. Slow traffic for 6 km	728

Ereignisbeschreibung (ALERT-C, german)	Event description (ALERT-C, CEN english)	ALERT-C code
Baustelle, 10 km dichter Verkehr	(Q sets of) roadworks. Slow traffic for 10 km	729
Störungen durch umgestürzte Bäume	fallen trees	905
Störungen durch Überschwemmung	flash floods	909
Störungen durch Lawinen	avalanches	911
Störungen durch Steinschlag	rockfalls	913
Störungen durch Erdbeben	landslips	914
Gefahr durch Tiere auf der Fahrbahn	animals on the road. Danger	923
Lawinensprengung	avalanches. Danger	992
gefährliche Fahrbahnverhältnisse	hazardous driving conditions (above Q hundred metres)	1001
Achtung außergewöhnliche Fahrbahnverhältnisse	danger of ice (above Q hundred metres)	1007
Achtung außergewöhnliche Fahrbahnverhältnisse	black ice (above Q hundred metres)	1008
Schneeglätte	snow on the road	1012
Schneeverwehungen	snow drifts	1016
Achtung starker Regen	heavy rain (Q)	1109
starker Hagel	damaging hail	1132
Sichtbehinderung durch dichten Nebel	dense fog (visibility reduced to Q)	1301
Personen auf der Fahrbahn	people on roadway. Danger	1482
(Q) Fahrzeug (e) auf falscher Fahrbahn	(Q) vehicle(s) on wrong carriageway	1701
(Q) Schwertransporte	(Q) abnormal load(s)	1751

Table 3: Current version of event categorization in the ASF-EMS

3.3 ETSI Application classes

Road operators focus particularly on use cases supporting road safety: saving lives and preventing harm has to be the number one intention to drive use cases from an operator's point of view. Cross-referencing the events in Table 3 with the applications defined in ETSI's Basic Set of Applications [ETSI 102 637-1] shows that most of the events are covered by the application class "Active road safety" and the application "Driving assistance – Road Hazard Warning RHW" (as shown in Table 4). [ETSI 102 637-1] clause 5.1.2 defines that this particular application is using DEN Messages.

Applications class	Application	#(see note)	Use Cases
Active road safety	Driving assistance - Road Hazard Warning (RHW)	UC005	UC005 Emergency electronic brake lights
		UC006	UC006 Wrong way driving warning
		UC007	UC007 Stationary vehicle - accident
		UC008	UC008 Stationary vehicle - vehicle problem
		UC009	UC009 Traffic condition warning
		UC010	UC010 Signal violation warning
		UC011	UC011 Roadwork warning
		UC012	UC012 Collision risk warning
		UC013	UC013 Decentralized floating car data - Hazardous location
		UC014	UC014 Decentralized floating car data - Precipitations

	UC015	UC015 Decentralized floating car data - Road adhesion
	UC016	UC016 Decentralized floating car data - Visibility
	UC017	UC017 Decentralized floating car data - Wind

Note: The identifier of the use case is defined and used only within [ETSI-BSA] document

Table 4: ETSI's Basic Set of Applications - Active Road Safety - Driving Assistance - RHW

3.4 Matching ASFINAG events to ETSI use cases

Important Note:

The event mapping presented here is based on the current version of the ASFINAG Event-Management-System, [ETSI 302 637-3] and [TPEG TEC] and can be used as a guideline to map ALERT-C events into DENM. The number of events may change over time, the principles will remain the same. The complete mapping information relevant for this use case can be found in the ECo-AT SWP3.1 DATEX II Mapping Tables [ECo-AT SWP3.1 DATEX II mapping] in the "DATEXII_Translation_OtherDENM_V03.60.xlsx" Excel spreadsheet.

ASF-EMS events have to be matched to a corresponding ETSI use case in order to encode them as DEN messages. This is done in Table 5.

UseCases from [ETSI-BSA] clause 4.1	ASF-EMS events
UC006 Wrong way driving warning	(Q) vehicle(s) on wrong carriageway
UC007 Stationary vehicle - accident	(Q)accident(s)
	(Q) serious accident(s)
	multi-vehicle accident (involving Q vehicles)
	accident involving (a/Q) heavy lorr(y/ies)
	(Q) accident(s) involving hazardous materials
	accident involving (a/Q) bus(es)
	(Q) secondary accident(s)
UC008 Stationary vehicle - vehicle problem	(Q) accident(s) in roadworks area
	(Q) broken down vehicle(s)
UC009 Traffic condition warning	(Q) broken down heavy lorr(y/ies)
	traffic problem
	over-height warning system triggered
	closed, rescue and recovery work in progress
	bridge closed
	tunnel closed
	road closed intermittently
	stationary traffic
slow traffic (with average speeds Q)	
(Q) shed load(s)	

UseCases from [ETSI-BSA] clause 4.1	ASF-EMS events
	(Q) vehicle fire(s)
	rescue and recovery work in progress
	closed
	closed for heavy vehicles (over Q)
	no through traffic for heavy lorries (over Q)
	(Q) entry slip road(s) closed
	(Q) exit slip road(s) closed
	connecting carriageway closed
	(Q) lane(s) closed
	(Q) right lane(s) closed
	(Q) centre lane(s) closed
	(Q) left lane(s) closed
	emergency lane closed
	(Q sets of) maintenance work
	bridge maintenance work (at Q bridges)
	(Q sets of) roadworks. Stationary traffic
	(Q sets of) roadworks. Slow traffic
	animals on the road. Danger
	avalanches. Danger
	hazardous driving conditions (above Q hundred metres)
	danger of ice (above Q hundred metres)
	black ice (above Q hundred metres)
	snow on the road
	heavy rain (Q)
	damaging hail
	dense fog (visibility reduced to Q)
	people on roadway. Danger
	(Q) abnormal load(s)
	tunnel ventilation not working
	Stationary traffic due to (Q) earlier accident(s)
	avalanches
	snow drifts
	rockfalls
	flash floods
	landslips
	fallen trees

Table 5: Matching of [ETSI-BSA] and current ASF-EMS events

3.5 DENM Events and Commission Delegated Regulation (EU) 886/2013

DENM based events could also be seen as C-ITS's way to comply with Commission Delegated Regulation (EU) 886/2013, also known as Priority action "c" of the ITS Directive (2010/40/EU), which prompts operators to provide a minimum set of safety related messages free of charge to users. They provide the necessary road safety-related information content (as stated in section 3.5.2) and also satisfy further requirements (listed in section 3.5.3).

3.5.1 ITS Directive and regulation

The European Commission has published an ITS Directive (20/40/EU) which identifies six priority actions. Priority action "c" demands *"data and procedures for the provision, where possible, of road safety related minimum universal traffic information free of charge to users"*.

It has further published a delegated regulation (886/2013) supplementing the ITS Directive. It states: *"Road safety-related traffic data are essential for the provision of road safety related minimum universal traffic information. They are collected and stored by public and/or private operators and service providers. In order for these data to be made easily available for exchange and re-use for the provision of information services, public and/or private road operators and service providers should make them accessible through individual access points or make sure that they are accessible through national access points set up and managed by the Member States. These national access points can take the form of a repository, registry, web portal or similar."*

3.5.2 Road Safety-related Information Content

The content of the road safety-related information service consists of events and conditions of road network. As stated in the specifications of the ITS directive and regulation, at least one of the following categories shall be deployed:

- a) temporary slippery road;
- b) animal, people, obstacles, debris on the road;
- c) unprotected accident area;
- d) short-term road works;
- e) reduced visibility;
- f) wrong-way driver;
- g) unmanaged blockage of a road;
- h) exceptional weather conditions.

Events or conditions should be made available with explanatory information of their location, category of event or condition and driving behavior advice (when appropriate).

3.5.3 Other requirements and guidelines

Specification includes a set of requirements and guidelines, of which some are worth of mention:

- “The data shall be available in the DATEX II (CEN/TS 16157) format or any fully compatible and interoperable with DATEX II machine-readable format through an access point.”
- “The data shall be accessible for exchange and re-use by any user of road safety-related minimum universal traffic information on a non-discriminatory basis.”
- “The information service shall be provided in such a way as to ensure the widest reach of end users concerned by the given event or condition.”
- “The information service shall be made available by public and/or private road operators and/or service providers and/or broadcasters where possible free of charge to end users.”
- “Public and private road operators and service providers shall collaborate to harmonize the presentation of the content of the information provided to end users”

3.6 DENM overview

Detailed information about the Decentralized Environmental Notification Message (DENM) deployed for this use case can be found in [ETSI-DENM].

Chapters of relevance for this document are:

Chapter 4 – DEN basic service introduction

Subchapter 4.1 – Background

Subchapter 4.2 – Services provided by the DEN basic service

Chapter 7 – DENM format specification

Subchapter 7.1.1 – General structure of a DENM

Subchapter 7.1.3 – DENM management container

Subchapter 7.1.4 – DENM situation container

3.7 Event Mapping

Section 3.2 describes the ASFINAG Event-Management-System. It aims to describe the current status of the motorway network by defining various event types which are triggered by human operators. The system and the associated events were released in early 2015. All events will have ALERT-C codes in order to facilitate easier interchange with other service providers.

In order to use this event information for sending out infrastructure based DENMs, there is a need for an event code-mapping from ALERT-C [ISO 14819] to ETSI DENM [ETSI 302 637-3] and the ETSI Common Data Dictionary [ETSI 102 894-2]: starting with the ALERT-C code, a corresponding equivalent has to be found in the in [ETSI 302 637-3] and [ETSI 102 894-2], in context with [TPEG TEC].

3.7.1 Process and Principles

1. Take ALERT-C code and find matching cause code according to [ETSI 302 637-3]. Note that one ALERT-C code can possibly result in more than one [ETSI 302 637-3] cause code mapping
2. Determine sub cause code(s) according to [ETSI 302 637-3] and / or (if possible) according to [TPEG TEC] specification. [ETSI 302 637-3] mostly refers directly to the [TPEG-TEC] specifications for the cause code and sub-cause code fields
3. If the description of the event is not sufficiently specific to allocate a proper sub-cause code the mapping is done to the cause code with the sub-cause code "unavailable"
4. If there is no correspondent cause found, no matching is done

3.7.2 Mapping results

Important Note:

The event mapping presented here is based on the current version of the ASFINAG Event-Management-System, [ETSI 302 637-3] and [TPEG TEC] and can be used as a guideline to map ALERT-C events into DENM. The number of events may change over time, the principles will remain the same. The complete mapping information relevant for this use case can be found in the ECo-AT SWP3.1 DATEX II Mapping Tables [ECo-AT SWP3.1 DATEX II mapping] in the “DATEXII_Translation_OtherDENM_V03.60.xlsx” Excel spreadsheet.

Table 6 below presents the result of mapping the events of the ASFINAG Event-Management-System (ASF-EM) to DENM based on the process and principles described in Section 3.7.1. Some events (mostly closures of various kind) cannot be mapped properly into DENM, because of the limited set of cause codes and sub cause codes used in [ETSI 302 637-3] compared to [TPEG TEC]. These events will therefore not be disseminated at all via ITS-G5. Some ASF-EM events break down into two separate DENM Cause codes – these shall be encoded as two separate DEN messages by the C-ITS system. The mapping table presented here is in line with the encoding guidelines for safety related messages published by TISA [TPEG DATEX safety] even though the overlap with this specification is rather small, covering only seven events (ALERT-C codes 703, 923, 992, 1109, 1301, 1482 and 1701).

ASF-EMS			DENM Cause Codes			
Ereignisbeschreibung (ALERT-C, german)	Event description (ALERT-C, CEN english)	Alert-C code	Cause code	Cause Code Description	Sub Cause Code	Sub Cause Code Description
Verkehrsbehinderung	traffic problem	1	X	Matching not possible	X	Matching not possible
Höhenkontrolle wurde ausgelöst	over-height warning system triggered	11	X	Matching not possible	X	Matching not possible
wegen Bergungsarbeiten gesperrt	closed, rescue and recovery work in progress	16	15	rescue and recovery work in progress	0	Unavailable

ASF-EMS			DENM Cause Codes			
Event description (ALERT-C, german)	Event description (ALERT-C, CEN english)	Alert-C code	Cause code	Cause Code Description	Sub Cause Code	Sub Cause Code Description
			X	Matching not possible	X	Matching not possible
Brücke gesperrt	bridge closed	24	X	Matching not possible	X	Matching not possible
Tunnel gesperrt	tunnel closed	25	X	Matching not possible	X	Matching not possible
Straße wird mehrfach gesperrt	road closed intermittently	28	X	Matching not possible	X	Matching not possible
Stau	stationary traffic	101	1	traffic condition	0	Unavailable
1 km Stau	stationary traffic for 1 km	102	1	traffic condition	0	Unavailable
2 km Stau	stationary traffic for 2 km	103	1	traffic condition	0	Unavailable
4 km Stau	stationary traffic for 4 km	104	1	traffic condition	0	Unavailable
6 km Stau	stationary traffic for 6 km	105	1	traffic condition	0	Unavailable
10 km Stau	stationary traffic for 10 km	106	1	traffic condition	0	Unavailable
dichter Verkehr	slow traffic (with average speeds Q)	115	1	traffic condition	0	Unavailable
1 km dichter Verkehr	slow traffic for 1 km (with average speeds Q)	116	1	traffic condition	0	Unavailable
2 km dichter Verkehr	slow traffic for 2 km (with average speeds Q)	117	1	traffic condition	0	Unavailable
4 km dichter Verkehr	slow traffic for 4 km (with average speeds Q)	118	1	traffic condition	0	Unavailable
6 km dichter Verkehr	slow traffic for 6 km (with average speeds Q)	119	1	traffic condition	0	Unavailable
10 km dichter Verkehr	slow traffic for 10 km (with average speeds Q)	120	1	traffic condition	0	Unavailable

ASF-EMS			DENM Cause Codes			
Ereignisbeschreibung (ALERT-C, german)	Event description (ALERT-C, CEN english)	Alert-C code	Cause code	Cause Code Description	Sub Cause Code	Sub Cause Code Description
Unfall	(Q)accident(s)	201	2	accident	0	Unavailable
Schwerer Unfall	(Q) serious accident(s)	202	2	accident	0	Unavailable
Unfall mit (Q) Fahrzeugen	multi-vehicle accident (involving Q vehicles)	203	2	accident	1	multi-vehicle accident
Unfall mit (Q) LKW	accident involving (a/Q) heavy lorr(y/ies)	204	2	accident	3	accident involving lorry
Unfall mit Gefahrguttransporter	(Q) accident(s) involving hazardous materials	205	2	accident	5	accident involving hazardous materials
Verkehrsbehinderung durch (Q) verlorene Ladungen	(Q) shed load(s)	210	10	objects on the road	1	shed load
Verkehrsbehinderung durch (Q) defekte Fahrzeuge	(Q) broken down vehicle(s)	211	94	stationary vehicle	2	vehicle breakdown
Verkehrsbehinderung durch (Q) defekte LKW	(Q) broken down heavy lorr(y/ies)	212	94	stationary vehicle	2	vehicle breakdown
(Q) brennende Fahrzeuge	(Q) vehicle fire(s)	213	94	stationary vehicle	2	vehicle breakdown
Unfall mit (Q) Bussen	accident involving (a/Q) bus(es)	335	2	accident	4	accident involving bus
Unfall, Folgeunfall	(Q) secondary accident(s)	345	2	accident	0	Unavailable
Unfall im Baustellenbereich	(Q) accident(s) in roadworks area	351	2	accident	0	Unavailable
Stau nach vorausgegangenem Unfall	Stationary traffic due to (Q) earlier accident(s)	379	1	traffic condition	0	Unavailable
dichter Verkehr nach vorausgegangenem Unfall	Slow traffic due to (Q) earlier accident(s)	383	1	traffic condition	0	Unavailable
Behinderungen durch Bergungsarbeiten	rescue and recovery work in progress	397	15	rescue and recovery work in progress	0	Unavailable

ASF-EMS			DENM Cause Codes			
Ereignisbeschreibung (ALERT-C, german)	Event description (ALERT-C, CEN english)	Alert-C code	Cause code	Cause Code Description	Sub Cause Code	Sub Cause Code Description
gesperrt	closed	401	X	Matching not possible	X	Matching not possible
Durchfahrt gesperrt für LKW	closed for heavy vehicles (over Q)	403	X	Matching not possible	X	Matching not possible
Durchfahrt gesperrt für Schwerlastverkehr	no through traffic for heavy lorries (over Q)	404	X	Matching not possible	X	Matching not possible
Einfahrt gesperrt	(Q) entry slip road(s) closed	471	X	Matching not possible	X	Matching not possible
Ausfahrt gesperrt	(Q) exit slip road(s) closed	474	X	Matching not possible	X	Matching not possible
Verbindungsfahrbahn gesperrt	connecting carriageway closed	478	X	Matching not possible	X	Matching not possible
Fahrstreifen gesperrt	(Q) lane(s) closed	500	X	Matching not possible	X	Matching not possible
rechter Fahrstreifen gesperrt	(Q) right lane(s) closed	501	X	Matching not possible	X	Matching not possible
mittlerer Fahrstreifen gesperrt	(Q) centre lane(s) closed	502	X	Matching not possible	X	Matching not possible
linker Fahrstreifen gesperrt	(Q) left lane(s) closed	503	X	Matching not possible	X	Matching not possible
Pannestreifen gesperrt	emergency lane closed	637	X	Matching not possible	X	Matching not possible
Instandhaltungsarbeiten Brückenarbeiten	(Q sets of) maintenance work bridge maintenance work (at Q bridges)	703	3	roadworks	0	Unavailable
		707	3	roadworks	0	Unavailable
Baustelle, Stau	(Q sets of) roadworks. Stationary traffic	710	3	roadworks	0	Unavailable
			1	traffic condition	0	Unavailable
Baustelle, 1 km Stau	(Q sets of) roadworks. Stationary traffic for 1 km	711	3	roadworks	0	Unavailable
			1	traffic condition	0	Unavailable
Baustelle, 2 km Stau		712	3	roadworks	0	Unavailable

ASF-EMS			DENM Cause Codes			
Event description (ALERT-C, german)	Event description (ALERT-C, CEN english)	Alert-C code	Cause code	Cause Code Description	Sub Cause Code	Sub Cause Code Description
	(Q sets of) roadworks. Stationary traffic for 2 km		1	traffic condition	0	Unavailable
Baustelle, 4 km Stau	(Q sets of) roadworks. Stationary traffic for 4 km	713	3	roadworks	0	Unavailable
			1	traffic condition	0	Unavailable
Baustelle, 6 km Stau	(Q sets of) roadworks. Stationary traffic for 6 km	714	3	roadworks	0	Unavailable
			1	traffic condition	0	Unavailable
Baustelle, 10 km Stau	(Q sets of) roadworks. Stationary traffic for 10 km	715	3	roadworks	0	Unavailable
			1	traffic condition	0	Unavailable
Baustelle, dichter Verkehr	(Q sets of) roadworks. Slow traffic	724	3	roadworks	0	Unavailable
			1	traffic condition	0	Unavailable
Baustelle, 1 km dichter Verkehr	(Q sets of) roadworks. Slow traffic for 1 km	725	3	roadworks	0	Unavailable
			1	traffic condition	0	Unavailable
Baustelle, 2 km dichter Verkehr	(Q sets of) roadworks. Slow traffic for 2 km	726	3	roadworks	0	Unavailable
			1	traffic condition	0	Unavailable
Baustelle, 4 km dichter Verkehr	(Q sets of) roadworks. Slow traffic for 4 km	727	3	roadworks	0	Unavailable
			1	traffic condition	0	Unavailable
Baustelle, 6 km dichter Verkehr	(Q sets of) roadworks. Slow traffic for 6 km	728	3	roadworks	0	Unavailable
			1	traffic condition	0	Unavailable
Baustelle, 10 km dichter Verkehr	(Q sets of) roadworks. Slow traffic for 10 km	729	3	roadworks	0	Unavailable
Lawinensprengung	avalanches. Danger	992	1	traffic condition	0	Unavailable
Störungen durch umgestürzte Bäume	fallen trees	905	10	objects on the road	5	fallenTrees
Störungen durch Überschwemmung	flash floods	909	9	Surface condition	0	Unavailable

ASF-EMS			DENM Cause Codes			
Ereignisbeschreibung (ALERT-C, german)	Event description (ALERT-C, CEN english)	Alert-C code	Cause code	Cause Code Description	Sub Cause Code	Sub Cause Code Description
Störungen durch Lawinen	avalanches	911	9	Surface condition	0	Unavailable
Störungen durch Steinschlag	rockfalls	913	9	Surface condition	1	rockfalls
Störungen durch Erdbeben	landslips	914	9	Surface condition	0	Unavailable
Gefahr durch Tiere auf der Fahrbahn	animals on the road. Danger	923	11	animals on roadway	0	Unavailable
Lawinensprengung	avalanches. Danger	992	9	Surface condition	0	Unavailable
gefährliche Fahrbahnverhältnisse	hazardous driving conditions (above Q hundred metres)	1001	9	hazardous driving conditions	0	Unavailable
Achtung außergewöhnliche Fahrbahnverhältnisse	danger of ice (above Q hundred metres)	1007	6	slippery road	5	ice on road
Achtung außergewöhnliche Fahrbahnverhältnisse	black ice (above Q hundred metres)	1008	6	slippery road	6	black ice on road
Schneeglätte	snow on the road	1012	6	slippery road	4	Snow is making the road surface slippery.
Schneeverwehungen	snow drifts	1016	9	Surface condition	5	snowDrifts
Achtung starker Regen	heavy rain (Q)	1109	19	precipitation	1	heavy rain
starker Hagel	damaging hail	1132	17	extreme weather conditions	2	damaging hail
Sichtbehinderung durch dichten Nebel	dense fog (visibility reduced to Q)	1301	18	visibility reduced	1	visibility reduced due to fog
Personen auf der Fahrbahn	people on roadway. Danger	1482	12	people on roadway	0	Unavailable
(Q) Fahrzeug (e) auf falscher Fahrbahn	(Q) vehicle(s) on wrong carriageway	1701	14	vehicle on wrong carriageway	0	Unavailable
(Q) Schwertransporte	(Q) abnormal load(s)	1751	26	slow moving vehicles	3	abnormal load

Table 6: Event mapping from ASF-EM to DENM

3.7.3 Current mapping problems

While working with Table 10 of [ETSI 302 637-3], it was noted that this standard refers to clause 5.3.8 of [ETSI 101 539-1] in order to specify the semantics of sub cause codes that have not been taken over from TISA specifications. The document is referred to as an informative reference i.4. The “Informative references” section holds an un-versioned and un-dated reference to this document. When accessing the currently publicly available version of [ETSI 101 539-1] it is apparent that this version doesn’t have a section 5.3. Searching for one of the sub cause code names (e.g. “traffic jam increasing”) finds it in another section of the document (6.3.8), so a simple re-structuring is assumed, but then the document refers to back to DENM [ETSI 302 637-3] for specification of the semantics.

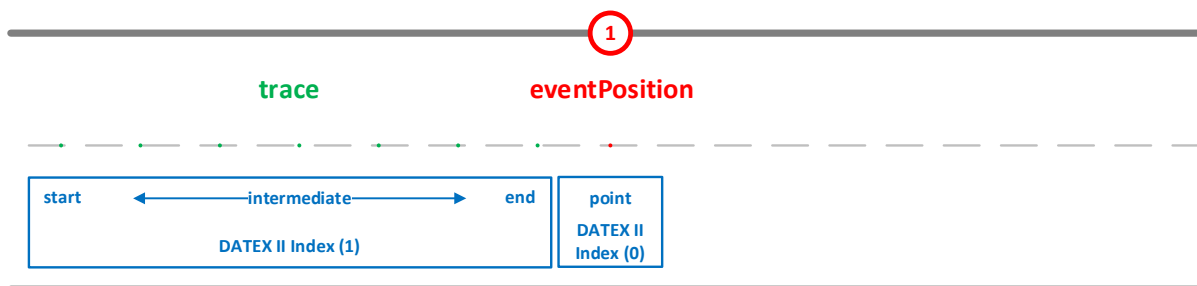
Feedback that the reference will have to be updated, versioned and dated and that the reference should be normative instead of informative will be forwarded to the editors of [ETSI 302 637-3] in ETSI.

3.8 Event Location

All events in the ASFINAG Event-Management-System are either point events (described by one location point which is the position of the event) or events with a spatial extension (described by two location points which are the beginning and end of an event). These points within these events are primarily encoded as a kilometer value on a selected motorway in a specific direction (e.g. the event is encoded as being on the A1 motorway in the direction of Vienna, starting at kilometer 26,2 and ending at kilometer 28,3). Several projections onto geographical map databases allow for the automated retrieval of WGS84 latitude / longitude coordinates for every kilometer value.

The TCC provides these WGS84 points, encoded in DATEX II, to the C-ITS system via the IF1 TCC <-> C-ITS-S interface where they are used for encoding all the necessary geographical information inside the DENM (more precisely the data elements eventPosition, eventHistory and trace). Figure 1 is a visualization of that process. The order of points in the DATEX II stream is always in the direction of the event, which means that for the trace, the order of points is reverse to the order in the DENM data frame, whereas for the eventHistory, the order is the same. The eventHistory in ECo-AT is a full history of the event (using equidistant points) from the eventPosition to the end of event. Default point distance is 50m but can increase if events are longer than 1150m due to the restriction of 23 points in the eventHistory.

Point events – TCC provides one location point (position of event)



Events with spatial extension – TCC provides two location points (begin and end of an event)

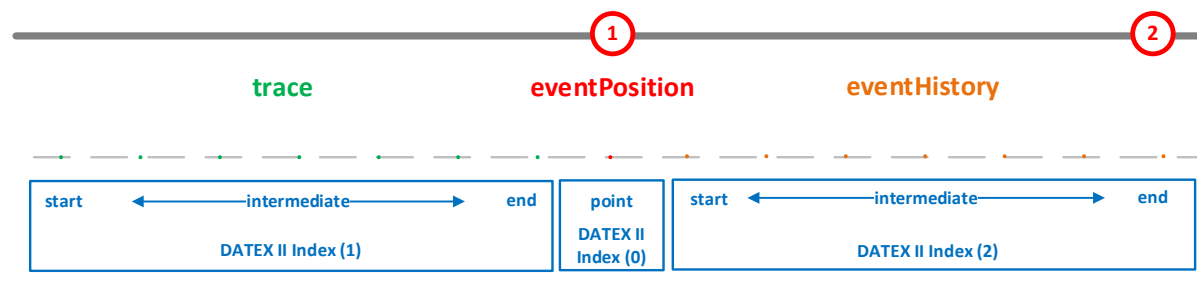


Figure 1: Event location encoding principles in ASF-EMS, DATEX II and DENM

Until Release 2 (March 2015), available automated projections at the TCC were based on older systems and requirements, which only covered whole carriageways and did not guarantee a positioning in the middle of the carriageway under all circumstances. Since Release 3 (July 2015), a better, more precise projection based on GIP (Austria's Graph Integration Platform) is available.

3.9 Event Timing

Infrastructure based DENM events will be created in the C-ITS system whenever there is a suitable event present in the ASFINAG Event-Management-System (ASF-EM). The duration of a singular DENM is based on the value of the "*validityDuration*" data element (with a maximum of 720 seconds for Day 1 use cases in ECo-AT). The DEN event message will therefore be continuously updated and re-sent (using DENM update and DENM repetition as described in [ETSI 302 637-3]) as long as the event itself is still valid.

The TCC will actively signal the end of event validity by sending an update with *validityStatus* "suspended" on the DATEX II based IF1 TCC <-> C-ITS-S interface. Until that happens, the C-ITS-S will always update the resulting DENM using the DENM update mechanism whenever the event changes according to the TCC (in categorization (cause code) or place (position / start and end point) or after half of "*validityDuration*" has passed. In between updates, the DENM is continuously repeated using the DENM repetition mechanism.

Negation or cancellation of DENM events will not be implemented for this use case for the time being: The maximum validity of a DENM will be rather short (20s – 720s) and the number of sending / receiving ITS stations quite low in the ECo-AT Day 1 scenario. Messages can therefore time out safely after the TCC has indicated the end of their validity, especially considering the low chances of a cancellation / negation actually reaching any receiver in time.

3.10 Event Triggering

DENM are usually created directly in the vehicle, if such a vehicle encounters certain "triggering conditions", a set of (pre)conditions and clearly defined circumstances outlined e.g. in the application profile and triggering conditions documents by the C2C-CC. This was done to ensure a consistent quality level for DENMs in the V2V and V2I domain. In regard to infrastructure based DENM events and the I2V domain, the same principles are true: each event in the ASFINAG Event-Management-System (ASF-EM) is based on a consistent set of triggering conditions, guided by previous experience, aided by a range of technical systems and trustable information sources and verified by experienced personnel. It can therefore be considered a trusted information source.

3.11 Linked Events

Events can be linked in the ASFINAG Event-Management-System (ASF-EM): an accident can for example generate a traffic jam and both events are clearly linked to each other in the TCC. The DATEX II based IF1 between TCC and C-ITS-S expresses this link by putting both events as individual SituationRecords into the same Situation. The C-ITS-S then creates one DENM out of each DATEX II SituationRecord. In the Roadworks Warning Use Case [ECo-AT SWP2.1 UC RWW], two or more such DENMs that represent the

same event (the same roadwork) are linked by the “*ReferenceDenms*” data frame in the DENM AlacarteContainer / roadWorks data frame, which, as the name indicates, is principally restricted to roadworks and cannot be used the same way for other DENMs as needed in this scenario. ECo-AT plans to raise this issue with ETSI / TC ITS by introducing a change request to the DENM to enable full DENM referencing outside of the (roadWorks) AlacarteContainer, for example in the SituationContainer. As long as full referencing is not possible, ECo-AT will use the “*linkedCause*” data frame in the SituationContainer to convey at least the cause code / sub cause code of linked events.

3.12 DENM Data Element Description

The following chapter describes the relevant data elements of the DENM structure, determines the source for the provision of the data elements and comments on the interpretation and default values for each data element.

3.12.1 Management Container

Data element	DENM Container		Source	Comment	Ref.
<i>actionID</i>	Management	M	C-ITS-S on behalf of TCC	<p>Def: station that implements the DEN message; Station ID + sequence number = action ID; Each ITS station needs a unique station ID</p> <p>C-ITS-S creates the <i>actionID</i> based on its own stationID (as originating station) and a sequence number based on the DATEX II identification of the event from the TCC.</p>	[ETSI 302 637-3]

Data element	DENM Container		Source	Comment	Ref.
<i>detectionTime</i>	Management	M	C-ITS-S (based on TCC data)	<p>Def: According to [ETSI 302 637-3], this is when the information was “detected”.</p> <p><i>detectionTime</i> shall be set based on C-ITS-S system time when it receives the event information from the TCC. Will be updated using the DENM update mechanism whenever the event changes according to the TCC or after half of <i>validityDuration</i> (720s) has passed.</p>	[ETSI 302 637-3]
<i>referenceTime</i>	Management	M	C-ITS-S	<p>Def: timestamp when message is generated / updated</p> <p><i>referenceTime</i> shall be the time the DENM is encoded or updated in the C-ITS-S. Will be updated in the same manner as <i>detectionTime</i>.</p>	[ETSI 302 637-3]

Data element	DENM Container		Source	Comment	Ref.
<i>isNegation</i>	Management	O	N.A.	<p>Def: indicates that in another (not the originating) ITS-S' "opinion" the information should not be valid any more.</p> <p>Not applicable for this use case. Not used. ECo-AT will work with validity durations, indicating the time when the event will end.</p>	[ETSI 302 637-3]
<i>isCancellation</i>	Management	O	N.A.	<p>Not applicable for this use case. Not used. ECo-AT will work with validity durations, indicating the time when the event will end.</p>	[ETSI 302 637-3]
<i>transmissionInterval</i>	Management	O	Not used for DENM based events on Day 1 (for later usage C-ITS-S)	<p>Def: If used, (i.e. if set by the originator ITS-S because an application has requested so) repetition and forward is done accordingly by originator and forwarder ITS-S.</p> <p>[ETSI 302 637-3] 6.1.2.3 requires <i>transmissionInterval</i>, <i>detectionTime</i> and <i>repetitionDuration</i> must be set if a DEN basic service of an ITS station shall repeat a message.</p> <p>Option not used</p>	[ETSI 302 637-3]

Data element	DENM Container		Source	Comment	Ref.
<i>eventPosition</i>	Management	M	TCC	TCC will deliver WGS84 Lat/Long information, which can directly be used on the information processing chain downwards. TCC will however not deliver altitude information, as there is no data source of sufficient quality.	[ETSI 302 637-3]
<i>relevanceDistance</i>	Management	O	C-ITS-S	Def: enumeration (0-7) indicating in which distance the event information is relevant for the receiver A default value of <i>lessThan5km(5)</i> is used	[ETSI 302 637-3]
<i>relevanceTrafficDirection</i>	Management	O	TCC	<i>upstreamTraffic(1)</i>	[ETSI 302 637-3]
<i>validityDuration</i>	Management	M	C-ITS-S based on TCC	Def: time (seconds since <i>detectionTime</i>) set by the originator ITS-S, at which DENM should be deleted by the DEN basic service of the receiver. If not set <i>defaultValidity=600 [s]</i> is applied <i>validityDuration</i> is related to <i>detectionTime</i> and must be set accordingly. For the Day 1 application of this use case, a range between 20s and 720s was defined by ECo-AT. Default value is 720s.	[ETSI 302 637-3]

Data element	DENM Container		Source	Comment	Ref.
<i>stationType</i>	Management	M	C-ITS-S or R-ITS-S	<p>Def: from [ETSI-CDD]:</p> <p>StationType ::= INTEGER { unknown(0), pedestrian(1), cyclist(2), moped(3), motorcycle(4), passengerCar(5), bus(6), lightTruck(7), heavyTruck(8), trailer(9), specialVehicles(10), tram(11), roadSideUnit(15) } (0..255)</p> <p>The station composing the DENM shall set this to <i>roadSideUnit(15)</i>.</p>	[ETSI 302 637-3]

Table 7: DEN message data elements - management container

3.12.2 Situation Container

Data element	DENM Container		Source	Comment	Ref.
<i>informationQuality</i>	Situation	M	C-ITS-S based on TCC	<p>Def: InformationQuality ::= INTEGER { unavailable(0), lowest(1), highest(7) }</p> <p>Amsterdam Group: Planned by operator (1) Simple GNSS(2) Differential GNSS(3) Validated position(4)</p> <p>Will be set to Validated position (4) for all infrastructure based events, based on Amsterdam Group recommendation, as all events are validated by the TCC and map-matched to provide the necessary points and traces.</p>	[ETSI 302 637-3]
<i>EventType</i>	Situation	M	C-ITS-S based on TCC	<p>C ITS S will have to execute a mapping of cause code and sub cause code based on an agreed ECo-AT specific mapping from the ASFINAG event management system as outlined in this document and in [ECo-AT SWP3.1 DATEX II mapping]</p>	[ETSI 302 637-3]

Data element	DENM Container		Source	Comment	Ref.
<i>linkedCause</i>	Situation	O	TCC	<p>Def: same as eventType: possibility to provide a further information using Cause/subCause.</p> <p>Option not used. Events may contain further events somehow linked to the original event but these events will be conveyed by separate DENMs, as they can also differ in other regards like geographical position.</p>	[ETSI 302 637-3]
<i>eventHistory</i>	Situation	O	TCC	<p>Consists of a list of event points which represents the dimension of a plain event in a predefined order. In case that the plain event is detected by a V-ITS-S, it consists of a list of event detection points along the path that the detecting ITS-S has travelled over some past time and/or distance. Each event point corresponds to a point at which the same event was detected along the path.</p> <p>Provided by the TCC (if the originating event is not a point event only), it describes the history of the event up until the final release point.</p>	[ETSI 302 637-3]

Table 8: DEN message data elements - situation container

3.12.3 Location Container

Data element	DENM Container		Source	Comment	Ref.
<i>eventSpeed</i>	Location	O	TCC	Def: moving speed of detected event Not available. Not used	[ETSI 302 637-3]
<i>eventPositionHeading</i>	Location	O	TCC	Def: heading direction of the event Not available. Not used.	[ETSI 302 637-3]
<i>traces</i>	Location	M	TCC	Def: up to 7 <i>pathHistory traces</i> composed of geocoordinates Created in the TCC from known event location information and provided to C-ITS-S.	[ETSI 302 637-3]
<i>roadType</i>	Location	O		Def: [ETSI-CDD] RoadType ::= ENUMERATED { urban-NoStructuralSeparationToOppositeLanes(0), urban-WithStructuralSeparationToOppositeLanes(1), nonUrban-NoStructuralSeparationToOppositeLanes(2), nonUrban-WithStructuralSeparationToOppositeLanes(3) } Not used for Events	[ETSI 302 637-3]

Table 9: DEN message data elements - location container

4 Vehicle based DENM events

C-ITS equipped vehicles are broadcasting DENMs that will be received by the R-ITS-Ss of the ECo-AT project. The DENMs received by the R-ITS-S will be from different V-ITS-Ss and may contain different events. The R-ITS-S therefore has to eliminate DENM duplicates (originated by the same V-ITS-S and containing the same event). Only unique DENMs are to be forwarded to the C-ITS-S via IF3. On the C-ITS-S level, the relevant event information contained in the DENM (cause and sub cause codes) and certain other parameters have to be extracted and mapped into corresponding DATEX II information sets to be sent to the TCC via IF1. Using this concept, the TCC receives one data set about a specific event from each vehicle in the range of one R-ITS-S. If more than one vehicle is broadcasting the same event in the range of one R-ITS-S, the TCC can use these multiplied DENM information (same event but from a greater number of vehicles) as a quality indicator: if one event is reported by many vehicles, the quality and reliability of information is certainly higher.

4.1 Mapping DENM events to DATEX II

From a functional point of view, the main task for the C-ITS system in this scenario will be the mapping of DENM events into corresponding DATEX II records. IF1, the DATEX II based interface between TCC and C-ITS-S, will provide a DATEX II profile [DATEX profile OtherDENM] for communicating event information to the C-ITS-S which can also be used the other way around, sending event information back to the TCC. In order to do so, the C-ITS-S will have to extract the cause and sub cause code combination of the DENM event and map it to a corresponding DATEX II SituationRecord, which is then populated with all the other information available in the DENM.

The complete mapping information relevant for this use case and this scenario of Vehicle based DENM events can be found in the ECo-AT SWP3.1 DATEX II Mapping Tables [ECo-AT SWP3.1 DATEX II mapping] in the "*DATEXII_Translation_OtherDENM_V03.60.xlsx*" Excel spreadsheet.

Part of this spreadsheet is a sheet called "*DENM_DATEXII*": it contains a mapping to DATEX II (using the relevant use case profile [DATEX profile OtherDENM]) for all cause and sub cause codes of the DENM. A short example of this process for cause code 1 / traffic condition can be found in Table 10. Mapping DENM cause codes 1 – 30, which are harmonized with TISA and the [TPEG TEC] specification, is rather straightforward. DENM cause codes 91 – 99 however represent vehicle specific events that have no correlation to TISA / TPEG TEC and are harder to map to DATEX II.

Whenever there is no direct mapping to DATEX II possible, the generic DATEX II record "*Conditions*" (with *drivingConditionType = passableWithCare*) is used and the description of the cause code has to be put into

the “nonGenericPublicComment” container which includes a “MultilingualString”. These mapping are marked in red in the full table in the spreadsheet (but not in the example shown in Table 10, as there is no mapping problem for cause code 1 / traffic condition).

DENM Cause Codes				DATEX II (SituationRecord)				
Cause Code	Cause Code Description	Sub Cause Code	Sub Cause Code Description	SituationRecord Type	PrimaryAttribute (SubType) Name	PrimaryAttribute (SubType) Value	SecondaryAttribute (SubType) Name	SecondaryAttribute (SubType) Value
1	traffic condition	0	Unavailable	AbnormalTraffic	abnormalTrafficType	stationaryTraffic		
1	traffic condition	1	increased volume of traffic	AbnormalTraffic	abnormalTrafficType	stationaryTraffic	trafficTrendType	increasing
1	traffic condition	2	Traffic jam slowly increasing	AbnormalTraffic	abnormalTrafficType	stationaryTraffic	trafficTrendType	increasing
1	traffic condition	3	Traffic jam increasing	AbnormalTraffic	abnormalTrafficType	stationaryTraffic	trafficTrendType	increasing
1	traffic condition	4	Traffic jam strongly increasing	AbnormalTraffic	abnormalTrafficType	stationaryTraffic	trafficTrendType	increasing
1	traffic condition	5	Traffic stationary	AbnormalTraffic	abnormalTrafficType	stationaryTraffic		
1	traffic condition	6	Traffic jam slightly decreasing	AbnormalTraffic	abnormalTrafficType	stationaryTraffic	trafficTrendType	decreasing
1	traffic condition	7	Traffic jam decreasing	AbnormalTraffic	abnormalTrafficType	stationaryTraffic	trafficTrendType	decreasing
1	traffic condition	8	Traffic jam strongly decreasing	AbnormalTraffic	abnormalTrafficType	stationaryTraffic	trafficTrendType	Decreasing

Table 10: Mapping from DENM cause codes to DATEX II example for cause code 1 / traffic condition