Intelligent transport systems — Cooperative systems — Data exchange specification for in-vehicle presentation of external road and traffic related data
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO’s adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 204, Intelligent transport systems.
### Introduction

Traditional fixed road signs are positioned on road verges to inform drivers about the applicable regulations, or to warn them about dangers or to provide them with other general information – this can be considered as roadside signage information. Beyond this fixed signage, the newer technologies have now allowed for some time for more accurate dynamic presentation of roadside signage information depending on the actual road and environmental conditions using variable or dynamic message signs. With the advent of Cooperative Intelligent Transport Systems (C-ITS) it is possible to provide more focused and timely guidance to vehicle controllers and drivers by supporting continuous presentation of the content of roadside signage information in the vehicle along the impacted road section rather only during the short moments its takes for a vehicle to pass traditional road signs. Direct in-vehicle presentation of roadside signage information, called In-Vehicle Signage, facilitates the potential provision of information to specific classes or characteristics of vehicles, and for potentially more granular definition of affected road sections than stationary-position traditional fixed plate signs and use of variable/dynamic road signs. It does not deal with contextual speeds which are covered by ISO/TS 17426.

Delivering the In-Vehicle Signage service to road users can improve road safety, support traffic management, and reduce greenhouse gas emissions. It does not preclude other usage of the delivered information but such services are not in the scope of this Technical Specification.

All ITS services follow the same abstract process structure consisting of a sequence of detection (of an event) including pre-processing of the detected content, execution of the service algorithm (processing of detected content), and presentation or utilization of the service result. Figure 1 (extracted from ISO/TS 17427) summarizes and details this process structure.

![Figure 1 — General description of process for In-Vehicle Signage (from ISO/TS 17427:2014, Annex A)](image)

Based on this abstract and general description of process steps in an ITS service, a large number of possible scenarios can be derived. This is true for In-Vehicle Signage. Every step in the process chain can be executed by different actors or stakeholders. Additionally, the execution of a process step for different spatial areas may be delivered by different actors. Each combination of different actors for different process steps can be used to identify distinct scenarios.

Assuming that there are two main stakeholder groups in C-ITS, the Infrastructure stakeholder and the Vehicle stakeholder, multiple combinations, and therefore multiple scenarios, are possible as every step might be delivered by either stakeholder group (see Figure 2) or shared between both stakeholder groups (see Figure 3).
Every scenario is one specific of combination of stakeholders executing process steps. This Technical Specification addresses the scenarios where detection, content pre-processing, and the information service generation (see Figure 1) are delivered under the responsibility of the infrastructure stakeholder group (scenario 7 as seen in Figure 2). In scenario 7, the information service presentation takes place in the vehicle. Scenario 7 is considered in detail in this Technical Specification.

The defined C-ITS applications rely on the functionality and procedures defined within the Communications Architecture and by the reference ITS station architecture (as defined in ISO 21217 and other International Standards or Technical Specifications from the C-ITS standard set).
Annex A and Annex B contain profiles that define an instantiation for the IVS service. Annex A and Annex B contain conditional mandatory requirements. There is no need to comply with these requirements to claim compliance with this Technical Specification.

Annex A contains a profile that is communication technology agnostic. Annex B contains a profile that is focused on ITS-G5. For details on the referenced standards, see the introduction of the corresponding Annex.

These profiles are expected to be implemented and validated in European initiatives. Based on the results of these initiatives, it is intended to specify one interoperable solution in a future version of this Technical Specification.
Intelligent transport systems — Cooperative systems — Data exchange specification for in-vehicle presentation of external road and traffic related data

1 Scope

This Technical Specification specifies the In-Vehicle Signage service and application that delivers In-Vehicle Signage information to ITS stations (vehicle ITS stations or personal ITS stations devices) concerning road and traffic conditions, qualified by road authorities/operators, in a consistent way with road authority's/operator's requirements, in the manner that is coherent with the information that would be displayed on a road sign or variable message sign (VMS).

NOTE A Variable Message Sign is also named dynamic message sign. Both terms are considered as synonyms and can be used interchangeably. In the text below, only variable message sign and its abbreviated term VMS are used.

This Technical Specification defines the following:

— the In-Vehicle Signage service and the In-Vehicle Signage application that instantiates this ITS service;

— the requirements to be fulfilled by the In-Vehicle Signage service;

— the requirements for using functions provided by the ITS station facilities layer supporting the use of the In-Vehicle Signage service;

— the ITS-S application processes in the different ITS station, that instantiate the In-Vehicle Signage ITS service.

This Technical Specification also specifies: the sets of communication requirements and objectives (profiles) using the methods defined in ISO/TS 17423 to select the level of performance (best effort or real-time, etc.), confidence and security (authentication, encryption, etc.) for each communication flow between ITS stations in the scope of the In-Vehicle Signage service.

This Technical Specification defines the selection of relevant functions and procedures provided by the ITS station facilities layer (ISO/TS 17429) and defines the message structure, content, syntax, atomic elements to be used by the In-Vehicle Signage application.

NOTE This application is colloquially called “In-Vehicle Signage”.

The In-Vehicle Signage service includes the on-board information management. This management ensures contextual coherence of the end-user ITS service (e.g. vehicle characteristics, message priority, etc. avoiding amongst others things the presentation of conflicting information to end-users).

The production of information supporting the In-Vehicle Signage application, its qualification, and its relevance are out of the scope of this Technical Specification.

This Technical Specification does not specify the design of in-vehicle Human Machine Interfaces (HMI), but it does specify requirements that such interfaces shall be capable of supporting in order to permit the correct dissemination and use of information provided by the In-Vehicle Signage service.
2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are
indispensable for its application. 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, Codes for the representation of names of languages — Part 1: Alpha-2 code
ISO 3166-1, Codes for the representation of names of countries and their subdivisions — Part 1: Country codes
ISO 21217, Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture
ISO/TS 14823, Traffic and travel information — Messages via media independent stationary dissemination
systems — Graphic data dictionary for pre-trip and in-trip information dissemination systems
ISO/TS 16951, Road vehicles — Ergonomic aspects of transport information and control systems (TICS) —
Procedures for determining priority of on-board messages presented to drivers
ISO/TS 17423, Intelligent transport systems — Cooperative systems — ITS application requirements and
objectives for selection of communication profiles
ISO/TS 17429, Intelligent transport systems — Cooperative systems — Profiles for processing and transfer
of information between ITS stations for applications related to transport infrastructure management,
control and guidance

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21217, ISO/TS 17423,
ISO/TS 17429, and the following apply.

3.1 additional service
IVS service able to deal with the lower levels of message priority

3.2 communication authority
entity in charge of regulating telecommunications and/or broadcast services

3.3 core service
IVS service able to deal with the two highest levels of message priority

3.4 driver awareness zone
DAZ
parts of road network on which a message is present to inform drivers about upcoming situations

3.5 HMI control unit
in-vehicle device that manages prioritisation and presentation of messages designed for consumption
by vehicle occupants

3.6 in-vehicle signage
in-vehicle signage service
IVS
ITS service that provides receiving ITS stations in order to inform drivers about static as well as
dynamic road signs and variable message signs
3.7
**IVS application**
ITS-S application process that instantiates the IVS service

3.8
**IVS application service provider**
application service provider
service provider
tentity that executes the corresponding ITS service

Note 1 to entry: According to ISO/TS 17427, its role can be defined as collecting the content that is required to run the IVS service, running the IVS service and providing a suitable service response.

3.9
**IVS content service provider**
content service provider
ccontent provider
dsource of the *in-vehicle signage* (3.6) information

Note 1 to entry: According to ISO/TS 17427, its role can be defined as providing the information content for the IVS service.

3.10
**IVS message**
message generated for the *in-vehicle signage* (3.6) ITS service as specified in this Technical Specification

3.11
**IVS receiving ITS station**
ITS station that receives and processes the *IVS messages* (3.10)

Note 1 to entry: It can be either a vehicle ITS-S or a personal ITS-S.

3.12
**IVS sending ITS station**
ITS station that generates and transmits the *IVS messages* (3.10)

Note 1 to entry: It can be either a central ITS-S or a roadside ITS-S.

3.13
**minimum dissemination area**
MDA
parts of the road network where the *IVS message* (3.10) can be received by the potentially targeted vehicles

3.14
**qualified information**
information issued by authorised sources (road authorities, traffic managers) for their operated network

3.15
**relevance zone**
RZ
parts of the road network for which the *IVS message* (3.10) is valid

3.16
**traffic manager**
entity in charge of operating a road network and managing traffic

Note 1 to entry: For this Technical Specification, this entity is also considered as an enacting road authority; although in some circumstances, these different activities can be operated by separate entities.
3.17 validity end time
STO
time from which the *IVS message* (3.10) shall no longer be presented

3.18 validity start time
STA
time from which the *IVS message* (3.10) shall be presented

4 Symbols and abbreviated terms

<table>
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<th>Definition</th>
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<tr>
<td>ADU</td>
<td>Application data unit</td>
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<tr>
<td>BSMD</td>
<td>Bounded secured managed domain</td>
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<td>C-ITS</td>
<td>Cooperative intelligent transport systems</td>
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<td>C-ITS-S</td>
<td>Central ITS station</td>
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<td>DAZ</td>
<td>Driver awareness zone</td>
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<td>DMB</td>
<td>Digital multimedia broadcast</td>
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<td>DMS</td>
<td>Dynamic message sign</td>
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<td>HMI</td>
<td>Human machine interface</td>
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<tr>
<td>ICT</td>
<td>Information and communication technologies</td>
</tr>
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<td>ITS</td>
<td>Intelligent transport systems</td>
</tr>
<tr>
<td>ITS-S</td>
<td>ITS station</td>
</tr>
<tr>
<td>ITS-SU</td>
<td>ITS station unit</td>
</tr>
<tr>
<td>ITS-SCU</td>
<td>ITS station communication unit</td>
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<td>IVS</td>
<td>In-Vehicle Signage</td>
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<td>LDM</td>
<td>Local dynamic map</td>
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<tr>
<td>MDA</td>
<td>Minimum dissemination area</td>
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<tr>
<td>P-ITS-S</td>
<td>Personal ITS station</td>
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<tr>
<td>R-ITS-S</td>
<td>Roadside ITS station</td>
</tr>
<tr>
<td>RZ</td>
<td>Relevance zone</td>
</tr>
<tr>
<td>STA</td>
<td>Validity start time</td>
</tr>
<tr>
<td>STO</td>
<td>Validity end time</td>
</tr>
<tr>
<td>TCC</td>
<td>Traffic control centre</td>
</tr>
<tr>
<td>TMC</td>
<td>Traffic management centre</td>
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**NOTE 1** TCC and TMC are considered as synonyms and can be used interchangeably. In the text below, TCC will be used.

**NOTE 2** VMS and DMS are considered as synonyms and can be used interchangeably. In the text below, VMS will be used.

5 Service definition and main concepts

5.1 General

The IVS service aims to provide information to road users from an authorized IVS content provider presented in the vehicle in a manner that is consistent with that of VMS or road signs. This information
is provided to drivers aiming to improve road safety, reduce environmental impact, and enhance traffic flow.

NOTE 1 The information conveyed within an IVS message is the information that is available on fixed road signs on roadside or on a VMS.

NOTE 2 In most circumstances, the IVS information is expected to be qualified by road authorities/operators, in a consistent way with road authority’s/operator’s requirements, in the manner that is coherent with the information that would be displayed on a road sign or a variable message sign (VMS).

Traffic information is presented automatically or at the request of the user.

Where possible, it is presented in the vehicle in a language chosen by the end-user.

NOTE 3 Such an ITS service is relevant when driving a terrestrial road vehicle but not for pedestrians. When in this Technical Specification it is said of vehicle it does not imply the ITS service is only based on Vehicle ITS-station. It may also be operated with a personal ITS-station present in a vehicle. In both cases, the information is presented to the driver through an adapted HMI.

Figure 4 — Example of dynamic message display

Every IVS message presented from the In-Vehicle Signage service can depict either a road sign or a variable message sign. Annex C provides some background information on road signage and Annex D on VMS technologies.

The static information on static road signs and VMS is managed through catalogues. There are two levels of pictogram catalogues:

a) the international level through the Convention on road signs and signals (also known as the Vienna convention - UNECE) used in around 100 countries;

b) the national level (generally defined through regulations) (like e.g. in France: Regulation of 1967).
NOTE 4 For countries having signed and ratified the Vienna convention, the national level is mainly based on this convention and only presents minor differences with the convention content. There may also be some slight differences regarding the used pictograms among countries for the same meaning.

NOTE 5 They allow independence between the content and its restitution. It needs to be updated when necessary.

Within IVS, messages are being defined including a priority scheme for HMI usage within the IVS service. Messages are being delivered to the HMI module, how the information is presented to the driver is the responsibility of the equipment supplier. Information covered by the primary services should be handled in the HMI with higher priority resulting in presentation to the driver in the driver awareness zone at least once.

Overall priority cannot be determined by a single ITS service. This is dependent on the context and all active ITS services inside the vehicle.

NOTE 6 The importance of high quality and safe HMI is recognized. However, as stated in Clause 1, HMI is out of the scope of IVS. IVS will be one of the ITS services/ITS applications available in-vehicle. How these ITS applications will work together in a harmonized manner is not specified in this Technical Specification.

5.2 Service definition

5.2.1 Definition

The In-Vehicle Signage ITS service supports the provision of information from an ITS-station to another ITS-station concerning either static or dynamic information about traffic conditions and traffic regulations. In countries where it is allowed, it can also include not directly traffic-relevant messages that can be displayed on variable message signs. The information is provided by traffic managers or authorized content providers to drivers seeking improved road safety, reduced environmental impact, and enhanced traffic flow.

NOTE The information is provided via a central or roadside ITS-station to another ITS-station located in a vehicle. Other schemes are possible such as messages hopping between ITS-stations in vehicles. This information is available on fixed road signs or variable message signs (VMS) on the roadside or mounted above specific lanes.

5.2.2 Message categories

The “In-Vehicle Signage” ITS service implements the following two message categories that are considered as part of service levels:

a) higher priority messages associated with core services (see 5.2.3);

b) lower priority messages associated with additional services (see 5.2.4).

5.2.3 Core services

The core services implement the following two message types:

a) Immediate danger warning message type: a warning alert concerning a danger involving drivers’ or other users’ safety.

NOTE 1 According to the UNO convention on traffic signs and signals (known as the Vienna convention), such warning messages are provided using either triangle-shaped or diamond-shaped signs depending on convention choices in specific countries.

NOTE 2 Typically on motorways or dual carriageway roads presentation of immediate danger warning messages is given at this distance between 2 km and 5 km from the danger; this varies according to national or regional rules. On other roads and in urban areas, this distance is typically shorter.

b) Regulatory message type: prohibition, restriction, obligation or special regulation (that may depend on the vehicle type), compulsory routes, and rerouting.
NOTE 3 Regulatory messages are subject to relevant local/national legislation enacted by and recognized in law. Such regulatory messages may be relevant to specific classes of vehicle, driver qualifications, vehicle loads, environmental conditions, etc.

NOTE 4 According to the UNO convention on traffic signs and signals (known as the Vienna convention), such prescriptions are generally provided using round-shaped signs.

5.2.4 Additional services

Secondary services are related to messages of more general interest. Secondary services implement one or several of the following message types:

a) Traffic-related information message type: events (that do not create not immediate dangers), driving conditions, forecasts (for traffic congestion, weather, events), travel time, advisory alternate route, etc.

b) Pollution message type: there are commonly two forms of such messages: information messages and warning messages. Both forms of message exclude driving prohibitions or obligations which are part of core service.

c) Not traffic-related information message type including but not limited to examples such as abduction alerts also sometimes called “amber alert”.

5.3 Fundamental parameters

5.3.1 Spatial relevance

Two fundamental parameters characterize an IVS message spatially that are:

— Relevance zone (RZ) which is defined by the parts of road network for which the IVS message is valid.

— Driver awareness zone (DAZ) which is defined by the parts of road network before entering the relevance zone, allowing presentation of the corresponding message to the driver in advance of entering the Relevance zone.

The two parameters are illustrated in Figure 5 below.
Figure 5 — Fundamental spatial parameters for IVS

NOTE 1 RZ or DAZ can be of length null (i.e. featured as a point). In the case where DAZ is of length null, it may be omitted.

NOTE 2 The DAZ of an IVS message can also include more than one road element where this message is also pertinent for drivers (modifying their route, etc.).

Annex E provides some information on the RZ topology for the road signs defined in the Vienna convention.

Minimum dissemination area (MDA) is defined by the area covering the minimum parts of the road network where an IVS message shall be transmitted for receipt by the potentially targeted vehicles.

5.3.2 Temporal validity

To characterize the temporal validity of an IVS message, two fundamental parameters are defined:

— validity start time (STA) which is the time from which the IVS message is valid;
— validity end time (STO) which is the time from which the IVS message is no longer valid.

A driver can successively meet along his/her route several road signs or VMS which can have overlapping RZ and different priority levels. Figure 6 presents an example of such a case.
Key

- **t** time scale ($t_{1a}$, $t_{1b}$, $t_{2a}$, ... represent different periods of time), e.g. Msg1 is valid between $t_{1a}$ and $t_{1b}$
- **p** priority level scale ($p_x$, $p_y$, $p_z$ represent different levels of IVS message priority)
- **a** The plain part of each bar represents when a message is transmitted to the HMI unit, whereas the dashed part represents when the message is stored in the receiving ITS-S and not transmitted to the HMI unit.

Figure 6 — Temporal relevance of several IVS messages

NOTE Temporal validity is an absolute concept based on a timeline whereas the spatial relevance is relative to the vehicle location, vehicle heading, and other vehicle characteristics.

5.3.3 Other parameters

Other parameters are to be taken into account when determining which vehicles and drivers are targeted such as vehicle characteristics, driver’s licence status, weather conditions, etc.

5.4 Example of system implementation

5.4.1 General description

Figure 7 illustrates an example of a possible system architecture implementing the IVS service.
5.4.2 Interface identification

The main interfaces are depicted on the figure above as follows.

A: Update of the IVS message by central ITS station (traffic management centre, WEB server, Mobility server, etc.)

B: Verification of the IVS messages being broadcasted

C: Broadcasting of IVS messages to in-vehicle ITS Stations

NOTE 1 The update and verification of an IVS message may be also achieved by a local personal ITS-S (smartphone, USB key...etc).

NOTE 2 Other interfaces can also be considered according to the choice made by the road/traffic operator.

6 Roles and responsibilities

6.1 Scenarios for In-Vehicle Signage

This subclause describes system operation including provision of content, provision of service, and provision of presentation. In the next subclauses, the different scenarios for In-Vehicle Signage are described based on the general scheme as presented in Figure 8.
In *Figure 8*, the character “V” in balloons in the figure stands for actor(s) responsible for the vehicle and/or nomadic devices in the vehicle (V-ITSS, P-ITSS). The character “I” in balloon stands for actor(s) responsible for the roadside infrastructure, e.g. the central ITS-station of a Traffic Control Centres (C-ITSS) or roadside ITS-stations (R-ITSS).

The roles are split into two levels, on the high level is the role Service provision. This can be fulfilled by actors from "V" and/or "I". For "I", the responsibility will be with the traffic manager; for "V", the responsibility will be determined by OEMs.

**NOTE 1** Service providers probably will be involved in the future.

The role “System operation” is split up in the roles Content Provision, Service provision, and Presentation Provision.

**NOTE 2** A detailed description of the different roles and their relationships can be found in ISO/TS 17427.

According to the general description of the service, the focus is set on scenario I–I–V, *Figure 8*. For this scenario, the responsible actor for the role of system operation probably will be the actor responsible for the roadside infrastructure (I). The responsibility might be shared with the actor responsible for the vehicle (V) – this is illustrated by the dashed line.

**NOTE 3** As explained in the Introduction of this Technical Specification, it can be named “scenario 7”.

**NOTE 4** The notation used in the different figures of *Clause 6* is explained in an informative annex of ISO/TS 17427.