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Intelligent transport systems — Hybrid communications — Access technology support

Systèmes intelligents de transport — Communications hybrides — Support à la technologie d'accès

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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).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

This third edition cancels and replaces the second edition (ISO 21218:2013), which has been technically revised. It also incorporates the Amendment ISO 21218:2013/Amd 1:2014.

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

— ASN.1 has been aligned with the latest developments in ISO/TC 204;

— provisioning for path and flow management has been added;

— normative annex related to conformance testing, that contains the PICS proforma, has been added;

— management commands have been added;

— minor technical and editorial improvements.

Introduction

This document is part of a family of International Standards for communications in Intelligent Transport Systems (ITS) based on the ITS station and communication architecture specified in ISO 21217.

Hybrid communications, i.e. simultaneous support of different communication protocol stacks with different access technologies, is essential for ITS.

This document supports

— hybrid communications as requested, e.g. for Cooperative ITS in Europe, and

— path and flow management, enabling abstraction of applications from communications details.

It determines general technical details related to the access layer of an ITS station specified in ISO 21217 and illustrated in Figure 1 which are applicable to all or several access layer technologies. This includes especially:

— the IN-SAP offered to the ITS-S networking & transport layer for communication purposes;

— functions of the service primitives in the MI-SAP with reference to the generic services of the MI-SAP specified in ISO 24102-3.

The IN-SAP and the MI-SAP are presented in Figure 1. The specification of the SI-SAP is not within the scope of the present version of this document.

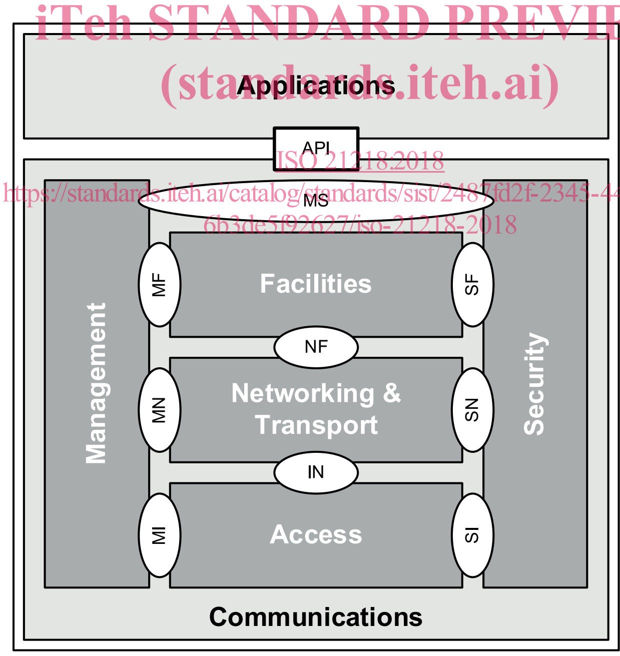

Figure 1 — ITS station reference architecture with named interfaces

This third edition cancels and replaces the second edition which has been revised and harmonized with newly developed C-ITS standards.

Intelligent transport systems — Hybrid communications — Access technology support

1 Scope

This document specifies general technical details related to the access layer of the ITS station reference architecture specified in ISO 21217 including:

— the service access point (SAP) of a communication interface (CI) as provided by the communication adaptation layer (CAL) for communication, named IN-SAP, and related service primitives and service primitive functions;

— the SAP provided by the CI management adaptation entity (MAE) for management of the communication interface, named MI-SAP, and related service primitives by reference to ISO 24102-3, and service primitive functions.

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/IEC 8825-2, *Information technology — ASN.1 encoding rules: Specification of Packed Encoding Rules (PER) — Part 2*

ISO 21217, *Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture*

ISO 24102-3, *Intelligent transport systems — ITS station management — Part 3: Service access points*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21217, ISO 24102-3 and the following apply.

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

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

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

3.1
(V)CI identifier
unique identifier of a (virtual) CI

3.2
communication interface
CI
instantiation of a specific ITS-S access layer technology and protocol

EXAMPLE An example of an ITS-S access layer technology and protocol is IR specified in[9].

3.3
medium
physical properties of a CI used to transmit a modulated signal, e.g. wireless or on a wire

Note 1 to entry: Medium is also referred to as access technology.

3.4
virtual communication interface
logical entity in a CI that is associated with a peer station

3.5
CI priority manager
logical entity in a CI that is managing priority queues

3.6
Link-ID
identifier of a link given by the address of a VCI

3.7
temps atomique international
time since 00:00:00 UTC, 1 January, 2004, identical with UTC except that no leap seconds need to be added

4 Abbreviated terms

APN	Access point name
BC-VCI	VCI for transmission to the broadcast MAC address
CAL	Communication adaptation layer
CEN	Comité Européen de Normalisation (European Committee for Standardization)
CI	Communication interface
CIC	Communication interface class
CIID	CI / VCI Identifier presented in a 64-bit EUI field
DLL	Data link layer
DNI	Distinct null identifier
DSRC	Dedicated short range communication (5,8 GHz back-scatter technology used in Europe for e.g. road tolling). This term is used in the USA to indicate IEEE 802.11 OCB communications in the 5,9 GHz band, see ISO 21215[10]
ETSI	European Telecommunications Standards Institute
EUI	ESxtended universal identifier
EUI-64	64-bit EUI
ICS	Implementation conformance statement
IN-SAP	Communication SAP as offered by the CAL to the ITS-S networking & transport layer
ITS-APDU	ITS station Access layer Protocol Data Unit
LocalCIID	CIID of a local CI

LSB	Least significant bit
MAC-48	48 bit MAC address
MAE	Management adaptation entity
MC-VCI	VCI for transmission to a multicast (group) MAC address
MI-SAP	Management SAP as offered by the ITS-S management towards the MAE
MSB	Most significant bit
OBU	On-board unit NOTE Term used for DSRC[16].
OSI	Open system interconnection
OUI	Organizational universal identifier
PIN	Personal identification number
RemoteCIID	CIID of a VCI enabling MAC groupcast transmissions and MAC unicast communication
RX/TX-CI	CI capable of operating in receive and transmit mode
RX-CI	CI capable of operating in receive mode only
RX-VCI	VCI for reception
SAE	Security adaptation entity
SIM	Subscriber identity module
SNAP	Sub-network access protocol
TAI	Temps Atomique International
TDMA	Time division multiple access
TX-CI	CI capable of operating in transmit mode only, either broadcast or multicast
TX-VCI	VCI for unicast transmission
UC-VCI	VCI for reception from and transmission to a unicast MAC address
UTC	Temps Universel Coordonné/Coordinated Universal Time
VCI	virtual communication interface
WAVE	Wireless access in vehicular environments NOTE IEEE work item related to [10].

5 Communication module adaptation

5.1 General

As ITS and the concept of an ITS station as a bounded secured managed domain (BSMD) specified in ISO 21217 does not only support access technologies (media) which are especially designed for implementations of ITS, there is a need to adapt the interfaces of these other access technologies to those interfaces expected by the ITS networking & transport layer, the ITS-S management entity, and the ITS-S security entity.

For these other access technologies, the task is to adapt:

— the interface on top of the access technology to the IN-SAP by means of a communication adaptation layer (CAL);

— the management interface to the MI-SAP by means of a management adaptation entity (MAE);

— the security interface to the SI-SAP by means of a security adaptation entity (SAE).

The CI adaptation is outlined in Figure 2.

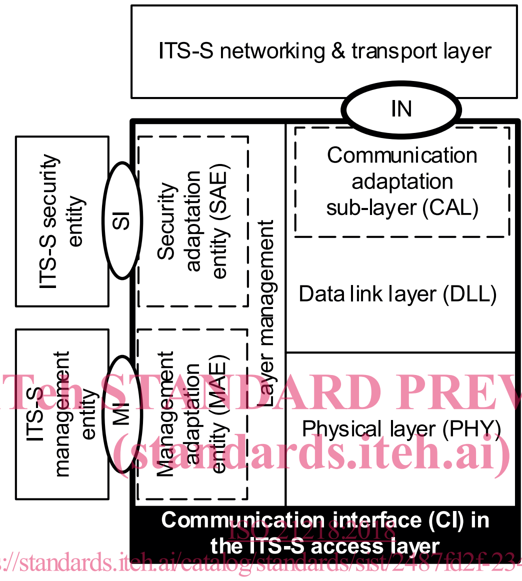

Figure 2 — Architecture

This document provides common basic functional specifications for the communication adaptation Layer, for the management adaptation entity (MAE), and for the security adaptation entity (SAE). It specifies the communication SAP (IN-SAP), the station management SAP (MI-SAP), and the security management SAP (SI-SAP).

5.2 Communication adaptation layer

The CIs built on different media are using the same ITS-S networking & transport layer. All CIs use the same type of IN-SAP between the ITS-S networking & transport layer and the CAL.

The medium-specific CAL provides an IN-SAP to the ITS-S networking & transport layer.

The CAL can be considered as an access technology (medium)-specific LLC or as an extension of an existing LLC providing the adaptation of the specific needs of an access technology (medium) to the common communication IN-SAP.

5.3 CI management adaptation entity

The CIs built on different media use the same ITS-S management, applying the functionality specified for the MI-SAP.

The MAE provides the MI-SAP to the ITS-S management following the same principles as outlined in ISO/IEC/IEEE 8802-11[2] with respect to the station management entity. The MI-SAP offers the services presented in Clause 9.

The MAE can be considered as medium-specific management providing the adaptation of the specific needs of an access technology (medium) to the common MI-SAP.

5.4 CI security adaptation entity

The current version of this document does not provide the specification of the SAE.

6 Communication interface

6.1 Architecture

This document uses the concept of

— Communication interface (CI), with

— virtual communication interfaces (VCIs).

A CI is a real communication equipment containing functionality of the ITS-S access layer. On top of a CI, one or several VCIs for transmission (TX-VCIs) to specific peer ITS-Ss, groups of ITS-Ss, or all ITS-Ss, and one or several receive VCIs (RX-VCIs), may be created.

NOTE The number of RX-VCIs is equal to the number of receive channels which can be operated simultaneously by the CI.

Further details on VCIs are specified in Clause 7.

6.2 Classification of CIs

6.2.1 CI Classes

CIs can be classified. Complementary classes shall be distinguished by means of CI classes presented in Table 1. A CI typically supports exctly one of the CI classes presented presented in Table 1. The set of applicable CI classes of a CI is given in I-Parameter CIclass of ASN.1 type `CIclass`. A single CI class is of ASN.1 type `CIclassSingle`.

NOTE New CI classes can be added as dynamic data, see Clause 11.

Table 1 — CI classes

Communication interface class	Definition and explanations
CIC-l1	CI that is capable of establishing simultaneous associations with different peer stations for unicast communication, and of receiving from and transmitting to broadcast and multicast (group) addresses. EXAMPLE Access technologies specified in [9],[10],[11]...
CIC-l2	CI that is capable of establishing a session via a single base station of a cellular network (typically to access Internet). Handover between different base stations may be possible, but not visible to the ITS upper layers and the ITS-S management. EXAMPLE Access technologies specified in [3],[7],[8]...
CIC-l3	CI that is capable to transmitting only on the basis of broadcast/multicast (group) addresses. EXAMPLE Access technologies specified in [9],[10],[11]...
CIC-l4	CI that is capable only of receiving frames from a broadcast station. EXAMPLE Satellite navigation receiver, satellite broadcast receiver, ...

Table 1 *(continued)*

Communication interface class	Definition and explanations
CIC-l5	CI that is capable only of performing communications between a car and a roadside station based on the master-slave principle with the roadside station being the master. Communication session establishment is done inside the CI. EXAMPLE Japanese DSRC, CEN DSRC, ...
CIC-l6	CI for a cellular network technology that is capable of supporting one-to-many communications either with support of a base station of a cellular network (allocation of resources on a packet-per-packet basis) or without support of the base station (pre-configured resources). Example: LTE technologies specified in [4],[5].
CIC-il1	CI for station-internal network of an ITS station. Non-deterministic.
CIC-il2	CI for station-internal network of an ITS station. Deterministic.

6.2.2 CI access classes

Access to a remote station may require authentication, for example:

— PIN for a SIM card;

— operator data:

  — provider name;

  — APN;

  — user name;

  — password.

This is identified by means of complementary CI access classes, i.e. a CI supports exactly one of the CI access classes presented in Table 2. The applicable CI access classes of a CI is given in I-Parameter CIaccessClass of ASN.1 type `CIaClass`.

NOTE New CI access classes can be added as dynamic data, see Clause 11.

Table 2 — CI access classes

CI access class	Definition and explanations
CIAC-1	No user authentication required.
CIAC-2	CI requires access credentials, e.g. PIN and operator data.
CIAC-3	CI may require access credentials, e.g. PIN and operator data, dependent on the operational mode.

6.3 Link identifier

CIs and VCIs are referenced/addressed by a unique Link-ID. The Link-ID shall be constructed according to Figure 3.

Link-ID					
RemoteCIID (remoteCIID)			LocalCIID (localCIID)		
EUI-64 field MSB ... LSB			EUI-64 field MSB ... LSB		
Byte 15	...	Byte 8	Byte 7	...	Byte 0

Figure 3 — Link-ID

The **LocalCIID** field identifies uniquely a specific CI in a specific ITS-S communication unit (ITS-SCU) in an instance of an ITS station.

NOTE A two octet ITS-SCU-ID specified in ISO 24102-4[13], identifying uniquely an ITS-SCU of an ITS-SU, can be derived from LocalCIID by means of a look-up table.

The **RemoteCIID** field identifies a VCI of the CI identified by LocalCIID which connects to a remote ITS-S unit (e.g. MAC unicast communication), or to a group of them (e.g. MAC broadcast or multicast communication). One reserved number of RemoteCIID identifies the CI which is addressed by the value of LocalCIID. This reserved number shall be

— the distinct null identifier (DNI) presented in D.2 for CIs supporting 48-bit MAC addresses;

— the "VCISerialNumber" field set to zero combined with the "UC/GC" field set to zero presented in D.3 for CIs which do not support 48-bit MAC addresses.

LocalCIID and RemoteCIID are presented in 64-bit global identifier (EUI-64) fields, see D.1, which may contain a 48-bit MAC address as illustrated in D.2.

For access technologies using 48-bit MAC addresses, LocalCIID may contain the globally unique MAC address of the CI, and RemoteCIID may contain either the individual MAC address reported in a received frame, or broadcast MAC address or a multicast MAC address.

Other access technologies use the numbering scheme specified in D.3.

The 48-bit MAC address is one example of a link layer address. Registered unique link layer addresses are presented in the medium-specific I-Parameter 8 "LLaddress". Locally assigned temporary values of a link layer address are stored in the I-Parameter 9 "LLaddressTemp".

6.4 CI procedures

6.4.1 General

The procedures as specified here use management services of the MI-SAP, as specified in Clause 9. The dynamic registration and deregistration procedures do not apply for CIs that are statically registered by implementation.

6.4.2 Registration

Registration of a CI at the ITS-S management is the process of making the CI known at the ITS-S management, and of making it addressable via a unique Link-ID. See the state machine in Figure 4.

The status of the CI before successful registration shall be CIstatus equal to "not existent".

A CI shall request registration of itself at the ITS-S management upon power-up, or upon physical insertion/activation of it. Two procedures are distinguished.

The following registration procedure shall be performed for CIs supporting 48-bit MAC addresses.

1) Create a Link-ID illustrated in Figure 3 with LocalCIID representing the globally valid unique MAC address of the CI as stored in I-Parameter **8** "LLaddress", with RemoteCIID equal to the "Distinct Null Indicator" (DNI) value presented in Annex C.

2) Send MI-REQUEST.request of ASN.1 type `RegistrationCI` indicating I-Parameter 14 "MedType" using the Link-ID constructed in step 1).

3) Set timer T_register to the value given in I-Parameter 7 "TimeoutRegister".

4) Await MI-REQUEST.confirm of ASN.1 type `RegistrationCIconf` providing the "ITS-SCU-ID" and "MedID" as long as T_register has not expired.

5) If the registration request was successfully performed, stop T_register and continue with the next step. If T_register had expired, start again with step 2).

6) Upon successful registration, set I-Parameter 4 "ITS-SCU-ID" as received in step 4. Set I-Parameter 12 "CIstatus" to the value "registered", and notify the new CIstatus value to the ITS-S management using MI-REQUEST.request of ASN.1 type `Event21218Notification` with event `E21218-5`.

The following registration procedure shall be performed for CIs not supporting 48-bit MAC addresses.

1) Create a preliminary Link-ID illustrated in Figure 3 with LocalCIID and RemoteCIID constructed as illustrated in Figure D.3 with:

   i) LocalCIID

      I) Set VCISerialNumber to the value zero, indicating the local CI.

      II) Set ITS-SCU-ID to the value zero, see ISO 24102-4[13].

      III) Set MedID to a value.

      IV) Set all bits in the UC/GC field to zero.

   The selected value of MedID might already be in use by another CI. Thus this value shall be confirmed by the ITS-S management entity in order to become valid.

   ii) RemoteCIID

      I) Set VCISerialNumber to the value zero, indicating the address of the CI.

      II) Set ITS-SCU-ID to the value zero.

      III) Set MedID to the same value as used in LocalCIID.

      IV) Set all bits in the UC/GC field to zero.

2) Send MI-REQUEST.request of ASN.1 type `RegistrationCI` indicating I-Parameter 14 "MedType".

3) Set timer T_register to the value given in I-Parameter 7 "TimeoutRegister".

4) Await MI-REQUEST.confirm of ASN.1 type `RegistrationCIconf` providing true values of "ITS-SCU-ID" and "MedID" as long as T_register has not expired.

5) If the registration request was successfully performed, stop T_register and continue with the next step. If T_register had expired, start again with step 1), using a different value for MedID.

6) Create the valid Link-ID of the CI using the values of ITS-SCU-ID, MedID as given by the ITS-S management in step 4).

7) Upon successful registration, set I-Parameter 4 "ITS-SCU-ID" and I-Parameter 5 "MedID"to the values received from the ITS station management. Set I-Parameter 12 "CIstatus" to the value "registered", and notify this value to the ITS management.

6.4.3 Deregistration

Deregistration of a CI at the ITS-S management is the reversal of the registration process of the CI. See the state machine in Figure 4.

Deregistration may be performed by the MAE or may be requested by the ITS-S management by sending the MI-COMMAND.request of ASN.1 type `CIstateChange` with the value "deregister".

Deregistration results in

— setting the ITS-SCU-ID to the value zero,

— deletion of all VCIs, and

— setting I-Parameter 12 "CIstatus" to the value "not existent".

The ITS- managament shall be notified of successful deregistration using the Link-ID as used for registration. Upon successful deregistration, the CI may be physically removed from the system.

6.4.4 Inactivation

Inactivation of a CI is the process to reset the CI and to block all subsequent communications. See the state machine in Figure 4.

Inactivation may be performed by the MAE or may be requested by the ITS-S management by sending the MI-COMMAND.request of ASN.1 type `CIstateChange` with the value "inactivate".

As a consequence of resetting a CI, no more VCIs exist, and thus there are no more pending data packets of the previously existing VCIs.

NOTE In a CI of class "CIC-l2" and access class "CIAC-2" such as specified in[7] or,[8] inactivation will result in disconnecting from the wireless service, i.e. ringing off.

The MAE shall set I-Parameter 12 "CIstatus" to the value "inactive" and shall notify the ITS-S management.

6.4.5 Activation

Activation of a CI is the process to enable communications in an inactive CI. See the state machine in Figure 4.

Activation may be performed by the MAE or may be requested by the ITS-S management by sending the MI-COMMAND.request of ASN.1 type `CIstateChange` with the value "activate".

This command shall trigger creation of VCIs as specified in 7.2.1.

The ITS-S management shall be notified of successful activation.

NOTE In a CI of class "CIC-l2" such as specified in [3],[7],[8] the state "active" indicates that the CI is within the communication zone of a base station and thus might connect to the service.

6.4.6 Suspension

Suspension of a CI is the process to put all communications of a CI on hold, without deleting any packets or state variables. See the state machine in Figure 4. A CI being in the state "suspended" shall still properly support the functionality of the primitives of the IN-SAP service IN-UNITDATA.

