ETSI TR 103 832 V2.1.1 (2023-06)

TECHNICAL REPORT

**Intelligent Transport Systems (ITS);
Vehicular Communications;
Basic Set of Applications;
Study on ITS Support for Pre-Crash based Applications;
Release 2**

Reference

DTR/ITS-001954

Keywords

application, ITS

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00   Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Important notice

The present document can be downloaded from:
http://www.etsi.org/standards-search

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

If you find a security vulnerability in the present document, please report it through our
Coordinated Vulnerability Disclosure Program:
https://www.etsi.org/standards/coordinated-vulnerability-disclosure

Notice of disclaimer & limitation of liability

The information provided in the present deliverable is directed solely to professionals who have the appropriate degree of experience to understand and interpret its content in accordance with generally accepted engineering or
other professional standard and applicable regulations.
No recommendation as to products and services or vendors is made or should be implied.
No representation or warranty is made that this deliverable is technically accurate or sufficient or conforms to any law and/or governmental rule and/or regulation and further, no representation or warranty is made of merchantability or fitness for any particular purpose or against infringement of intellectual property rights.
In no event shall ETSI be held liable for loss of profits or any other incidental or consequential damages.

Any software contained in this deliverable is provided "AS IS" with no warranties, express or implied, including but not limited to, the warranties of merchantability, fitness for a particular purpose and non-infringement of intellectual property rights and ETSI shall not be held liable in any event for any damages whatsoever (including, without limitation, damages for loss of profits, business interruption, loss of information, or any other pecuniary loss) arising out of or related to the use of or inability to use the software.

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Intelligent Transport Systems (ITS).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

This message extension aims at sharing of dedicated information about a critical/pre-crash situation with other ITS-Ss in the immediate surrounding, in cases where a collision is likely. The proposed Pre-Crash à la carte container provides use case relevant data about the sending ITS-S and the detected critical objects (i.e. relative speed and distance between the sending vehicle and the critical object). This enables a receiving vehicle (ITS-S) to assess the individual risk and take appropriate Pre-Crash measures.

1 Scope

The present document provides the relevant data for the implementation of a DENM Pre-Crash specific à la carte container in Decentralized Environmental Notification Messages in ETSI TS 103 831 [i.3] and in the Common Data Dictionary (ETSI TS 102 894-2 [i.5]) specifications to support primarily Pre-Crash application as well as other potential traffic safety use cases.

The present document includes the definition of the Pre-Crash à la carte container and detailed description of the data, the message and the message handling to increase the awareness of the environment in a cooperative manner.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative 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.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

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] C2C-CC RS2066 (Release 1.6.1/ 2021-12-17): "Triggering Conditions and Data Quality Pre-Crash Information".

[i.2] C2C-CC RS2067 (Release 1.6.1/ 2021-12-17): "ASN.1 extension for Pre-Crash Information".

[i.3] ETSI TS 103 831: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Decentralized Environmental Notification Service; Release 2".

[i.4] ETSI TS 103 900: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Specification of Cooperative Awareness Basic Service; Release 2".

[i.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".

[i.6] ETSI TR 103 562: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Analysis of the Collective Perception Service (CPS); Release 2".

[i.7] C2C-CC RS2004 (Release 1.6.1/ 2021-12-17): "Triggering Conditions and Data Quality Exchange of IRCs".

[i.8] ETSI TS 103 898: "Intelligent Transport Systems (ITS); Communications Architecture; Release 2".

[i.9] Regulation No 48 of the Economic Commission for Europe of the United Nations (UN/ECE) - Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices [2016/1723].

3   Definition of terms, symbols and abbreviations

3.1   Terms

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

à la carte container: container of DENM that includes information about the detected event in addition to management, situation and location containers

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

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

event: road hazard, driving environment, or traffic condition

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

ITS Central System: ITS system in the backend, e.g. traffic control centre, traffic management centre, or cloud system from road authorities, ITS application suppliers or automotive OEMs

    NOTE: See clause 4.5.1.1 of ETSI TS 103 898 [i.8].

ITS station: functional entity specified by the ITS station (ITS-S) reference architecture

    NOTE: The definition is conformant to ETSI TS 103 898.

management container: container of DEN service that includes management data for DEN 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

pre-crash situation: situation in which a collision is imminent and unavoidable

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

Roadside ITS station: ITS station in a roadside ITS sub-system

    NOTE: The definition is compliant to ETSI TS 103 898 [i.8].

V2X: vehicle-to-everything which includes vehicle to vehicle (V2V), vehicle to infrastructure (V2I) and/or infrastructure to vehicle (I2V), or vehicle to network (V2N) and/or network to vehicle (N2V)

3.2   Symbols

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

    V1   V1 denotes the vehicle that is about to collide with another vehicle in its direction of travel, by driving, rolling or sliding into this other vehicle.

    V2   V2 denotes the vehicle that is about to collide with another vehicle [V1], not in its direction of travel by being stationary or moving in another direction.

3.3   Abbreviations

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

ASN.1	Abstract Syntax Notation One
AT	Authorisation Ticket
CAM	Co-operative Awareness Message
C-ITS	Cooperative-Intelligent Transport Systems-Station
CP	Collective Perception
CPM	Collective Perception Message
CPS	Collective Perception Service
DE	Data Element
DEN	Decentralized Environmental Notification
DENM	Decentralized Environmental Notification Message
ECE	Economic Commission for Europe (UNECE)
GNSS	Global Navigation Satellite System
HLN	Hazardous Location Notification
I2V	Infrastructure-to-Vehicle
IRC	Impact Reduction Container
ITS	Intelligent Transportation Systems
N2V	Network-to-Vehicle
OEM	Original Equipment Manufacturer
PDU	Protocol Data Unit
R-ITS-S	Roadside-Intelligent Transport Systems-Station
TTC	Time To Collision
UN	United Nations
V2I	Vehicle-to-Infrastructure
V2N	Vehicle-to-Network
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-everything

4   The Concept of Pre-Crash à la carte container for the DENM

4.1   Background and Use-Case

The Pre-Crash à la carte container for the DENM in ETSI TS 103 831 [i.3] offers ITS stations the possibility to share information about critical objects in the surroundings that have been detected by sensors, cameras or other information sources mounted to the station, and with which an imminent collision is highly likely, i.e.:

1)   the time to collision is insufficient to allow for preventative action, and therefore;

2)   a complete mitigation of a collision is unlikely.

Figure 1 illustrates one example of a representative Pre-Crash situation, where Vehicle 1 (V1) is about to have a collision with the stationary Vehicle 2 (V2). The Time-To-Collision (TTC) is so low, that a collision is likely (e.g. < 1,5 seconds). In this situation Vehicle 2 could take appropriate measures to mitigate the severity of the collision, e.g. tension the seatbelts, if it knew about the imminent collision.
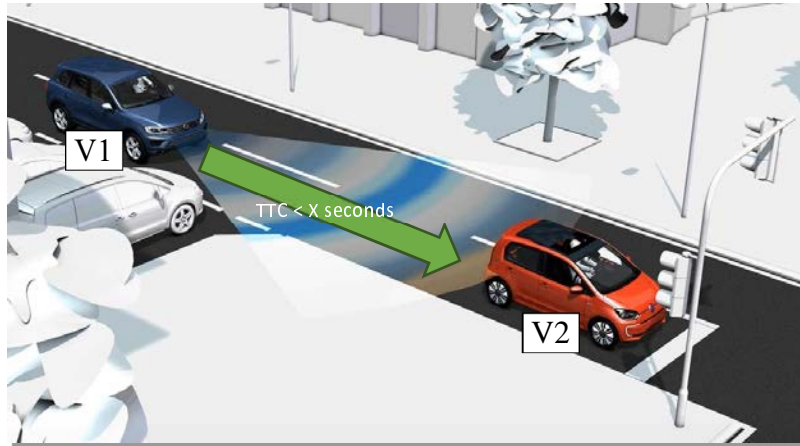
Figure 1: Pre-Crash Rear Use Case - DENM triggered by vehicle ITS-S
©Volkswagen, ETSI use authorized

Use Case Sequence (as shown in Figure 1):

1)   Front Vehicle V2 is equipped with V2X, but is not equipped with rear sensor(s).

2)   Oncoming Vehicle V1 detects Vehicle V2 with its front sensors and that a collision is imminent.

3)   Vehicle V1 sends DENM with a Pre-Crash à la carte container.

4)   Vehicle V2 prepares for a possible collision based on the DENM from V1.

The following Figure 2 shows another representative Use Case, where the rear-vehicle (V1) is not equipped with V2X and where the front-vehicle (V2) is equipped with V2X and not with rear sensor(s). A roadside ITS station (R-ITS-S) obtains object information from stationary sensors (e.g. mounted on the traffic light) and is able to detect a pre-crash situation between vehicles V2 and V1.
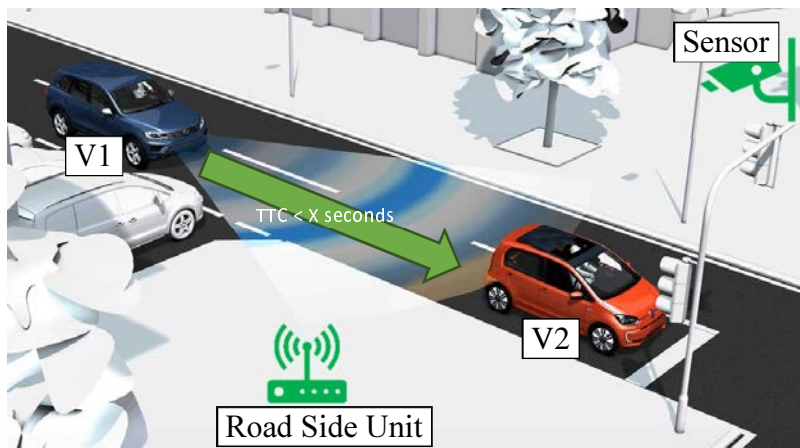
Figure 2: Pre-Crash Rear Use Case - Warning triggered by a R-ITS-S
©Volkswagen, ETSI use authorized

Use Case sequence (as shown in Figure 2):

1)   Front vehicle V2 is equipped with V2X, but is not equipped with rear sensor(s).

2)   Roadside sensor is recognizing an approaching vehicle V1 having a high rear-collision risk with another vehicle.

3)   Road Side Unit sends DENM with a Pre-Crash à la carte container.

4)   Front vehicle V2 prepares for a possible collision based on the received DENM.

4.2   Pre-Crash Use Case

The Pre-Crash use case is described in detail below.

Use Case Name	Pre-Crash
Category	Safety
Short Description	Road users, depicted as V2 in Figure 1 or Figure 2 may not be able to sufficiently detect imminent collisions with other road users (V1), due to a limited number of sensors or other limiting factors. This is especially the case for rear-end collisions where the other road user has a higher velocity and the first road user is not equipped with adequate rear sensors. With the Pre-Crash à la carte container for the DENM, a road user (depicted as V1) or a roadside infrastructure (R-ITS-S) is able to communicate a critical object with which a collision is likely. This allows other ITS stations (including V2) to assess the situation and determine whether they are the communicated critical object themselves, and perform crash mitigation actions. An example of such crash mitigation actions is the so called "Rear-End Collision Alert Signal" or "RECAS", which describes the flashing of the amber hazard warning signal as defined by the UN ECE Regulation No. 48 [i.9].
Actors	Road user (V1) transmitting a detected object with which a collision is imminent. Or Roadside Infrastructure (R-ITS-S) transmitting detected object with which a collision is imminent. Road users (V2) receiving the messages, being able assess the situation and perform collision mitigation actions.
Infrastructure Roles	Optional: Roadside infrastructure equipped with stationary sensors obtaining object information from stationary sensors. It estimates the risk of a collision between the objects.
ITS Central System Roles	-
Other Traffic Participants Roles	-
Goal	• To detect imminent collisions without a 360° sensor coverage of every road user or despite other sensor limitations • To mitigate and reduce the severity of collisions
Needs	To communicate imminent collisions to the surrounding and enable other participant to mitigate and reduce the severity of collisions.
Constrains/Presumptions	• At least one ITS station equipped with sensors. (One of the ITS stations can be a roadside ITS station). • It is assumed, that at least one of the involved vehicles is able to assess the situation because it drives head on into the collision (e. g. with Autonomous Emergency Braking capabilities). This vehicle is considered as V1 (see Figures 1 or 2). Whereas the other vehicle might not be able to assess the situation, because it is being crashed into from an angle where sufficient sensor coverage cannot be assumed e.g. from behind or from a side. This vehicle is considered as V2 (see Figures 1 or 2). • It is not possible to ensure the functional safety of the transmitted data with the DENM à la carte container. The receiving function has to consider this fact.
Geographic Scope	Applicable to any road situation
Pre-Conditions	• ITS stations equipped with sensors able to detect imminent collisions. (ITS stations can include R-ITS-S) • ITS stations able to perform pre-crash measures.
Main Event Flow	1) An imminent collision object (critical object) is detected by a road user (vehicle) or by roadside sensors. 2) Relevant information about the host vehicle or R-ITS-S and the critical object is transmitted via a DENM with a Pre-Crash à la carte container. 3) Other road users receiving such DENM assess the situation and the relevance and are able to perform Pre-Crash measures if necessary.
Alternative Event Flow	
Post Conditions	

Information Requirements	• Sensor information of the collision object ((relative) position, (relative) speed, heading, dimensions, classification, etc.). • Host vehicle information (position, speed, heading, dimension, etc.) or R-ITS-S information (reference position) • Crash related information (predicted Time To Collision (TTC), predicted impact velocity, etc.)

4.3 Reasoning for a Pre-Crash à la carte Container for DENM and Distinction to other Services

A precedent study on the Pre-Crash à la carte Container for the DENM has been performed by the Car-2-Car Communication Consortium and published as Triggering Conditions and Quality Requirements together with a Container Structure [i.1] and an ASN.1-Defintion [i.2] as part of the Basic System Profile of the Car-2-Car Communication Consortium. During the making of the study the appropriate way to communicate Pre-Crash information has been assessed by the members of the Car-2-Car Communication Consortium, the conclusion being that a Pre-Crash à la carte Container for the DENM is the most suitable way to transmit the Pre-Crash information.

The benefits of a DENM Pre-Crash à la carte Container is the event-based character of the DENM. The Pre-Crash Use Case is event based - giving very specific danger and object information, so the receiver is made aware of a potentially dangerous situation directly at the moment of message reception. A DENM with a Pre-Crash à la carte Container can even be prioritized for the safety use case. It is also possible to send information about emergency braking actions in the same message for further evaluations. Further, the use case can operate and utilize the DEN Service in the already used frequency range 5 895 MHz - 5 905 MHz.

The Pre-Crash Use Case cannot solely rely on Co-operative Awareness Messages (CAMs) (ETSI TS 103 900 [i.4]) because CAM transmission rates might be lower and the priority is lower than for a DENM. Also the relative positioning on the receiver side just based on external GNSS-Positions received via CAMs might not be sufficient for Pre-Crash measures. A DENM à la carte container would include the relative distances between the Vehicle 1 and Vehicle 2, measured by a sensor from Vehicle 1. This is assumed to be far better than distance calculations based on relative GNSS positions.

Another closely related service is the Collective Perception Service ETSI TR 103 562 [i.6]. But although the purpose of the CPS is to transmit object information, it is rather intended for continuous transmission of the whole field of view, including a large amount of sensor information. The Collective Perception Message (CPM) is not intended to be used only in specific situations and to provide only information about one critical object. Further, the amount of data required for CPM exchange will likely require a dedicated communication channel and a receiving C-ITS station would have to support multi-channel operation. A future variant of the Pre-Crash use case may however consider a migration path to the CPM.

A complementary concept is the dissemination of a DENM with an Impact Reduction Container (IRC) (ETSI TS 103 831 [i.3], ETSI TS 102 894-2 [i.5] and [i.7]). The Exchange of Impact Reduction Container aims at providing static crash-relevant information about the affected vehicles. The message is basically sent only once. So the whole use case would benefit from a dissemination of a DENM with an IRC parallel to the DENM with a Pre-Crash Container that is coming from the other car.

4.4 Pre-Crash DENM à la carte Container Dissemination

The definition of triggering conditions and profiling is out of scope of the present document, as this has to be done through the common processes of profiling V2X messages. An example can be found in [i.1].

5   Pre-Crash à la carte Container Format and Data Elements

5.1   General Structure

Figure 3 depicts the structure of the proposed Pre-Crash DENM à la carte container.

The container includes the perceived pre-crash object. This data field reuses the perceivedObject data field of the CPM (ETSI TR 103 562 [i.6]). This data field contains information about a perceived object including its kinematic state and attitude vector in a pre-defined coordinate system and with respect to a reference time. Figure 4 gives an overview of the distance and direction data elements and their relation to each other.
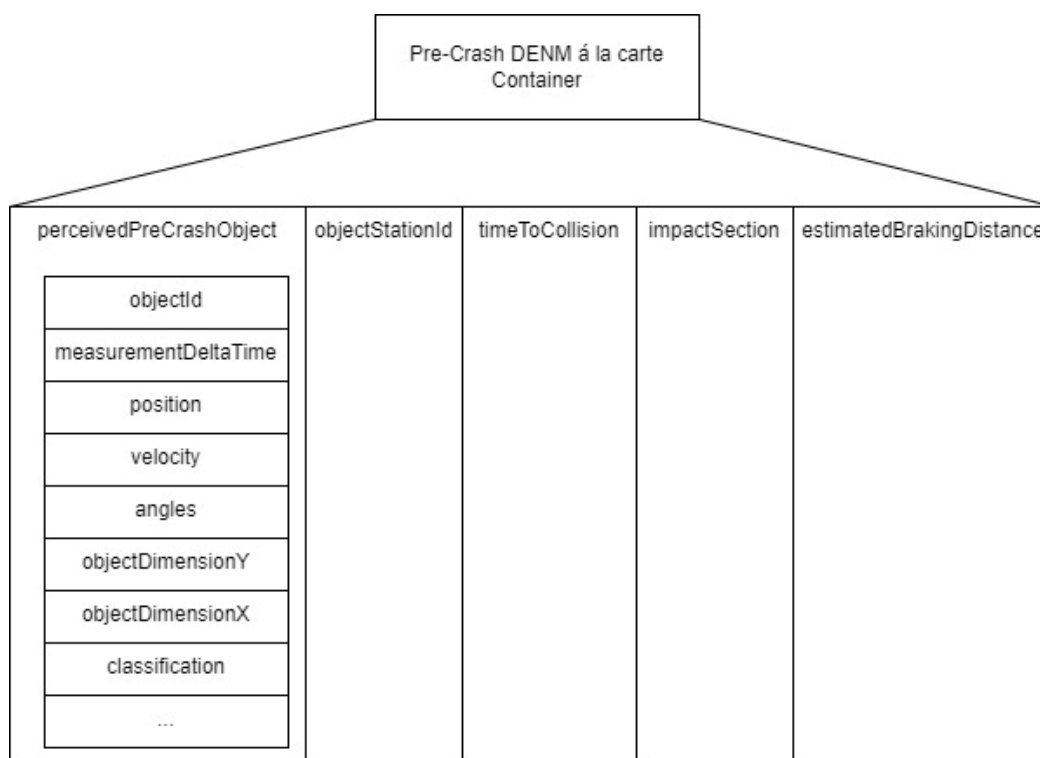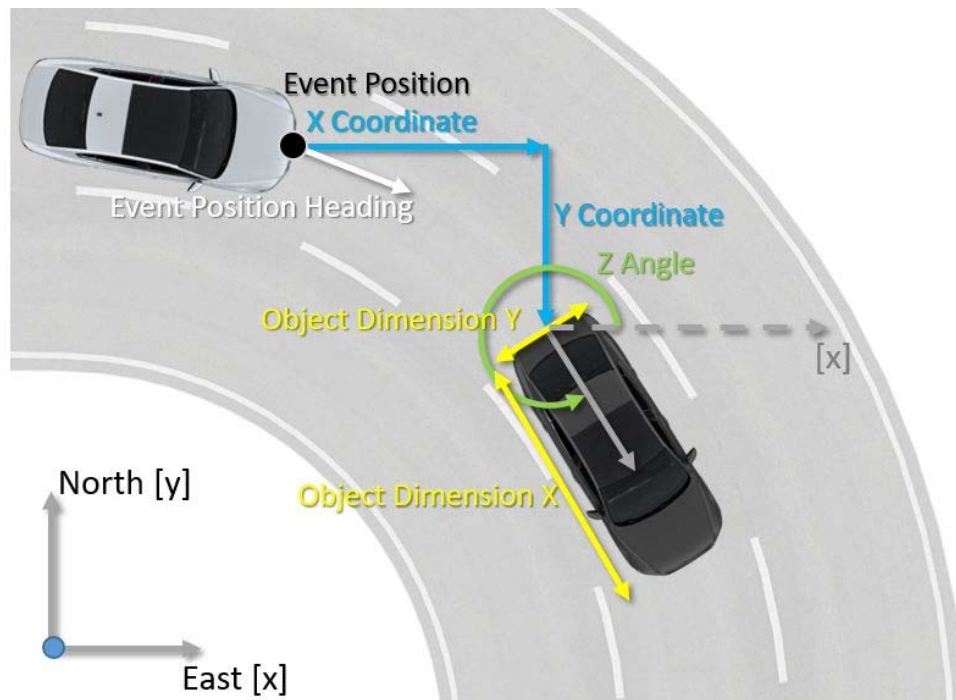

Figure 3: Structure of the Pre-Crash DENM à la carte container

Independent of the use case characteristic (i.e. the DENM being sent from a vehicle or a roadside ITS Station), the reference frame and object measurements described in clause 5.2 apply, as depicted in Figure 4.

NOTE: In the depicted situation the shown Y Coordinate is of negative value in the global coordinate system.

**Figure 4: Representation of the measurement point for the Pre-Crash
à la carte container and related quantities**

5.2   Object Measurements and Reference Frame

5.2.1   Event Position

The event position of the DENM marks the reference point of the measurements and values given in the Pre-Crash à la carte container.

- In case of a vehicle disseminating the DENM, the event position should be the reference position of the vehicle as defined in ETSI TS 103 900 [i.4] *referencePosition*. i.e. the reference point needs to be the ground position of the center of the front side of the bounding box of the vehicle.

- In case of a roadside ITS station disseminating the DENM, the event position should be the estimated reference position of the Vehicle (V1) that approaches the other vehicle.

5.2.2   Event Position Heading

The event position heading in the DENM should be set in conformance with ETSI TS 103 900 [i.4] *heading*, to the direction of movement of the vehicle (V1) that approaches the other vehicle.

5.2.3   position.xCoordinate, position.yCoordinate

The x- and y-coordinate given in the perceivedPreCrashObject field of the Pre-Crash à la carte container mark the distances of the event position to the position of the geometric center of the object's bounding box within the pre-defined coordinate system of the perceivedPreCrashObject. The distances should be given in the global coordinate system (East-North-Up), with their origin in the reference position.

5.2.4   eulerAnglesWithConfidence.zAngle

The z-angle given in the perceivedPreCrashObject field of the Pre-Crash à la carte container marks the estimated orientation of the perceivedPreCrashObject around the z axis.

5.2.5 objectDimensionX and objectDimensionY

The object dimension given in the perceivedPreCrashObject field of the Pre-Crash à la carte container marks the estimated dimensions of the bounding box of the perceivedPreCrashObject.

6 Other foreseeable Use Cases of the Pre-Crash à la carte Container

Another use case that can make use of the Pre-Crash à la carte container are described in detail below.

Use Case Name	I2V potential collision warning
Category	Safety
Short Description	The infrastructure is capable of detecting objects on the road that either may not belong there, or that behave so that they endanger the traffic flow and the single traffic participants (e.g. slow moving or standing vehicles). In addition to sending a DENM HLN to warn vehicles about the hazardous location, the connected infrastructure can send detailed information about the object itself, so to warn connected traffic participants more precisely about a potential collision.

Actors	Road users ("objects") such as:
	• Vehicles and vulnerable road users such as:
	  – cyclists;
	  – pedestrians;
	  – animals;
	  – etc.
	They move on or occupy the carriageway and are detected by:
	• Roadside infrastructure equipped with sensors.
	I2V messages are sent by
	• Roadside ITS-S and received by:
	  – Vehicle ITS-Ss mounted in/on vehicles.

Infrastructure Roles	Roadside infrastructure equipped with stationary sensors obtains object information from mounted stationary sensors. It estimates the risk of a collision between the object and the current traffic (but not the single vehicles).
	Collision Risk is intended as: estimated impact * probability, where:
	• Estimated impact is strongly related to the estimated size and weight of the object.
	• Probability is strongly related to:
	  – the position of the object on or near the carriageway; and
	  – the behavior of the object.
	
	The Roadside ITS-S is connected to a central ITS system and optionally to the roadside infrastructure. It broadcasts information (DENM HLN) received from the central ITS system augmented with real-time information about the detected objects received from the central ITS system and/or directly from the roadside infrastructure.

Vehicle Roles	Vehicle ITS-Ss receive I2V messages and the human drivers are warned about the risk of a collision. Driving automation systems can in addition take measures to avoid a collision or to limit the damage in case of a collision.
ITS Central System Roles	Central ITS systems such as traffic management systems generate traffic information (including HLNs) centrally, based on peripheral information (e.g. video/sensor streams or information supplied by human observers) and validated by established processes (human and/or artificial intelligence). This information is provided to the Roadside ITS-S and augmented as described in "infrastructure Roles".
Other Traffic Participant Roles	The object itself (if equipped with an ITS-S) receives the I2V message and is notified that it is causing danger.
Goal	To avoid a collision between ITS-S equipped vehicles and dangerous objects and/or to prepare the vehicles for the crash.
Needs	Road users need to travel safely without unacceptable risks.
Constraints/Presumptions	Roadside infrastructure sensors, central ITS system and Roadside ITS-S are all interconnected and able to share data with low latency.
Geographic Scope	Applicable to any road situation. Mostly suited for motorway environments.

Pre-Conditions	Roadside infrastructure sensors are operational on relevant road sections Trusted V2X communication among ITS-Ss is operational.
Main Event Flow	In addition to a DENM HLN, sensor-based information about objects is broadcast by Roadside ITS-Ss for consumption by other ITS-Ss.
Alternative Event Flow	-
Post Conditions	Vehicles are informed about a potential collision.
Information Requirements	Sensor information (position, speed, heading, dimensions, classification, etc.) about the object. Estimated Collision Risk related to the object for the traffic (not for the single vehicle)

Annex A:
ASN.1 Proposal for Pre-Crash à la carte Container Syntax

This annex provides the ASN.1 syntax proposal of the Pre-Crash à la carte Container.

> NOTE 1: Some of the optional data elements and data frames conditions for the availability are specified in annex B.

> NOTE 2: The ASN.1 proposal provided in the present document is informative only. The syntax may change considerably in a future normative document.

```
PreCrashContainer ::= SEQUENCE {
    perceivedPreCrashObject  PerceivedObject,
    objectStationId StationID OPTIONAL,
    timeToCollision DeltaTimeMilliSecondPositive OPTIONAL,
    impactSection ObjectFace OPTIONAL,
    estimatedBrakingDistance StandardLength12b,
    ...
}
}
```

The PreCrashContainer should be added inside the `AlacarteContainer` of the DENM ASN.1 module after the extension indicator as follows:

```
AlacarteContainer ::= SEQUENCE {
   lanePosition LanePosition OPTIONAL,
   impactReduction ImpactReductionContainer OPTIONAL,
   externalTemperature Temperature OPTIONAL,
   roadWorks RoadWorksContainerExtended OPTIONAL,
   positioningSolution PositioningSolutionType OPTIONAL,
   stationaryVehicle StationaryVehicleContainer OPTIONAL,
   ...,
   preCrashContainer  PreCrashContainer OPTIONAL
}
```

Annex B:
Description of Data Elements and Data Frames

B.1   General

Mandatory data elements should be set to "unavailable" only under error conditions of temporary nature, when data are not available or erroneous due to any failure in the data provisioning facilities.

B.2   Pre-Crash à la carte Container

B.2.1   Introduction

The following clauses provide information about each Data Element and Data Frame which constitutes a Pre-Crash à la carte container. References to data type declarations are provided as applicable.

B.2.2   perceivedPreCrashObject

Description	perceivedPreCrashObject is a component of the *AlacarteContainer* and contains information about a perceived pre-crash object in the East, North, Up reference frame.
Data setting and presentation requirements	The component should be of type *PerceivedObject* as specified in ETSI TS 102 894-2 [i.5] and constrained as specified in annex A.

B.2.3   objectStationID

Description	The object station id of the object for which the values are provided. See note.
Data setting and presentation requirements	This DE should be of type *stationID* as specified in ETSI TS 102 894-2 [i.5]. This data element should be optional.
NOTE: The object station id of the object may change during the use case, when the object changes its AT.	

B.2.4   timeToCollision

Description	The calculated (or estimated) time to collision of the vehicle towards the pre-crash object, determined by the host vehicle or a roadside ITS system. The computation of the time to collision should include the velocities, accelerations and relative distances between the vehicles.
Data setting and presentation requirements	This DE should be of type *DeltaTimeMilliSecondPositive* as specified in ETSI TS 102 894-2 [i.5]. This data element should be optional.

B.2.5   impactSection

Description	Indication of the object's section where the impact will most likely occur. When the target object is likely to be a vehicle, then this data element should be made available, otherwise (every other type of object) the data element should not be provided. See note.
Data setting and presentation requirements	This DE should be of type *ObjectFace* as specified in ETSI TS 102 894-2 [i.5].
NOTE: It is permissible to derive the required object dimensions and orientation from models to provide a best guess.	

B.2.6   estimatedBrakingDistance

Description	Estimated distance the host vehicle would need to come to a complete hold, if no obstruction was in the way. This data element should be optional.
Data setting and presentation requirements	This DE should be of type *StandardLength12b* as specified in ETSI TS 102 894-2 [i.5].

History

Document history		
V2.1.1	June 2023	Publication