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Intelligent transport systems — Cooperative ITS — Dictionary of in-vehicle information (IVI) data structures

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National foreword

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Intelligente Transportsysteme - Kooperative ITS - Verzeichnis von Datenstrukturen fahrzeuginterner Informationen (IVI) (ISO/TS 19321:2020)

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European foreword

This document (CEN ISO/TS 19321:2020) has been prepared by Technical Committee ISO/TC 204 "Intelligent transport systems" in collaboration with Technical Committee CEN/TC 278 “Intelligent transport systems” the secretariat of which is held by NEN.

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 278, *Intelligent transport systems (ITS)*, in collaboration with Technical Committee ISO/TC 204, *Intelligent transport systems*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO/TS 19321:2015) which has been technically revised.

The main changes compared to the previous edition are as follows.

— The Scope has been edited.

— Several containers have been renamed or newly introduced and an "Automated Vehicle Container" has been added to better manage automated vehicles.

— The abstract syntax notation one (ASN.1) code in Annex A has been captured separately. This edition is backwards compatible with the previous edition in that it adds information elements (e.g. data elements and data frames) to the IVI Structure by using ASN.1 extensions. The ASN.1 extension feature ensures that implementations of the previous edition can correctly parse IVI Structures compliant with this edition and process the information specified in the previous edition without needing knowledge about the extensions.

— The former Annex B has been replaced with new visual examples.

— C-Roads and Eco-AT documents have been added to the Bibliography.

— Data types are imported from ISO 14823 which are backwards compatible with the first edition of this document.

— Data types are imported from updated editions of ISO 14906, ISO 17419 and ETSI/TS 102 894-2, which are backwards compatible with the first edition of this document.

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Introduction

In a Cooperative Intelligent Transport System (C-ITS), presenting information related to the traffic situation or regulation of a road to the driver of a vehicle is an important component of road operations. The road operators are responsible for road setup, operation, signage, and maintenance for traffic management and road safety, and in some countries, also for the enforcement of road laws. For road operators, efficient transport of vehicles on roadways ensures a safe and predictable trip for all road users. Road operators, together with equipment manufacturers, whether of vehicles or of roadside equipment, contribute to how road information is properly presented to drivers.

So far, one defined C-ITS method for notifying road users of road and/or traffic situations and events is by transmission of messages such as Cooperative Awareness Messages (CAM), Decentralized Environment Notification Messages (DENM), or Basic Safety Messages (BSM).

This document supports mandatory and advisory road signage such as contextual speeds and road works warnings. In-vehicle information can be sent by an ITS Station (ITS-S) and either corresponds to physical road signs such as static or variable road signs or does not correspond to physical road signs (a virtual sign) or corresponds to road works. In-vehicle information (IVI) does not include identification of road events as already provided by DENM.

This document provides a toolbox of information elements for IVI. It can be used to fulfil the requirements of the service provider considering the needs of receiving ITS-S. The container concept provides a way for an ITS-S to manage the relevant IVI information, determine where the IVI is relevant, and to provide details for the application of IVI. The description of data elements encompasses the data syntax and semantics, i.e. a definition of data format and content, together with a description of how to use those data elements.

This document is of an enabling nature. It does not specify which information is necessary for a certain service, but it supports those IVI information elements that can be necessary to be transmitted to a receiving ITS-S to carry out a certain service. Usage of the IVI information elements depends on the specific context and application of IVI for a specific service and usage is established as mandatory or optional only for messaging purposes, not for application purposes. The IVI Structure is intended to be profiled to fulfil the requirements of a specific service.

This document refers to ISO 14823 as one system of standardized codes for existing road signs codes.

NOTE ISO 14823 does not contain codes for specific national or regional signs that are not commonly used, and it does not represent a catalogue of road sign pictograms for all applicable nations.

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Intelligent transport systems — Cooperative ITS — Dictionary of in-vehicle information (IVI) data structures

1 Scope

This document specifies the in-vehicle information (IVI) data structures that are required by different intelligent transport system (ITS) services for exchanging information between ITS Stations (ITS-S). A general, extensible data structure is specified, which is split into structures called containers to accommodate current-day information. Transmitted information includes IVI such as contextual speed, road works warnings, vehicle restrictions, lane restrictions, road hazard warnings, location-based services, re-routing. The information in the containers is organized in sub-structures called data frames and data elements, which are described in terms of its content and its syntax.

The data structures are specified as communications agnostic. This document does not provide the communication protocols. This document provides scenarios for usage of the data structure, e.g. in case of real time, short-range communications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 639-1:2002, *Codes for the representation of names of languages — Part 1: Alpha-2 code*

ISO 14823:2017, *Intelligent transport systems — Graphic data dictionary*

ISO 14906:2018, *Electronic fee collection — Application interface definition for dedicated short-range communication*

ISO/TS 19091:2019, *Intelligent transport systems — Cooperative ITS — Using V2I and I2V communications for applications related to signalized intersections*

ISO 24534-3:2016, *Intelligent transport systems — Automatic vehicle and equipment identification — Electronic registration identification (ERI) for vehicles — Part 3: Vehicle data*

ETSI/TS 102 894-2 V1.3.1 (2018-08), *Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
application data unit
data unit exchanged between ITS Station applications

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3.2
container
group of *data frames* (3.4) and *data elements* (3.3) semantically belonging together in one place in the *in-vehicle information* (3.8) structure

3.3
data element
DE
data type that contains one single data

[SOURCE: ETSI/TS 102 894-2 V1.3.1]

3.4
data frame
data type that contains more than one *data element* (3.3) in a predefined order

[SOURCE: ETSI/TS 102 894-2 V1.3.1]

3.5
detection zone
part of the road network that is passed by a vehicle in approach of the *relevance zone* (3.17)

3.6
digital map database
structured set of digital and alphanumeric data portraying geographic locations and relationships of spatial features

[SOURCE: ISO 17572-1:2015, 2.1.10, modified — Note to entry has been deleted.]

3.7
driver awareness zone
parts of the road network on which a message is presented to inform drivers about upcoming situations

3.8
in-vehicle information
information contained in the in-vehicle information data structure that is required by different intelligent transport system services

3.9
in-vehicle signage
intelligent transport system service that provides static, as well as dynamic, road sign and message sign information to drivers

3.10
intersection
crossing and/or connection of two or more *roads* (3.14)

[SOURCE: ISO 17572-1:2015, 2.1.17, modified — Notes to entry have been deleted.]

3.11
link
direct topological connection between two nodes that has a unique *link ID* (3.12) in a given *digital map database* (3.6)

[SOURCE: ISO 17572-1:2015, 2.1.20, modified — Second term “edge” and Note to entry have been deleted.]

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3.12
link identifier
link ID
identifier that is uniquely assigned to a *link* (3.11)

[SOURCE: ISO 17572-1:2015, 2.1.21, modified — Note to entry has been deleted.]

3.13
minimum dissemination area
parts of the road network where the in-vehicle signage message can be received by the potentially targeted vehicles

3.14
road
part of the road network which is generally considered as a whole and which can be addressed by a single identification like a road name or road number throughout

[SOURCE: ISO 17572-1:2015, 2.1.39, modified — Notes to entry have been deleted.]

3.15
road section
road segment (3.16) that is bounded by two *intersections* (3.10) and has the same attributes throughout

[SOURCE: ISO 17572-1:2015, 2.1.42, modified — Note to entry has been deleted.]

3.16
road segment
part of a *road* (3.14), having its start and end along that road

[SOURCE: ISO 17572-1:2015, 2.1.43, modified — Note to entry has been deleted.]

3.17
relevance zone
parts of the road network for which the information in an Application Container is valid

3.18
road works warning
alerts for routing road users around road construction and/or road repair

3.19
variable message sign
electronic sign board presenting text, symbols, or a combination of them

4 Abbreviated terms

ASN.1	Abstract Syntax Notation One
C-ITS	Cooperative Intelligent Transport System
DE	Data Element
DENM	Decentralized Environmental Notification Message
DF	Data Frame
GLC	Geographic Location Container
ID	Identification
ITS	Intelligent Transport Systems

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ITS-S	ITS Station
IVI	In-Vehicle Information
IVS	In-Vehicle Signage
MAP	Map Data Message
MLC	Map Location Container
RWW	Road Works Warning

5 In-vehicle information data structure

5.1 Structural model

5.1.1 General model

The in-vehicle information (IVI) structure represents the Application Data Unit to be transmitted and received by an ITS Station (ITS-S). The IVI Structure shall comply with the syntax defined in Annex A as the data type `IviStructure`. This means that it shall be composed of Containers defined in this document and follow the form depicted in Figure 1.

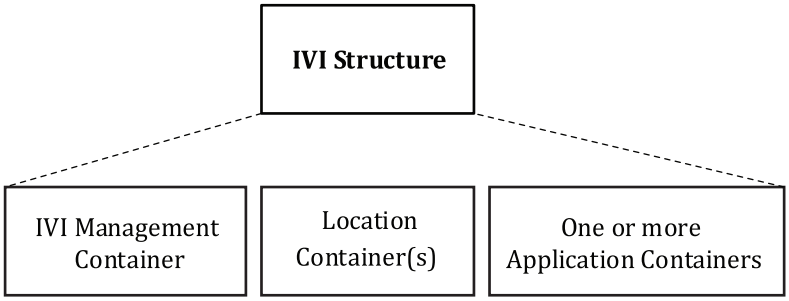

Figure 1 — IVI Structure

The IVI Structure is extensible and other containers can be added in the future.

The IVI Structure is intended to be encapsulated in a message with the appropriate ITS Common Header, for example, the `ItsPduHeader` of ETSI/TS 102 894-2. The header structure and contents are out of the scope of this document and are for example specified in ETSI/TS 103 301.

The IVI Structure shall contain a Management Container. The information in the IVI Management Container is applicable to the entire IVI Structure. This Container is mandatory to be present and provides a receiving ITS-S with enough information to handle the IVI Structure and decide on its further processing.

The IVI Structure can contain one or more Location Container(s). The Location Container describes the essential information for applications in the receiving ITS-S. Applications can use the location information to understand how to apply information provided by IVI Application Containers. Location Containers can carry information relevant for different IVI Application Containers or carry the same content but expressed in different forms (see 5.2). This enables a receiving ITS-S to choose the appropriate location referencing system that the ITS-S supports.

The IVI Structure can contain one or more IVI Application Container(s). The IVI Application Container provides IVI information for use by an application. Application information is self-contained and refers to the location information for its spatial validity. Application information of the same type shall not

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refer to overlapping Reference Zones. Each Application Container refers to zones defined in the Location Container identified by their identifications (IDs) for the following usage:

a) Detection Zone,

b) Relevance Zone, and

c) Driver Awareness Zone.

An Application Container may optionally provide information about the minimum awareness time, that is, the minimum time that the IVI should be available before the vehicle enters the Relevance Zone. This MinimumAwarenessTime information can be used by the receiving ITS-S to determine the appropriate Driver Awareness Zone.

5.1.2 Conceptual zones

When an ITS-S receives the IVI Structure, the ITS-S can interpret the application information in the context of the appropriate location information. Principally, there are four conceptual zones:

a) Minimum Dissemination Area;

b) Detection Zone;

c) Driver Awareness Zone;

d) Relevance Zone.

The Minimum Dissemination Area refers to the minimum area where the IVI Structure is disseminated by an ITS-S based on application requirements. The Minimum Dissemination Area is defined in the relevant application standards or specification(s) and is therefore out of scope of this document.

In some situations, a vehicle ITS-S needs to be able to detect whether or not it is approaching a Relevance Zone at a certain minimum time before it enters the Relevance Zone. This is, for example, to guarantee that the Relevance Zone is detected immediately at its entry (e.g. in case of a very small Relevance Zone) or to guarantee that the Relevance Zone is correctly detected (in case it is near to other road segments, e.g. parallel or on different altitude level). Therefore, a Detection Zone occurs in approach to a Relevance Zone. If a receiving ITS-S moves through the Detection Zone, then the received IVI will be enabled for further usage in the receiving ITS-S.

The IVI can be used to inform drivers about upcoming situations in the Driver Awareness Zone. The Driver Awareness Zone can be determined by the receiving ITS-S because the Driver Awareness Zone can be based on the dynamic status of the receiving ITS-S and can depend on the presence of other higher priority information to be presented. Alternatively, the Driver Awareness Zone can be provided by the sending ITS-S for usage by the receiving ITS-S.

The Relevance Zone covers the area where the IVI is applicable.

Examples of the Detection and Relevance Zones for the spatial validity of the IVI Structure are illustrated in Figure 2. In traffic direction East (right-hand traffic), the figure shows a Detection Zone and a Relevance Zone for the entire carriageway. The Driver Awareness Zone can be physically overlapping with the Detection Zone (but is not necessarily equal in size). In traffic direction West, the figure shows lane specific Detection and Relevance Zones.

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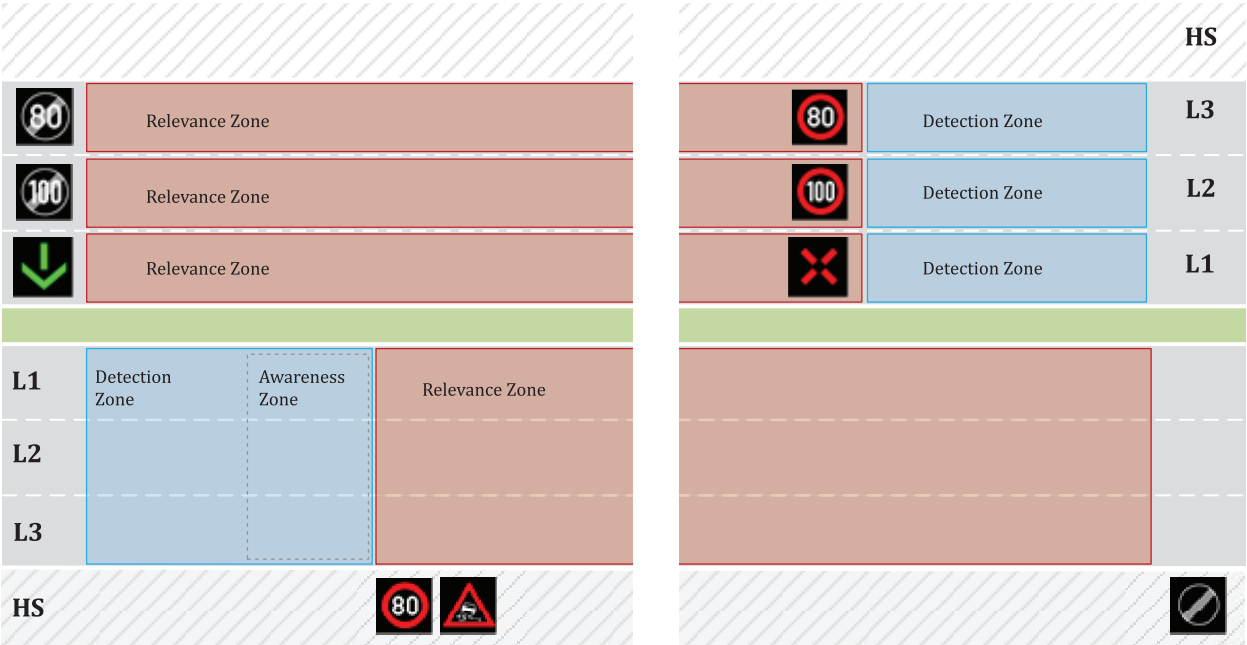

Figure 2 — Spatial validity for IVI: Detection and Relevance Zones

The Location Container always contains a definition of one or more zones which can represent a Detection Zone, a Relevance Zone, or both. In Figure 2 in traffic direction East, from left to right, the first zone represents a Detection Zone and the second zone represents a Relevance Zone.

In Figure 3 in traffic direction East, from left to right, the first zone represents a Detection Zone. The second zone then represents Relevance Zone 1, but this same zone also serves as a Detection Zone for Relevance Zone 2 and so on.

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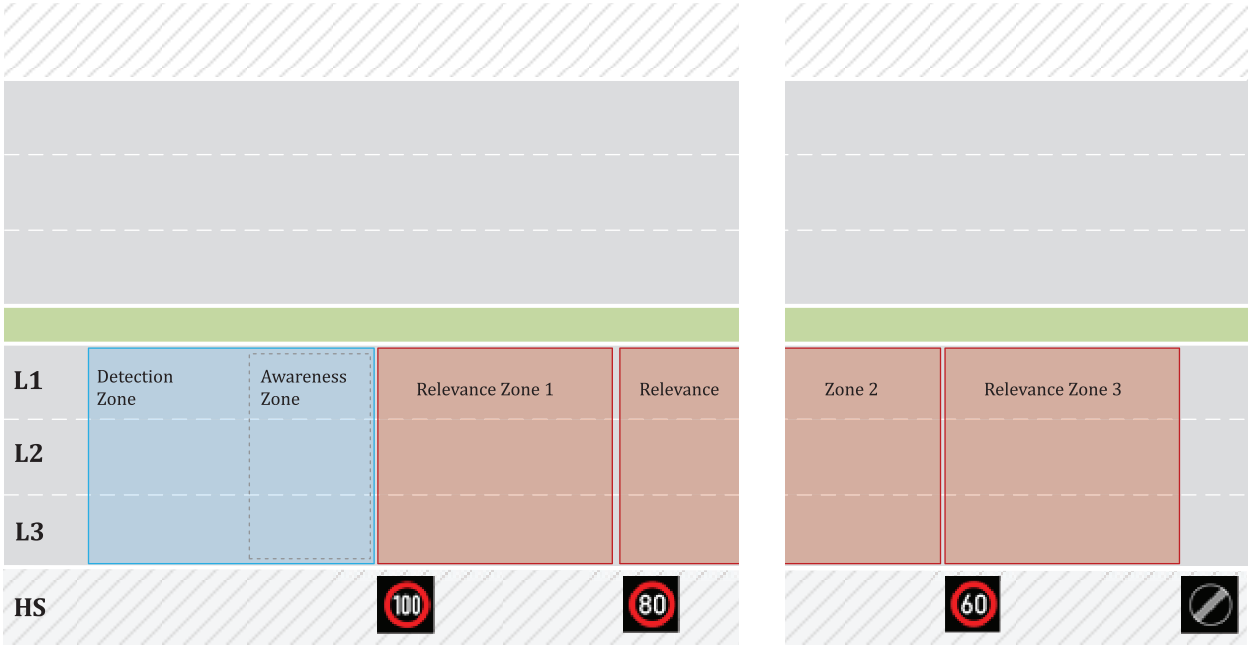

Figure 3 — Concatenated Relevance Zones

5.2 Location referencing

5.2.1 General

There are essentially two different ways of referencing road locations (refer to ISO 17572-1):

— map-based location referencing, when referencing attributes of the road network itself;

— geographic location referencing, when referencing a regular or irregular division of space which exists independent of the representation of the road network.

5.2.2 Geographic positioning

Geographic location systems or coordinate systems are location maps composed of imaginary, intersecting lines forming a grid. Coordinate values of the grid, expressed as numeric or alphanumeric characters, are used to describe a position.

To translate position data expressed in longitude, latitude, and height to the corresponding real position on earth or vice-versa, the earth-centred, earth-fixed, polar-coordinate geodetic datum WGS84 (G1150) shall be used (see NIMA TR8350.2, ed.3). Alternatively, any earth-centred, earth-fixed polar coordinate geodetic datum can be used as long as the maximum datum displacement relative to the geodetic datum agreed on, or relative to WGS84 (G1150) in case of no agreement, is acceptable to the application.

NOTE A suggested tolerance of 0,3 m in datum displacement (also called datum shift) is intended, for example, to allow for using the International Terrestrial Reference Frame (ITRF) or the European Terrestrial Reference Frame (ETRF) geodetic datum as alternative to the WGS84. Datum displacements can be calculated according to the definitions in ASME Y14.5-2009.

An ITS-S sending an IVI Structure provides one or more Reference Point(s). The Reference Point can be the reference for the description of a static zone or a dynamic (moving) zone. The zone can be described by a polygonal line which delineates a segment or an area or can be described by a distance value

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indicating the extension of the relevance zone from the Reference Position and the heading relative to the Reference Position.

The detection zone can optionally be provided as a polygonal line in approach to the Reference Position. If the Reference Position is the position of a moving object, the polygonal line is represented by the last positions of the path of the moving object (e.g. the trace of a roadworks vehicle).

Determining the relevance of IVI is carried out by referencing the location of a receiving ITS-S relative to a reference in a coordinate-based system.

As a vehicle progresses, its motion creates a series of points. The series, when assembled as a set, trace the path of the vehicle. The path enables a receiving ITS-S to detect the applicability of a Relevance Zone and the approach into a Relevance Zone.

5.2.3 Map-based location referencing

This document supports map-based location referencing, by reference to a link ID in a digital map database (the "map"). The supported map is the Map Data Message (MAP) defined in ISO/TS 19091. This can also be a MAP Extended Message as defined in ETSI/TS 103 301.

An ITS-S sending an IVI Structure provides one or more references to Map Data Messages. The Map Data Message can either represent an intersection: this is when the option `intersections` is used. Or the Map Data Message can represent a road segment: this is when the option `roadSegments` is used. The reference to the Map Data Message includes the type of option that is referred to.

A zone can be described with reference to one or more links defined in the Map Data Message. The link ID in such a message is called `LaneID`.

Determining the relevance of IVI is carried out by referencing the location of a receiving ITS-S relative to the links in the Map Data Message.

6 IVI Containers

6.1 IVI Management Container

6.1.1 Definition

IVI Management Container contains information regarding the management of the IVI Structure which supports the receiving ITS-S to deal with the lifecycle of the IVI. It includes information which allows receiving ITS stations to identify further processing. Table 1 describes the contents for inclusion in the IVI Management Container. The syntax is defined in Annex A as mandatory component of the data type `IviStructure` of type `IviManagementContainer`.

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