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Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Decentralized Environmental Notification Service; Release 2

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Intelligent Transport Systems (ITS).

Modal verbs terminology

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Introduction

The DEN service is an application support functionality facility at the facilities layer. It generates, manages and processes the Decentralized Environmental Notification Message (DENM). The generation of a DENM is triggered by an ITS-S application. A DENM contains information related to a road hazard or an abnormal traffic condition, such as its type and its position. The DEN service delivers the DENM as payload to the ITS networking & transport layer for the message dissemination. Typically for an ITS application, a DENM is disseminated to ITS-Ss that are located in a geographic area through communications among ITS stations. At the receiving side, the DEN service of an receiving ITS-S processes the received DENM and provides the DENM content to an ITS-S application. This ITS-S application may present the information to the driver if information of the road hazard or traffic condition is assessed to be relevant to the driver. The driver is then able to take appropriate actions to react to the situation accordingly.

The Release 1 edition of the DEN service has been published as ETSI EN 302 637-3 [i.9] called the DEN basic service. The first Release 2 version of the present document provides an improved specification of the Release 1 version as a basis for future Release 2 versions of the DEN service. The present document specifies extensions to the DENM Release 1 format to support additional use cases in a way allowing the facilities layer standard to be used with different security and lower layer technologies.

All future Release 2 versions will be based on the latest Release 1 version of the DEN service and will be backwards compatible with it in the sense that Release 1 implementations can receive and decode Release 2 DENM and utilize the Release 1 content without the need to understand the Release 2 content.

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1 Scope

The present document provides the specification of the Release 2 DEN service.

More specifically, the present document specifies the syntax and semantics of the "Decentralized Environmental Notification Message" (DENM) and the DENM protocol handling.

The DEN service may be implemented in a vehicle ITS-S, a road side ITS-S, a personal ITS-S or a central ITS-S.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

- [1] [ETSI TS 103 836-4-1](#): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality; Release 2".
- [2] [ETSI TS 103 836-5-1](#): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol; Release 2".
- [3] [ETSI TS 102 965](#): "Intelligent Transport Systems (ITS); Application Object Identifier (ITS-AID); Registration; Release 2".
- [4] [ETSI TS 103 899](#): "Intelligent Transport Systems (ITS); Vehicular Communications; Geographical Area Definition; Release 2".
- [5] [ETSI TS 102 894-2](#): "Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary; Release 2".
- [6] [Recommendation ITU-T X.691/ISO/IEC 8825-2](#): "Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)".
- [7] [ETSI EN 302 890-2](#): "Intelligent Transport Systems (ITS); Facilities Layer function; Part 2: Position and Time management (PoTi); Release 2" "Intelligent Transport Systems (ITS); Facilities Layer function; Part 2: Position and Time management (PoTi); Release 2".
- [8] [ETSI TS 103 097](#): "Intelligent Transport Systems (ITS); Security; Security header and certificate formats; Release 2".
- [9] [ETSI TS 102 940](#): "Intelligent Transport Systems (ITS); Security; ITS communications security architecture and security management; Release 2".
- [10] [ETSI TS 103 141](#): "Intelligent Transport Systems (ITS); Facilities layer function; Multi-Channel Operation (MCO) for Cooperative ITS (C-ITS); Release 2".

2.2 Informative references

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] ETSI TR 102 638 (V2.1.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Release 2".
- [i.2] Car2Car Communication Consortium: "[Basic System Profile](#)".
- [i.3] Car2Car Communication Consortium: "[Guidance for day 2 and beyond roadmap](#)".
- [i.4] C-Roads: "[Harmonised C-ITS Specifications for Europe](#)".
- [i.5] ETSI TS 103 938: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Local Dynamic Map (LDM); Release 2".
- [i.6] ETSI TS 103 898: "Intelligent Transport Systems (ITS); Communications Architecture; Release 2".
- [i.7] ETSI TS 103 836-3: "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 3: Network Architecture; Release 2".
- [i.8] ISO EN 17419: "Intelligent Transport Systems - Cooperative Systems - Classification and management of ITS applications in a global context".
- [i.9] ETSI EN 302 637-3 (V1.3.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service".
- [i.10] ETSI TS 103 301: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services; Release 2".
- [i.11] ETSI TR 103 832: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Study on ITS Support for Pre-Crash based Applications; Release 2".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI TS 103 301 [i.10], ETSI TS 103 898 [i.6], ETSI TS 102 894-2 [5], ETSI TS 103 938 [i.5] and the following apply:

actionId: identifier of a detected event

À La Carte container: container of DENM that includes information of the detected event in addition to management container, situation container and location container

NOTE: Due to coding constraints in programming language, the term "alacarte" is also used.

awareness area: geographic area in which information concerning the event is potentially applicable for use or for further distribution

basic set of applications: group of applications, supported by the vehicular communication system

NOTE: The BSA is defined in ETSI TR 102 638 [i.1].

cancellation Decentralized Environmental Notification Message (DENM): DEN message type generated by the ITS-S, which originated the new DENM, indicating the event termination

Decentralized Environmental Notification (DEN) basic service: facility at the facilities layer to support ITS-S applications, DENM management and DENM dissemination

Decentralized Environmental Notification Message (DENM): ITS facilities layer PDU providing event information

Decentralized Environmental Notification Message (DENM) protocol: ITS facilities layer protocol that operates the DENM transmission, forwarding and reception

destination area: geographical area for DENM dissemination

NOTE: The destination area is specified in ETSI TS 103 899 [4].

downstream traffic: portion of traffic in a given direction that is beyond (past) a certain point and is going away from it

event: road hazard, driving environment, or traffic condition

facility: functionality, service or data provided by the ITS facilities layer

forwarding Intelligent Transport System Station (ITS-S): ITS-S that forwards DENMs and implements the DENM protocol

location container: container of DENM that includes location data of the detected event

management container: container of DENM that includes management data for DENM protocol

negation Decentralized Environmental Notification Message (DENM): DEN message type generated by an ITS-S other than the ITS-S, which originated the new DENM, indicating the event termination

new Decentralized Environmental Notification Message (DENM): DEN message type indicating that the event is detected for the first time

originating Intelligent Transport System Station (ITS-S): ITS-S that generates DENMs and implements the DENM protocol

receiving Intelligent Transport System Station (ITS-S): ITS-S that receives DENMs from the ITS networking & transport layer and implements the DENM protocol

situation container: container of DENM that includes data related to the detected event

update Decentralized Environmental Notification Message (DENM): DEN message type indicating the evolution of the event

upstream traffic: portion of traffic in a given direction that has not yet arrived at a certain point and is going towards it

3.2 Symbols

For the purposes of the present document, the following symbols apply:

actionId	Identifier of an event that is detected by an ITS-S
appDENM_trigger	Application request type to generate a new DENM for a newly detected event
appDENM_update	Application request type to generate an update DENM for an update of the event
appDENM_termination	Application request type to generate a cancellation or negation DENM for termination of the event
detectionTime	Timestamp at which an event or event update/termination is detected
IF.DEN1	Interface between the DEN service and ITS-S applications for DENM transmission
IF.DEN2	Interface between the DEN service and ITS-S applications for DENM reception
IF.Mng	Interface between the DEN service and the ITS management entity

IF.MCO	Interface between the DEN service and the MCO facility layer entity
IF.N&T	Interface between the DEN service and the ITS networking & transport layer
IF.SEC	Interface between the DEN service and the ITS security entity
referenceTime	Timestamp at which a new, update or cancellation DENM is generated by the DEN service

NOTE: A negation DENM contains the *referenceTime* of the DENM that is negated.

repetitionDuration	Duration of the DENM repetition
repetitionInterval	Time interval of the DENM repetition
stationId	Identifier of an ITS-S
T_F_VValidity	Timer that indicates the end of the DENM processing of one specific actionId of the forwarding ITS-S
T_Forwarding	Timer for the scheduling of the DENM forwarding by the forwarding ITS-S
T_O_VValidity	Timer that indicates the end of the DENM processing of one specific actionId of the originating ITS-S
T_R_VValidity	Timer that indicates the end of the DENM processing of one specific actionId of the receiving ITS-S
T_Repetition	Timer for the scheduling of the DENM repetition by the originating ITS-S
T_RepetitionDuration	Timer that indicates the end of the DENM repetition
termination	Parameter that indicates the termination of an event
transmissionInterval	Time interval for DENM transmission
validityDuration	Duration of the DENM validity

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI TS 103 898 [i.6] and the following apply:

ASN.1	Abstract Syntax Notation One
BSA	Basic Set of Applications
BTP	Basic Transport Protocol
C2C-CC	Car to Car Communication Consortium
DE	Data Element
DEN	Decentralized Environmental Notification
DENM	Decentralized Environmental Notification Message
DF	Data Frame
EEBL	Electronic Emergency Break Light
GN	GeoNetworking
HMI	Human Machine Interface
ISO	International Standardization Organization
ITS	Intelligent Transport System
ITS-AID	ITS-Application IDentifier
ITS-S	ITS Station
IVIM	In-Vehicle Information Message
KAF	Keep Alive Forwarding
LDM	Local Dynamic Map
MAPEM	MAP Extended Message
MSB	Most Significant Bit
MCI	MCO Control Information
MCO	Multi Channel Operations
OSI	Open System Interconnection
PCI	Protocol Control Information
PDU	Protocol Data Unit
PER	Packed Encoding Rules
SSP	Service Specific Permissions
TS	Technical Specification

4 DEN service introduction

4.1 Background

The Decentralized Environmental Notification service (DEN) is an application support functionality operating at the facilities layer. The DEN service is responsible for the generation of DEN Messages (DENMs) based on received triggering information from applications. It is also responsible for the processing of received DENMs from other C-ITS stations. The DEN service is especially suited for the exchange of event based safety related information. The DENM information is mainly used by ITS applications in order to alert road users of a detected event using ITS communication technologies. DENM is used to describe a variety of events that can be detected by ITS Stations (ITS-S). A set of ITS applications, ITS services and use cases are specified in the ETSI Basic Set of Applications [i.1], in the C2C-CC Basic System Profile [i.2] and the C-Roads Release [i.4]. Further use cases are specified in the C2C-CC Roadmap [i.3].

The dissemination of DENM by an ITS-S is operated by DENM protocol.

The general processing procedure of an ITS use case that is supported by the DENM protocol is as follows:

- Upon detection of an event, an ITS-S transmits DENMs in order to disseminate the information about this event to other ITS-Ss located inside a destination area. The ITS-S that generates the DENM is denoted as originating ITS-S.
- DENM transmission is initiated and terminated by an ITS-S application at the ITS application layer.
- The transmission of a DENM may be repeated.
- DENM transmission may persist as long as the event is present.
- An ITS-S may forward a DENM. This ITS-S is denoted as forwarding ITS-S.
- The termination of DENM transmission is either automatically achieved by the facilities layer, i.e. the DEN service of the originating ITS-S when a predefined expiry time is reached, or by an ITS-S application that requests the generation of a DENM to inform that the event has terminated.
- An ITS-S, which receives a DENM, processes the information and may decide to present an appropriate warning or information to user, as long as the information in the received DENM is relevant to the ITS-S. This ITS-S is denoted as receiving ITS-S.

A general inter-layer and inter-ITS-Ss dataflow for DENM exchange is provided in Figure 1.

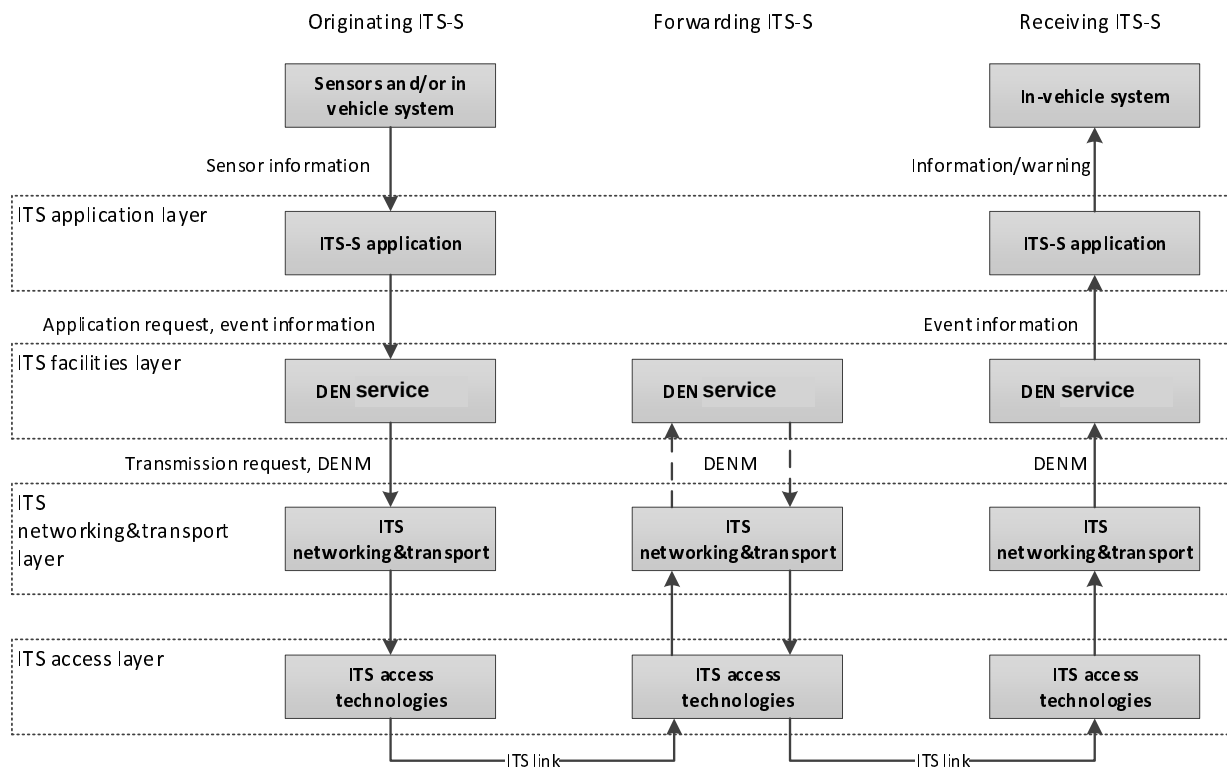


Figure 1: General data flow for ITS-S application supported by the DEN service

The solid lines illustrate the dataflow that is mandatory for all ITS applications using the DENM protocol. The dotted lines illustrate the dataflow that may apply only in certain situations.

NOTE: A DENM may be forwarded by intermediate ITS-Ss in order to disseminate DENM from the originating ITS-S to the receiving ITS-S, if the receiving ITS-S is not located in the direct communication range of the originating ITS-S. This forwarding is realized by the ITS networking & transport layer. In addition, the DEN service may provide forwarding functionality at the facilities layer, in order to maintain the DENM retransmission in certain situations, for example when the originating ITS-S has lost the capability to repeat DENM transmission. This optional facilities layer forwarding functionality is illustrated as dotted lines in Figure 1.

4.2 Services provided by the DEN service

The DEN service provides services to entities at the ITS application layer. At the originating ITS-S, an ITS-S application may trigger, update and terminate the transmission of DENMs. At the receiving ITS-S, the DEN service processes received DENMs and makes the information available for usage by ITS-S applications. Optionally, the DEN service may also provide forwarding functionality.

The DEN service uses the services provided by the protocol entities of the ITS networking & transport layer to disseminate DENM.

NOTE 1: Typically, for road safety ITS applications, the destination of a DENM transmission are ITS-Ss that are located in a pre-defined geographic area in which the event information may be relevant for traffic participants, e.g. close to the detected event reference position.

NOTE 2: A DENM may also be disseminated over a long distance or to a central ITS-S, such as for vehicle rerouting or road traffic management purposes.

A DENM contains information related to an event that has potential impact on road safety or traffic condition. An event is characterized by an event type, an event reference position, a detection time and a duration. These attributes may change over space and over time.

In some situations, the originating ITS-S transmits a DENM of an event originated by the vehicle itself, such as an electronic brake light event. The originating ITS-S manages the transmission and the termination of the DENM for this event. However, in some other situations, DENMs related to the same event may be transmitted by more than one originating ITS-Ss that detect the same event, such as several vehicle ITS-Ss travelling through the same location. In yet some other situations, the event might instead or additionally be detected by roadside sensors connected to a traffic management centre and the event information relayed to selected roadside ITS-S(s) to generate and transmit DENMs within or near to the destination area. In addition, in case the originating ITS-S is mobile (e.g. vehicle ITS-S or personal ITS-S), an event may persist even after the originating ITS-S has moved to a position far from the event reference position where the event was originally detected. For example, multiple vehicle ITS-Ss may detect black ice on the road surface and transmit DENMs. These DENMs can optionally be maintained by and relayed to other ITS-Ss, even after the detecting vehicle ITS-Ss have left the black ice location.

The DENM protocol is designed to manage these situations. The following DENM types are defined:

- **New DENM:** A DENM generated by the DEN service when:
 - an event is detected by the ITS-S application of an originating ITS-S; or
 - when information about an event is received by the ITS-S application of an originating ITS-S from a connected system;
 - for the first time and a corresponding trigger is sent to the DEN service. Each new DENM is assigned with a new identifier, denoted as *actionId*. A new DENM provides event attributes, such as event reference position, event type, event detection time, and other attributes as defined in clause 7.
- **Update DENM:** A DENM generated by the DEN service that includes update information of an event. An update DENM is transmitted by the same originating ITS-S, which had generated the new DENM for the same event.
- **Cancellation DENM:** A DENM that informs about the termination of an event. A cancellation DENM is transmitted by the same originating ITS-S which has generated the new DENM for the same event.
- **Negation DENM:** A DENM that informs about the termination of an event for which a DENM has been received by the originating ITS-S from another ITS-S. A negation DENM may be used to announce the termination of an event if the originating ITS-S has the capacity to detect the termination of an event which has been previously announced by other ITS-Ss. As example, the originating ITS-S of a DENM indicating black ice has left the event reference position, some time later, another ITS-S receiving this new DENM reaches the indicated black ice position and detects that the back ice has disappeared. The latter ITS-S may in this case generate a negation DENM for this event.

NOTE 3: Whether a negation DENM is transmitted may depend on the application requirements and the deployment requirements defined for example in the C2C-CC Basic System Profile [i.2] and the C-Roads Release [i.4]. Therefore, definition of conditions under which the generation and transmission of negation DENM is allowed is out of scope of the present document.

The DEN service of the originating ITS-S shall be able to generate at least DENMs of type New and Update. The generation of Cancellation and Negation DENMs is optional. The ITS-S application of the originating ITS-S sends an application request to the DEN service in order to trigger the generation of DENMs. The type of the DENM to be generated depends on the type of the application request.

Due to the different detection capabilities of ITS-Ss, the quality of the provided information in a DENM may vary. However, predefined conditions are to be satisfied by an ITS-S in order to initiate and terminate the transmission of DENMs for a specific event. These conditions are specified as ITS application requirements in the C2C-CC Basic System Profile [i.2] and the C-Roads Release [i.4].