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Intelligent transport systems — Communications access for land mobiles (CALM) — Access technology support

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National foreword

This British Standard is the UK implementation of ISO 21218:2013+A1:2014. It supersedes BS ISO 21218:2013 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to ISO text carry the number of the ISO amendment. For example, text altered by ISO amendment 1 is indicated by [A1⟩ ⟨A1].

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INTERNATIONAL STANDARD

ISO 21218

Second edition
2013-03-15

Intelligent transport systems — Communications access for land mobiles (CALM) — Access technology support

Systèmes intelligents de transport — Accès aux communications des services mobiles terrestres (CALM) — Support à la technologie d'accès

Reference number
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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. www.iso.org/directives

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

This second edition cancels and replaces the first edition (ISO 21218:2008) which has been technically revised.

Introduction

This International Standard is part of a family of International Standards for communications access for land mobiles (CALM). An introduction to the whole set of International Standards is provided in ISO 21217.

This International Standard 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.

The MI-SAP presented in Figure 1 is specified by means of a reference to ISO 24102-3. The specification of the SI-SAP is not within the scope of this International Standard.

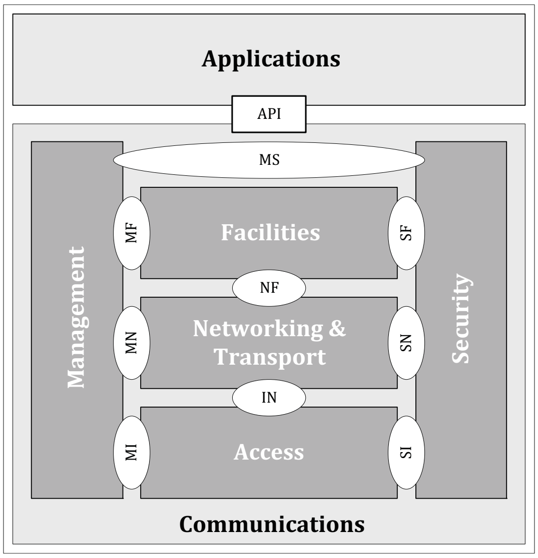

Figure 1 — ITS station reference architecture with named interfaces

Intelligent transport systems — Communications access for land mobiles (CALM) — Access technology support

1 Scope

This International Standard determines general technical details related to the access layer of the ITS station reference architecture specified in ISO 21217 which are applicable to all or several access layer technologies. This includes especially the service access point (SAP) of a communication interface (CI) as provided by the communication adaptation layer (CAL) for communication. The SAP provided by the CI management adaptation entity (MAE) for management of the communication interface is specified by reference to ISO 24102-3.

2 Normative references

The following referenced documents are indispensable for the application 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 8802-2, *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 2: Logical link control*

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 24102-1, *Intelligent transport systems — Communications access for land mobiles (CALM) — ITS station management — Part 1: Local management*

ISO 24102-3: *Intelligent transport systems — Communications access for land mobiles (CALM) — ITS station management — Part 3: Service access points*

ISO 24102-4, *Intelligent transport systems — Communications access for land mobiles (CALM) — ITS station management — Part 4: Station-internal management communications*

ETSI TS 102 760-1, *Intelligent transport systems; Road Transport and Traffic Telematics (RTTT); Test specifications for ITS; Communications Access for Land Mobiles (CALM), Medium Service Access Points (ISO 21218); Part 1: Protocol Implementation Conformance Statement (PICS) proforma*

ETSI TS 102 760-2, *Intelligent transport systems; Road Transport and Traffic Telematics (RTTT); Test specifications for ITS; Communications Access for Land Mobiles (CALM), Medium Service Access Points (ISO 21218); Part 2: Test Suite Structure and Test Purposes (TSS & TP)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 8802-2, ISO 21217, ISO 24102-1, ISO 24102-3, ISO 24102-4 and the following apply.

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 communication protocol is IR [5].

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

[A1) **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 (A1]

4 Abbreviated terms

NOTE See also: ISO/IEC 8802-2, ISO 21217, ISO 24102-1, ISO 24102-3, ISO 24102-4.

APN	Access point name
BC-VCI	VCI for transmission to the broadcast MAC address
CAL	Communication adaptation layer
CEN	"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
ETSI	"European Telecommunications Standards Institute"
EUI	Extended universal identifier
EUI-64	64-bit EUI
IN-SAP	Communication SAP as offered by the CAL to the ITS-S networking & transport layer

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 [14]
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
[A1) TAI	Temps Atomique International (A1]
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
[A1) UTC	Temps Universel Coordonné/Coordinated Universal Time (A1]
VCI	virtual communication interface
WAVE	Wireless access in vehicular environments NOTE IEEE work item related to [6]

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), and

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

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

The implementation of an existing access technology, which was not designed especially for ITS, may include higher layers of the OSI communication protocol stack than just the ITS access layer including the related management. This inclusion of higher protocol layers shall be restricted to those communication technologies already existing and not being aware of ITS and the concept of a BSMD, e.g. the cellular media [3, 4].

The CI adaptation is outlined in Figure 2.

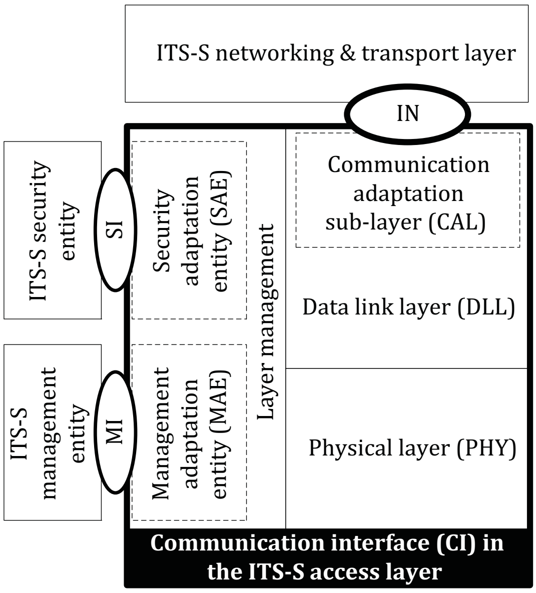

Figure 2 — Architecture

This International Standard 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 shall 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 following the same principles as outlined in ISO/IEC 8802-2. The supported types of LLC operation and LLC services may depend on the ITS-S networking & transport layer protocol selected.

— For ad-hoc communications, Type I. operation is mandatory, with the LLC service XID being prohibited.

— The other types of LLC operation, i.e. Type II. and Type III., are optional.

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 are using 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 8802-11 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 International Standard does not provide the specification of the SAE.

6 Communication interface

6.1 Architecture

This International Standard 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

6.2.1.1 CI Classes

Table 1 identifies and distinguishes the classes of CIs. [A1⟩ A CI shall support exactly one of these CI classes presented in Table 1. ⟨A1]

Table 1 — CI classes

Communication interface class	Definition and explanations
CIC-[A1⟩ *Text deleted* ⟨A1] l1	[A1⟩ *Text deleted* ⟨A1] CI that is capable of establishing simultaneous associations with different peer stations for MAC unicast communication, and of receiving from and transmitting to MAC broadcast and multicast (group) addresses. Examples: Access technologies specified in [5, 6, 7, …]
CIC-[A1⟩ *Text deleted* ⟨A1] l2	[A1⟩ *Text deleted* ⟨A1] CI that is capable of establishing a session with a single base station. Handover between different base stations may be possible, but not visible to the ITS upper layers and the ITS-S management. Examples: Access technologies specified in [3, 4, …]
CIC-[A1⟩ *Text deleted* ⟨A1] l3	[A1⟩ *Text deleted* ⟨A1] CI that is capable to transmitting only on the basis of MAC broadcast/multicast (group) addresses. Examples: Access technologies specified in [5, 6, 7, …]
CIC-[A1⟩ *Text deleted* ⟨A1] l4	[A1⟩ *Text deleted* ⟨A1] CI that is capable only of receiving frames from a broadcast station. Examples: Satellite navigation receiver, satellite broadcast receiver, …
CIC-[A1⟩ *Text deleted* ⟨A1] l5	[A1⟩ *Text deleted* ⟨A1] 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. Examples: Japanese DSRC, CEN DSRC, …
CIC-[A1⟩ il ⟨A1] 1	CI for station-internal network of an ITS station. Non-deterministic.
CIC-[A1⟩ il ⟨A1] 2	CI for station-internal network of an ITS station. Deterministic.

6.2.1.2 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 CI access classes. A CI shall support exactly one of the CI access classes presented in Table 2 [A1⟩ *Text deleted* ⟨A1].

Table 2 — CI access classes

CI access class	Definition and explanations
CIAC-1	No user authentication required. Usage of CI is free of any charge.
CIAC-2	CI requires access credentials, e.g. PIN and operator data. Usage of CI is subject of a service charge, e.g. price per time unit/per data amount unit/flat-rate.
CIAC-3	CI requires access credentials, e.g. PIN and operator data. However, usage of CI is free of any charge.

[A1) *Text deleted* (A1]

6.3 Link Identifier

CIs and VCIs shall be 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, identifying uniquely an ITS-SCU of an ITS-S, can be derived from LocalCIID be 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 shall identify the CI which is addressed by the value of LocalCIID. This reserved number shall be

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

— the VCISerialNumber zero presented in Annex C.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 annex C.1, which may contain a 48-bit MAC address as illustrated in Annex C.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 shall use the numbering scheme specified in Annex C.3.

NOTE LocalCIID andRemoteCIID may appear in an access layer frame in the communication link between peer ITS station units as part of an NPDU dependent on the networking & transport layer protocol being used. Thus LocalCIID and RemoteCIID may become subject for considerations on privacy.

6.4 Procedures

6.4.1 General

The procedures as specified here use management services of the MI-SAP, as specified in 8.5.

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".

Upon power-up, or upon physical insertion/activation of a CI, a CI supporting 48-bit MAC addresses shall request registration of itself at the ITS-S management. The following procedure shall apply.

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 9 "MAC address", with RemoteCIID equal to the "Distinct Null Indicator" (DNI) value presented in Annex C.

2) Send MI-REQUEST "RegReq" indicating I-Parameter 17 "MedType" using the Link-ID constructed in step 1).

3) Set timer T_register to the value given in I-Parameter 8 "TimeoutRegister".

4) Await MI-COMMAND "RegCmd" providing the "ITS-SCU-ID" and "MedID" as long as T_register has not expired.

5) If the command in the previous step was successfully received, 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 5 "ITS-SCU-ID" as received in MI-COMMAND "RegCmd". Set I-Parameter 13 "CIstatus" to the value "registered", and notify this value to the ITS-S management. This setting shall trigger creation of VCIs as specified in Clause 7.

Upon power-up, or upon physical insertion/activation of a CI, a CI not supporting 48-bit MAC addresses shall request registration of itself at the ITS-S management. The following procedure shall apply.

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

      III) Set MedID to a value.

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

NOTE The selected value for MedID might already be in use by another CI. Thus this value needs to 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 REQUEST "RegReq" indicating I-Parameter 17 "MedType".

3) Set timer T_register to the value given in I-Parameter 8 "TimeoutRegister".

4) Await COMMAND "RegCmd" providing true values of "ITS-SCU-ID" and "MedID" as long as T_register has not expired.

5) If the command in the previous step was successfully received, 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 5 "ITS-SCU-ID" and I-Parameter 6 "MedID" as received in COMMAND "RegCmd". Set I-Parameter 13 "CIstatus" to the value "registered", and notify this value to the ITS management. This setting shall trigger creation of VCIs as specified in 7.

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 "CIstateChng" with the value "deregister".

Deregistration shall result in

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

— deletion of all VCIs and

— setting of I-Parameter 13 "CIstatus" to the value "not existent".

Successful deregistration shall be notified to the ITS-S management 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 "CIstateChng" with the value "inactivate".

Inactivation shall result in resetting the CI. As a consequence, all VCIs shall be deleted and no more pending data packets shall be existent in the CI.

NOTE In a CI of class "CIC-wl2" and access class "CIAC-2" such as specified in [3 or 4], inactivation will result in disconnecting from the wireless service, i.e. ringing off.

The MAE shall set I-Parameter 13 "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 "CIstateChng" with the value "activate".

This command shall trigger creation of VCIs as specified below in this document.

Successful activation shall be notified to the ITS-S management.

NOTE In a CI of class "CIC-wl2" and access class "CIAC-2" such as specified in [3 or 4], 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.

Suspension may be performed by the MAE or may be requested by the ITS-S management by sending the MI-COMMAND "CIstateChng" with the value "suspend".

All VCIs shall be maintained. No pending data packets shall be lost. An on-going frame transmission shall be stopped as quickly as possible. An on-going frame reception shall be finalized.

The MAE shall set I-Parameter 13 "CIstatus" to the value "suspended" and shall notify it to the ITS-S management.

6.4.7 Resuming

Resuming of a CI is the process to resume communications in a suspended CI. See the state machine in Figure 4.

Resuming may be performed by the MAE or may be requested by the ITS-S management by sending the MI-COMMAND "CIstateChng" with the value "resume".

The MAE shall set I-Parameter 13 "CIstatus" to the value "connected" and shall notify it to the ITS-S management. Pending packets shall be processed after resuming, if possible, otherwise pending packets may be deleted without notification to the ITS-S management.

6.4.8 Connection

Connection of a CI is a process that depends on the CI access class. See the state machine in Figure 4.

For CI access class "CIAC-1" connection is established upon first usage of a TX-VCI or upon reception of a frame from a peer station.

For CI access classes "CIAC-2" and "CIAC-3" connection is achieved upon confirmed establishment of a connection to the communication network. Connection may be requested by the ITS-S management by sending the MI-COMMAND "CIstateChng" with the value "connect".

The MAE shall set the I-Parameter 42 "CIstatus" to the value "connected" and shall notify it to the ITS-S management.

6.4.9 Disconnection

Disconnection of a CI is a process that depends on the CI access class. See the state machine in Figure 4.

For CI access class "CIAC-1", disconnection shall be performed upon the situation that no more TX-VCI with a relation to a peer station are known.

For CI access classes "CIAC-2" and "CIAC-3" this is the termination of the connection to the communication network. Disconnection may be requested by the ITS-S management by sending MI-COMMAND "CIstateChng" with the value "disconnect". There may be an implicit disconnection caused by deletion of a VCI.

The MAE shall set I-Parameter 42 "CIstatus" to the value "active" and shall notify the ITS-S management.

6.4.10 CI state machine

Figure 4 shows the state machine of a CI. It covers

a) the start and end state

   1) not_existent,

b) the interim states

   1) existent, and

   2) registered,

c) the operational states

   1) active, and

   2) connected, [A1) not applicable for receive-only CIs (CIC-I4) (A1]

d) the non-operational states [A1⟩ not applicable for receive-only CIs (CIC-l4) ⟨A1]

1) suspended, and

2) inactive,

see I-Parameter 13 "CIstatus". The transitions between the states are

- power on/activate, see 6.4.2,
- register, see 6.4.2,
- deregister, see 6.4.3,
- create VCI, see 7.3.1,
- inactivate, see 6.4.4,
- activate, see 6.4.5,
- suspend, see 6.4.6,
- resume, see 6.4.7,
- connect, see 6.4.8,
- disconnect, see 6.4.9, and
- delete VCI, see 7.3.3.

Requests to perform invalid transitions shall be acknowledged with error code ErrStatus="INVALID COMMAND/REQUEST VALUE" specified in ISO 24102-3.

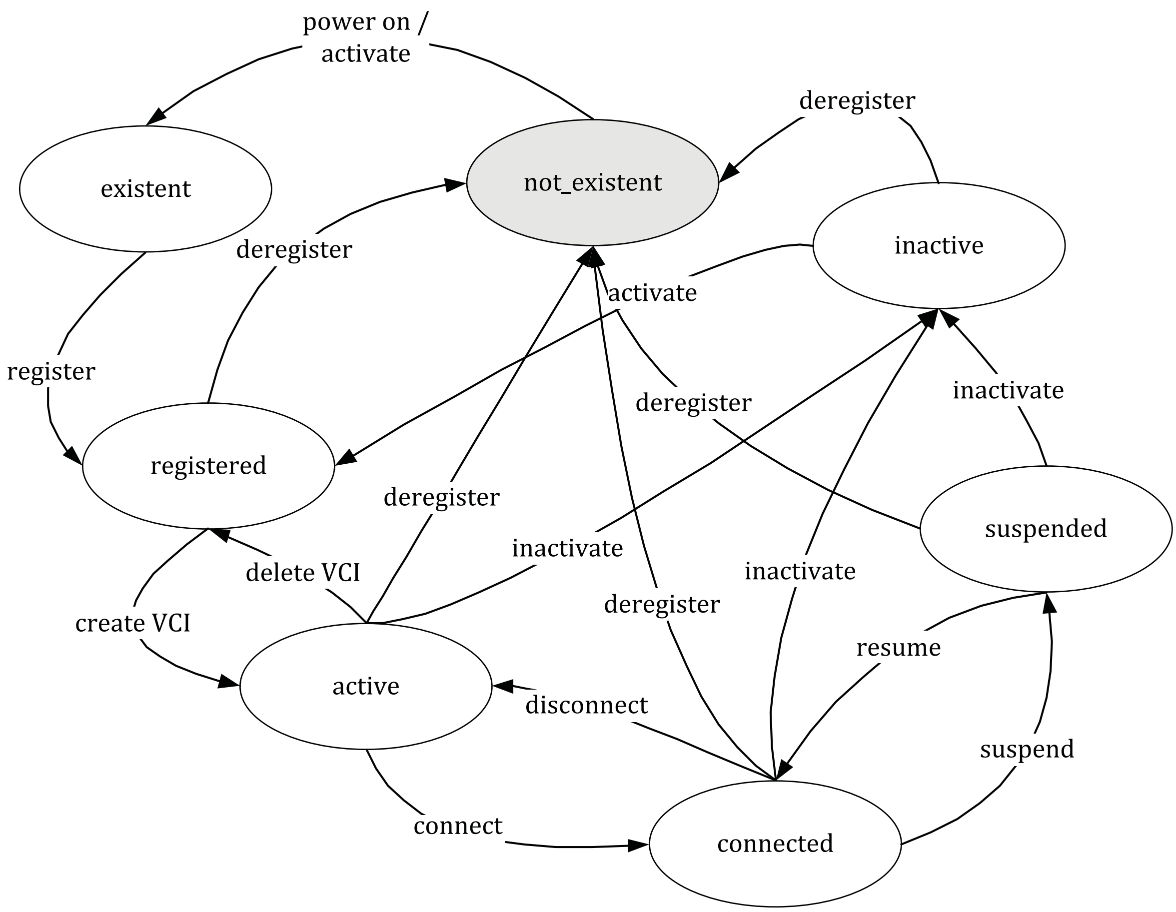

Figure 4 — CI state machine

6.4.11 Cross-CI prioritization

6.4.11.1 General

Wireless TX-VCIs in an instance of an ITS station might suffer from cross-interference. 6.4.11 considers the case in which at least two local TX-VCIs, e.g. using the same medium, need to be synchronized in order to avoid cross-interference. The procedure to synchronize transmission of multiple CIs based on user priority is called "Cross-CI prioritization".

The design and integration goal shall be to avoid such cross-interference to the greatest possible extent. A possible means of achieving this is proper assignment of allowed wireless communication channels to the CIs.

Priority management across CIs requires involvement of the ITS-S management for every packet to be prioritized.

This procedure "Cross-CI prioritization" is an optional procedure.

6.4.11.2 Registration of CI for prioritization REQUEST

A CI may register itself at the ITS-S management for the cross-CI prioritization procedure. This registration shall include

— the types of potentially interfering media, see I-Parameter 17 "MedType", and

— the prioritization timeout in milliseconds.

Registration for cross-CI prioritization shall use MI-REQUEST "PrioReg".

It is assumed that potentially interfering media are known *a priori* by the CI. Settings shall be made by the manufacturer of the victim device. Settings may be overruled by the ITS-S management.

6.4.11.3 Prioritization request

If registration for the cross-CI prioritization procedure is performed, a packet to be transmitted with a given high priority is notified via the ITS-S management to other CIs not being in charge of transmitting this packet by means of a dummy transmission request, i.e. by sending MI-REQUEST "RTSreq". The minimum required priority is specified in the I-Parameter “MinPrioCrossCI”.

— RTSreq.priority shall be set equal to the user priority of the pending packet,

— RTSreq.seqNo shall be set to a value unique for this CI,

— RTSreq.status shall be set to "request".

NOTE The ITS-S management accepts a prioritization request only if RTSreq.priority is at least equal to MinPrioCrossCI.

Upon transmission of the request, the CI may start a timer T_DummyAckReq for this request.

In the case of protection only (see 6.4.12) the CI may try immediately to perform the intended transaction without awaiting receipt of an acknowledgement, if it will not cause interference to other CIs in this ITS station.

Otherwise, upon reception of the acknowledge MI-COMMAND "RTSackCmd" from the ITS-S management with

— RTSackCmd.seqNo equal to the related request, and

— RTSackCmd.status equal to "granted",

the CI shall send the pending packet. The CI shall cancel the timer T_DummyAckReq.

If the acknowledge command shows RTSackCmd.status equal to "ignored", the CI may either send the pending packet or delete it. The CI shall cancel the timer T_DummyAckReq. The MAE shall set I-Parameter 34 "MinPrioCrossCI" equal to the value provided in RTSackCmd.priority.

Upon expiration of the timer T_DummyAckReq, if applicable, the CI may either send the pending packet or may delete it.

6.4.11.4 Prioritization release

Upon transmission or deletion of the pending packet, the CI shall release the prioritization request by means of MI-REQUEST "RTSreq" to the ITS-S management:

— RTSreq.priority shall be set equal to the request value;

— RTSreq.seqNo shall be set equal to the request value;

— RTSreq.reqStatus shall be set to "release".

The CI priority manager shall continue to serve the priority queues.

6.4.11.5 Interferer procedures

The information contained in MI-REQUEST "RTSreq" shall be used in the priority queue of the potential interferer CI. All potential interferers shall be notified by the ITS-S management by means of the MI-COMMAND "RTScmd":

- RTScmd.reqID shall be set equal to LocalCIID of the related request;
- RTScmd.priority shall be set equal to the user priority of the related request;
- RTScmd.seqNo shall be set equal to the value of the related request;
- RTScmd.status shall be set to "request".

Once such a dummy entry in the priority queue is subject to transmission,

- the dummy request shall be acknowledged by means of MI-REQUEST "RTSackReq", thus
  - RTSackReq.reqID shall be set equal to LocalCIID of the related request,
  - RTSackReq.seqNo shall be set equal to the value of the related request, and
  - RTSackReq.status shall be set to "granted", then
- the transmitter shall be disabled and a timer T_dummyAckGrant for this request shall be started,
- the CI priority manager shall await either time out of T_dummyAckGrant or shall await release of this dummy transmission request by means of the MI-COMMAND "RTScmd", with the parameters set as follows:
  - RTScmd.reqID shall be set equal to LocalCIID of the related request;
  - RTScmd.priority shall be set equal to the user priority of the related request;
  - RTScmd.seqNo shall be set equal to the value of the related request;
  - RTScmd.status shall be set to "release";
- the CI priority manager shall then delete the dummy transmission request from the queue and shall continue serving the priority queues.

6.4.12 Protection of CI

Wireless transmitters and receivers integrated in an instance of an ITS station may suffer from cross-interference. Depending on user priorities, the interfering local CI transmitters are disabled for a defined period. This is called "Protection of CI".

NOTE An example of a CI in need of protection is a CEN DSRC OBU as widely used in payment and access control systems.

The design and integration goal is to avoid such cross-interference to the greatest possible extent.

"Protection of CI" shall make use of the "Cross-CI Prioritization" procedure.

Independent of the protection status, the CI may try to perform an intended communication at any time, unless it is requested to disable its transmitter due to a transmission request of a packet with higher priority, announced by means of the Cross-CI prioritization procedure.

The procedure for protection of a CI may be hard-wired in an implementation.

6.4.13 Regulatory information management

If regulation limits the capabilities of an access technology (medium), the CI shall control proper settings of parameters in line with the actually valid regulation. The regulations could depend on, for example,

— the geographical location of the ITS station, or

— the legal type (owner) of the ITS station.

It is possible to get updates of the regulatory information with the following three options:

a) The CI continuously monitors reception of frames with regulatory information, if applicable, in order to have an up-to-date regulatory information list.

b) Alternatively, regulatory information may be derived from a local regulatory database located inside the CI using latitude and longitude of the geographical location of the ITS station. The geographical location of the ITS station shall be provided by a positioning service via the ITS-S management, if applicable, otherwise directly from a positioning unit being integrated within the CI. The CI may request to receive updates of the kinematic vector, see I-Parameter 48 "KinematicVector", containing latitude and longitude information by means of MI-REQUEST "PosUpdateReq", which defines the update interval and activates/disables updates.

c) Alternatively, regulatory information may be received via other CIs.

    — A CI may request retrieval of regulatory information with MI-REQUEST "RIreq". Upon this request the ITS-S management shall try to retrieve an update of regulatory information via the selected CI.

    — Upon availability of regulatory information, the ITS-S management shall forward the complete regulatory information to the related CIs by means of MI-COMMAND "RIcmd".

Attempts of the ITS-S management to set parameters of the CI such that regulation would be violated shall be ignored and acknowledged with error code ErrStatus="RI VIOLATION" specified in ISO 24102-3.

The details of regulatory information data content and format are outside the scope of this International Standard.

7 Virtual communication interface

7.1 Concept

The concept of a virtual communication interface (VCI) provides a quick and efficient method to set the properties of a CI on a packet-by-packet basis without the continuous involvement of the ITS-S management.

A TX-VCI is a software instance on top of a CI which is used for transmission towards either

— a specific receiver (UC-VCI), applying MAC unicast communications, or

— all possible receivers (BC-VCI), applying MAC broadcast communications, or

— a group of possible receivers (MC-VCI), applying MAC multicast communications.

The concept of a CI with TX-VCIs in relation to other instances of an ITS station is illustrated in Figures 5, 6 and 7. It is assumed, that in these figures only CIs of the same access technology (MedType *x*) are presented. Note that these figures do not show all functional blocks of an ITS station specified in ISO 21217.

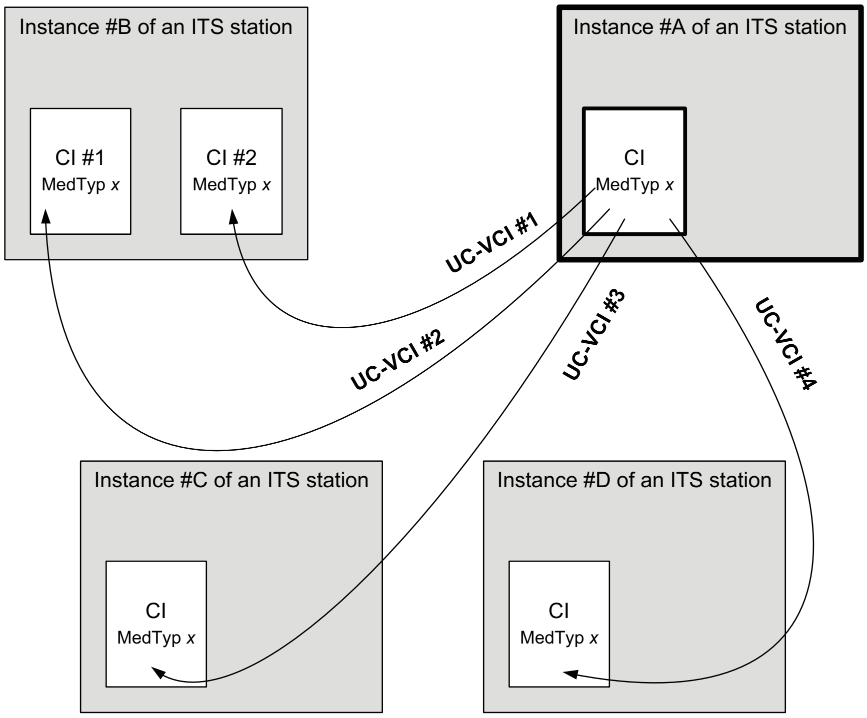

Figure 5 — UC-VCIs of instance #A of an ITS station

The CI in instance #A of an ITS station presented in Figure 5 maintains unicast links to four receivers installed in three instances of an ITS station, i.e. there are four UC-VCIs available, connecting to the RX-VCIs of the three other instances of an ITS station.

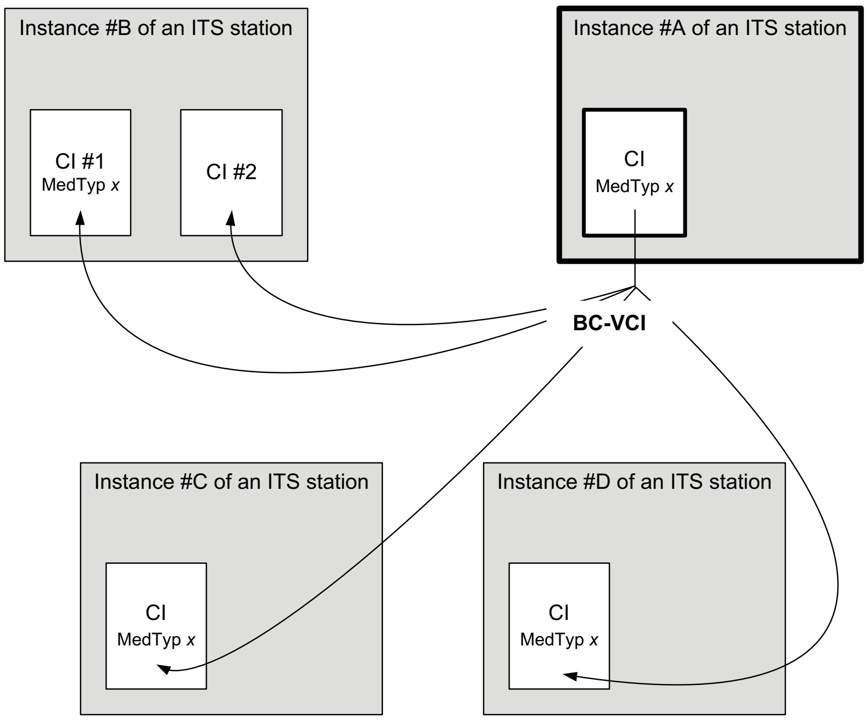

Figure 6 — BC-VCI of instance #A of an ITS station

The CI in instance #A of an ITS station presented in Figure 6 maintains one broadcast link, which in this given scenario lead to four receivers installed in three instances of an ITS station, i.e. there is one BC-VCI available, connecting to the RX-VCIs of the three other instances of an ITS station.

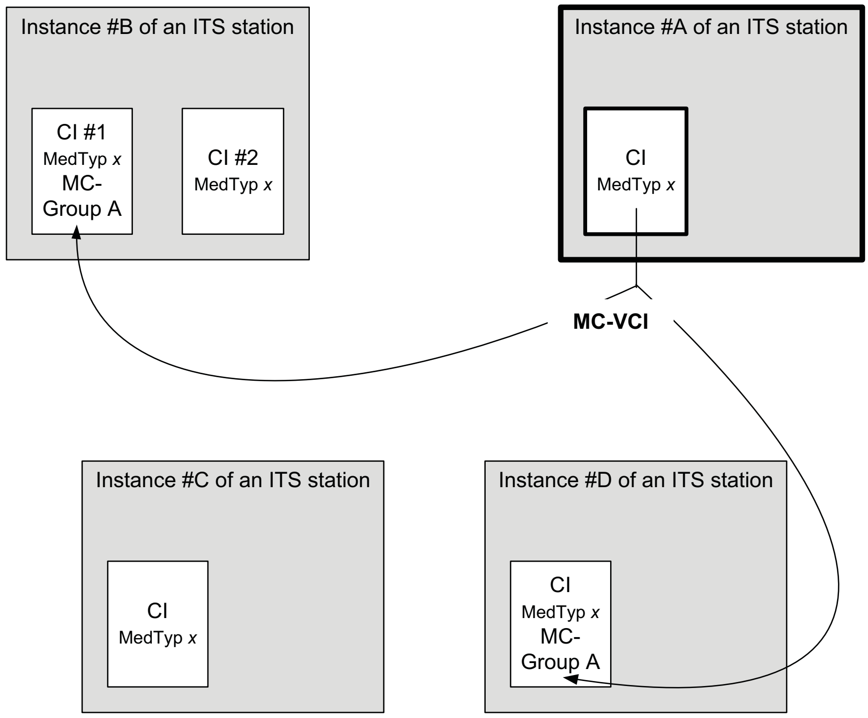

Figure 7 — MC-VCI of instance #A of an ITS station for MC-group A

The CI in instance #A of an ITS station maintains one multicast link for the MC-group A, which in this given scenario leads to two receivers installed in two instances of an ITS station, i.e. there is one MC-VCI available, connecting to RX-VCIs of two other instances of an ITS station. The other CIs also receive the related multicast frames, but these are ignored due to an invalid multicast address.

Each VCI may maintain its own set of I-Parameters in order to allow for an automatic packet-by-packet switching of transmit parameters without involving the ITS-S management, and without the need of additional parameters used in the IN-SAP service primitives. Different I-Parameter settings may apply for every association with a specific peer station, i.e. for every TX-VCI. Access to a TX-VCI may require a minimum user priority.

[A1⟩ Each RX/TX-CI shall maintain at least one RX-VCI for reception of frames. There is a single UC-VCI for every known peer CI. The RX-VCI of a CI is shared by all of its TX-VCIs. ⟨A1] There shall be one TX-VCI for transmission to the MAC broadcast address (BC-VCI), if applicable. There may be multiple TX-VCIs for transmission to MAC multicast (group) addresses (MC-VCI), if applicable.

NOTE Broadcast address and multicast addresses are referred to as groupcast addresses.

TX CIs, i.e. groupcast transmitters, contain BC-VCIs and/or MC-VCIs only. There is no RX-VCI.

RX CIs, e.g. groupcast or satellite positioning receivers, contain only one or several RX-VCIs. The number of RX-VCIs is equal to the number of receive channels which can be simultaneously operated.

Figure 8 explains how virtual entities of a CI and user priority are to be handled. After priority checking is performed by the CI priority manager, the CI I-Parameters are set to the values of the TX-VCI I-Parameters valid for the selected packet.

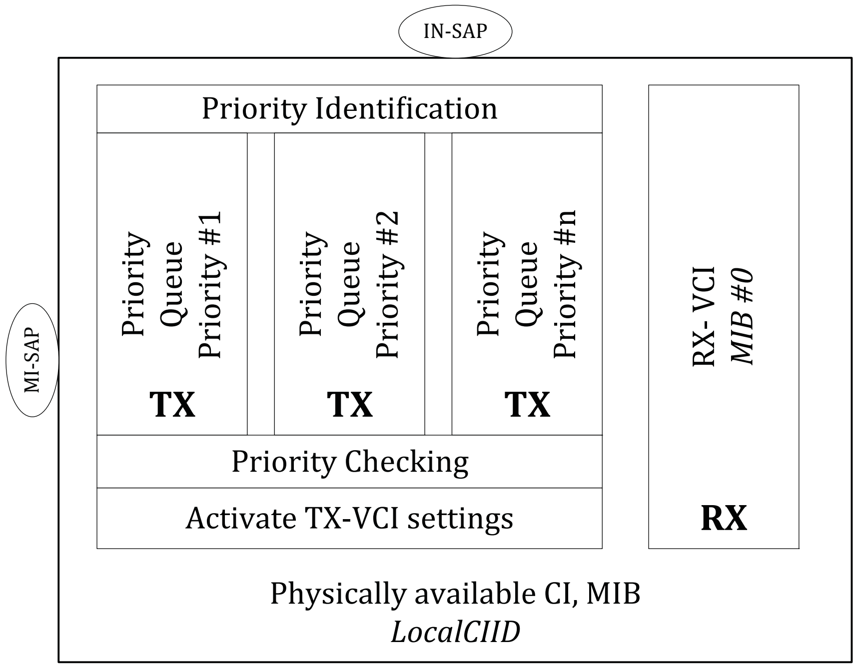

Figure 8 — CI priority queues and virtual communication interfaces

Each TX-VCI shall have its own set of I-Parameters. The differences between the I-Parameters of different VCIs of the same CI are only in

a) the TX-parameters, and

b) the MAC addresses of the peer stations.

The CI shall use the transmit parameter settings as provided by the I-Parameters of the active VCI. These settings shall apply until another VCI is being used for transmission or is requested by the ITS-S management.

User priority shall be handled according to the priority parameter provided by the ITS-S networking & transport layer in the service primitive for communication, e.g. IN-UNITDATA.request, see Clause 8. Priority queues for transmission shall be maintained either in the CAL, the LLC or the MAC of the CI. There shall be only a single set of queues for all TX-VCIs of a CI.

Multiple CIs of the same type, i.e. same medium, are allowed. If these CIs guarantee real simultaneous operation, these CIs may use the same or different priorities without a common priority checking entity. If these CIs operate simultaneously on interfering channels, a cross-CI prioritization mechanism may be applied.

NOTE Further on, it is allowed to provide a medium-specific bridge. This bridge may cover all CIs of the same type. Details are outside the scope of this International Standard.

7.2 VCI identifier

VCIs shall be referenced / addressed by a unique Link-ID.

The Link-ID illustrated in Figure 3 shall be constructed as specified in 6.3.

7.3 Procedures

7.3.1 Creation of VCI

Upon registration of an RX/TX-CI of CI class "CIC-wl2", the CI shall create an RX-VCI and shall continuously monitor for a base station providing possible access to the communication network. Once a base station is identified that may provide access to the communication network, a TX-VCI shall be created by the MAE based upon the default set of I-Parameters. I-Parameter 13 "CIstatus" shall be set to "active". Such a CI shall connect to the service automatically if it is of CI access class "CIAC-1" or "CIAC-3". If it is of CI access class "CIAC-2", initiation of connection depends on I-Parameter 19 "Connect". If "Connect" is set to "manual" it shall await a request from ITS-S management to connect by means of MI-COMMAND "CONcmd". If "Connect" is set to "automatic" it shall connect automatically upon reception of the first data transmission request IN-UNITDATA.request.

Upon registration of an RX/TX-CI of CI class "CIC-wl1", a BC-VCI, if applicable, and an RX-VCI shall be created by the MAE based on the default set of I-Parameters. I-Parameter 13 "CIstatus" shall be set to "active". Upon reception of the first frame from a peer station, a UC-VCI shall be created. The Link-ID.RemoteCIID of the UC-VCI shall identify the peer station as illustrated in annexes C.2 or C.3, respectively. The value of the MAC address or SerialNumber, respectively, shall be notified to the ITS-S management.

Upon registration of an RX-CI, I-Parameter 13 "CIstatus" shall be set to "active".

Upon registration of a TX-CI, a BC-VCI shall be created by the MAE based on the default set of I-Parameters. I-Parameter 13 "CIstatus" shall be set to "active".

Creation of a VCI shall be notified to the ITS-S management by means of MI-REQUEST "Events", reporting the Link-ID.

Upon request from the ITS-S management, the MAE shall create a VCI, e.g. UC-VCI or MC-VCI, for a remote MAC address as requested by the ITS-S management by means of MI-COMMAND "VCIcmd". The I-Parameters of this new VCI shall use default values in line with the settings of the shared RX-VCI, if applicable. Subsequently the actual set of I-Parameters of the new VCI may be modified by the ITS-S management.

7.3.2 Reset of VCI

Upon reset request by means of MI-COMMAND "VCIcmd" all state variables of the VCI and all pending packets and frames shall be deleted. A relation to a peer station, if applicable, shall remain. All VCI I-Parameters shall be set to default values, if applicable.

Successful reset of a VCI shall be notified to the ITS-S management by means of MI-REQUEST "Events".

7.3.3 Deletion of VCI

The MAE may delete a UC-VCI in case no frames were received from the related peer station within a time span given by I-Parameter 13 "InactivityTimeLimit", see also Table 5.

Deletion of a VCI shall be notified to the ITS-S management by means of MI-REQUEST "Events".

Upon request from the ITS-S management, the MAE shall delete a VCI by means of MI-COMMAND "VCIcmd".

7.3.4 Association of peer with Link-ID

All packets received from a peer station shall be identified by means of the Link-ID of the related TX-VCI created for this peer station.

Details on assignment of values and relation to MAC addresses are specified in Table 5 and Table 6.

NOTE A CI may change its locally administered MAC address for the purpose of privacy. Procedures on how to manage a change of MAC address are medium-specific and outside the scope of this International Standard. A change of MAC address without notification of the peer station will thus result in creation of a new VCI and termination of on-going communications at the higher OSI layers based on the old MAC address.

The MAE shall maintain the following Table 4 with the mappings of peer MAC address and related Link-ID together with time of last reception of a frame.

Table 4 — Peer-list

Peer MAC address	Link-ID	Time of last reception
As received from peer station.	Complete Link-ID according to Figure 3, and annexes C.2 and C.3, respectively.	ASN.1 [A1⟩ Time48IAT ⟨A1] with at least one byte for fractional seconds. See I-Parameter 28 "TimeOfLastReception" in Annex A.

The time of last reception may be used to estimate whether a peer station has left the communication zone.

7.3.5 Change of I-Parameter settings

The CI may automatically change I-Parameter settings according to rules that are specific to the medium.

The ITS-S management may request change of I-Parameter settings according to rules specified in ISO 24102-1.

8 Communication SAP

8.1 LLC Types of Operation

ISO/IEC 8802-2 defines three types of LLC operation, i.e. Type 1, Type 2 and Type 3 and related DL-SERVICEs. Table 5 presents these types of LLC operation and their mapping on the IN-SERVICEs specified in this International Standard.

Table 5 — Mapping of 802.2 DL-services onto ITS IN-services

DL-SERVICE ISO/IEC 8802-2	**IN-SERVICE** extension of DL-SERVICE for ITS	**Service type**	**Comment**
DL-UNITDATA	IN-UNITDATA	Type 1 operation: Unacknowledged connectionless-mode data transfer	mandatory
-	IN-UNITDATA-STATUS		optional
DL-DATA-ACK DL-DATA-ACK-STATUS	IN-DATA-ACK IN-DATA-ACK-STATUS	Type 3 operation: Acknowledged connectionless-mode data unit transmission	optional
DL-REPLY DL-REPLY-STATUS	IN-REPLY IN-REPLY-STATUS	Acknowledged connectionless-mode data unit exchange	
DL-REPLY-UPDATE DL-REPLY-UPDATE-STATUS	IN-REPLY-UPDATE IN-REPLY-UPDATE-STATUS	Acknowledged connectionless-mode reply data unit preparation	
DL-CONNECT	IN-CONNECT	Type 2 operation: Connection-mode services connection establishment	optional
DL-DATA	IN-DATA	Connection-mode data transfer	
DL-DISCONNECT	IN-DISCONNECT	Connection-mode services connection termination	
DL-RESET	IN-RESET	Connection-mode services connection reset	
DL-CONNECTION-FLOWCONTROL	IN-CONNECTION-FLOWCONTROL	Connection-mode services connection flow control	

As a minimum, a CI shall support LLC Type I. operations, i.e. the IN-UNITDATA service.

The handling of address parameters and priority for optional LLC services shall be the same as specified in this International Standard for the mandatory service.

ISO/IEC 8802-2 defines four classes of LLC, i.e. Class I., Class II., Class III. and Class IV.

Class I. shall be mandatory for CIs with possible restrictions of the LLC services XID and TEST depending on the networking protocol. For the ITS-S networking & transport layer protocol FNTP specified in [12], XID shall be prohibited.

Further details are outside the scope of this International Standard.

8.2 Addressing

8.2.1 SAP addresses

IN-SAP addresses describe which network protocol is associated with the message to be transferred; refer to [1]. IN-SAP addresses for the source, i.e. SSAP address, and IN-SAP addresses for the destination, i.e. DSAP address, are distinguished. SSAP and DSAP shall be transmitted via the CI in a medium-specific way.

NOTE The requirement to use DSAP and SSAP addresses in the IN-SAP in no way imposes any requirements on the respective addressing scheme used by a specific access technology. Consequently, e.g. EtherType addressing may be used in a MAC frame.

Table 6 — Addresses for the Link Service Access Point (IN-SAP) — Informative

IN-SAP address	IN-SAP address binary LSB .... MSB	Description Network Usage	Comment
	x 0 d d d d d d	DSAP address	ISO/IEC 8802-2
	x 0 s s s s s s	SSAP address	ISO/IEC 8802-2
	x 1 d d d d d d	Reserved DSAP for ISO definition	ISO/IEC 8802-2
	x 1 s s s s s s	Reserved SSAP for ISO definition	ISO/IEC 8802-2
even	0 x d d d d d d	Individual DSAP	ISO/IEC 8802-2, applicable for IN-SAP
odd	1 x d d d d d d	Group DSAP	ISO/IEC 8802-2, usage not defined in this International Standard
even	0 x s s s s s s	Command SSAP	ISO/IEC 8802-2, applicable for IN-SAP
odd	1 x s s s s s s	Response SSAP	ISO/IEC 8802-2, not applicable for IN-SAP, as only UNITDATE service is specified.
0 = 0x00	0 0 0 0 0 0 0 0	Null LSAP	Usable as both DSAP and SSAP. Local address.
2 = 0x02	0 1 0 0 0 0 0 0	Individual DSAP for the LLC sub-layer management function at that station	ISO/IEC 15802-2 Remote LAN management, http://iana.org
3 = 0x03	1 1 0 0 0 0 0 0	Group DSAP for the LLC sub-layer management at that station	ISO/IEC 15802-2 Remote LAN management, http://iana.org
166 = 0xA6	0 1 1 0 0 1 0 1	RDE SAP address	RDE = route determination entity To support bridges ISO/IEC 8802-2

IN-SAP address	IN-SAP address binary LSB .... MSB	Description Network Usage	Comment
255 = 0xFF	1 1 1 1 1 1 1 1	Global DSAP	ISO/IEC 8802-2

The following address mapping applies for ITS:

Table 7 — Addresses for the Link Service Access Point (IN-SAP)

IN-SAP address decimal and hexadecimal	IN-SAP address binary LSB .... MSB	Description Network Usage	Comment
170 = 0xAA	0 1 0 1 0 1 0 1	SNAP	Sub-Network Access Protocol DLL extension See ISO/IEC 8802-2, http://iana.org
182 = 0xB6	x 1 1 0 1 1 0 1	IPv6	Specified in [2]
186 = 0xBA	x 1 0 1 1 1 0 1	FNTP	Specified in [12].
190 = 0xBE	x 1 1 1 1 1 0 1	GeoNetworking	Specified in [13].
242 = 0xF2	x 1 0 0 1 1 1 1	Reserved for future use	—
246 = 0xF6	x 1 1 0 1 1 1 1		
250 =0xFA	x 1 0 1 1 1 1 1		

8.2.2 IN-SAP source and destination addresses

The IN-SAP source_address and destination_address as used in the LLC services shall be the concatenation of a Link-ID and a IN-SAP address as presented in Figure 5.

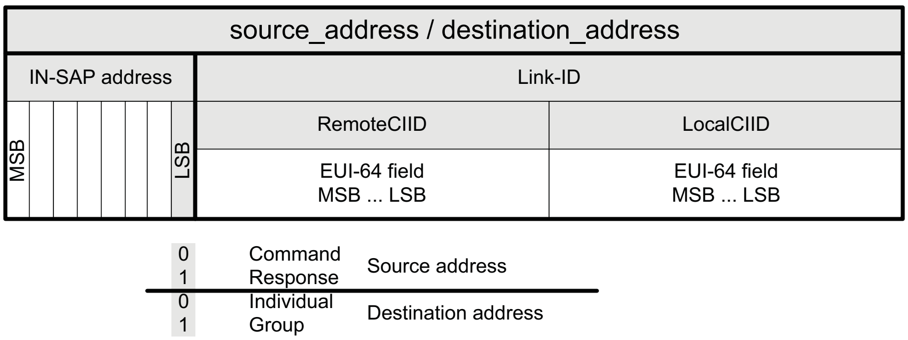

Figure 9 — IN-SAP Source and Destination Address Format

The IN-SAP address shall constitute the most significant byte of source_address and destination_address.

Tables 8 and 9 specify the mapping of MAC addresses on Link-ID in source_address and destination_address, see also Annex C.2. In case, usage of MAC addresses in Link-IDs is not allowed or not possible, Annex C.3 provides information on how to generate replacements for MAC addresses.

Table 8 — Address parameters in e.g. IN-UNITDATA.request for CIs using 48-bit MAC addresses

Source MAC address	Destination MAC address	RemoteCIID of source_address	RemoteCIID of destination_address	LocalCIID
Private MAC_{local} of transmitting local CI	BC-MAC	DNI, or ID containing UC-MAC address MAClocal	ID containing BC-MAC address	ID of CI to be used for transmission of the frame
	MC-MAC (MAC group) Mgroup		ID containing MC-MAC address Mgroup	
	Private MACpeer of peer CI		ID containing UC-MAC address MACpeer	

Table 9 — Address parameters in e.g. IN-UNITDATA.indication for CIs using 48-bit MAC addresses

Source MAC address	Destination MAC address	RemoteCIID of source_address	RemoteCIID of destination_address	LocalCIID
Private MAC_{peer} of transmitting peer CI	BC-MAC	ID containing MACpeer	Containing BC-MAC address	ID of the CI that received the frame
	MC-MAC (MAC group) Mgroup		Containing MC-MAC address Mgroup	
	Private MAClocal of local CI		DNI, or ID containing UC-MAC address MAClocal	

8.2.3 SNAP

The sub-network access protocol (SNAP) is an optional extension of the LLC, see http://iana.org. SNAP is designed to extend the address space for selecting a network protocol. It applies only to Type I. Unnumbered Information (UI) commands according to ISO/IEC 8802-2.

SNAP is not mandatory, as the IN-SAP elements DSAP and SSAP defined are sufficient to select the proper network protocol.

From the information in the SNAP header, the correct IN-SAP values shall be derived. Removal of a SNAP header and generation of IN-SAP values shall be done at the CAL prior to submission of the packets to the ITS-S networking & transport layer in a UNITDATA.indication service primitive via the proper IN-SAP as indicated in the SNAP header.

Generation of the SNAP header in an access technology (medium) supporting SNAP shall be done at the CAL prior to submission of the packet to the MAC sub-layer.

Further details are outside the scope of this International Standard.

8.3 Service primitives (informative)

8.3.1 IN-UNITDATA.request

8.3.1.1 Function

The service primitive IN-UNITDATA.request is used for transmission of data.

8.3.1.2 Semantics of the service primitive

```
IN-UNITDATA.request     (
                        source_address,
                        destination_address,
                        data,
                        priority,
                        access parameters
                        )
```

The source_address is defined in 8.2.2.

The destination_address is defined in 8.2.2.

The data parameter contains the data to be transferred as payload. This parameter is referred to as NPDU.

The priority parameter is defined in 8.4.

The access_parameters parameter is defined in 8.5.

8.3.1.3 When generated

IN-UNITDATA.request is passed from the ITS-S networking & transport layer to the addressed CAL to request that an LSDU be sent to one or more remote IN-SAPs using unacknowledged connectionless-mode data transfer procedures.

8.3.1.4 Effect on receipt

Receipt of IN-UNITDATA.request causes the CAL to attempt to send the LSDU using the unacknowledged connectionless-mode data transfer mode considering the adaptation procedures for the selected VCI and the type of adaptation as indicated by the value of DSAP.

NOTE A packet addressed to a non-existent VCI will be discarded.

Success or failure of the transmission attempt may be reported to the ITS-S networking & transport layer using the IN-UNITDATA-STAUS.indication service primitive.

8.3.1.5 Additional comments

IN-UNITDATA.request is independent of any connection with the remote IN-SAP.

8.3.2 IN-UNITDATA.indication

8.3.2.1 Function

The service primitive IN-UNITDATA.indication is used for reception of data.

8.3.2.2 Semantics of the service primitive

IN-UNITDATA.indication (
source_address,
destination_address,
data
priority
access_parameters
)

The source_address is defined in 8.2.2.

The destination_address is defined in 8.2.2.

The data parameter contains the data that are to be transferred.

The priority parameter is defined in 8.4. It shall

— present the value used for transmission of the related IN-UNITDATA.request in case of success indicated by the parameter transmission_status,

— be identical to the one in the related IN-UNITDATA.request service primitive in case of failure.

The access_parameters parameter is defined in 8.5.

8.3.2.3 When generated

IN-UNITDATA.indication is passed from the CAL to the ITS-S networking & transport layer in the case of error-free reception of the physical layer frame to indicate the arrival of an LSDU from the specific remote entity. In the case of fragmentation performed in the CI, this service primitive is passed on only upon complete error-free reception of all fragments of the same block.

8.3.2.4 Effect on receipt

The effect on receipt of IN-UNITDATA.indication by the ITS-S networking & transport layer depends on the network protocol addressed.

8.3.2.5 Additional comments

IN-UNITDATA.indication is independent of any connection to the remote IN-SAP. In the absence of errors, the content of the data parameter is logically complete and unchanged relative to the data parameter in the associated IN-UNITDATA.request primitive.

8.3.3 IN-UNITDATA-STATUS.indication

8.3.3.1 Function

The service primitive IN-UNITDATA-STATUS.indication is used to notify success or failure of a related IN-UNITDATA.request.

8.3.3.2 Semantics of the service primitive

IN-UNITDATA-STATUS.indication (
source_address,
destination_address,
data,
priority,
access_parameters,
transmission_status
)

The source_address is defined in 8.2.2.

The destination_address is defined in 8.2.2.

The parameter transmission_status is defined in 8.6.

The data parameter contains the data that were to be transmitted.

The priority parameter is defined in 8.4.

The access_parameters parameter is defined in 8.5.

8.3.3.3 When generated

IN-UNITDATA-STATUS.indication is passed from the CAL to the ITS-S networking & transport layer in order to notify success of failure of a previous transmission request. Details on how to detect a failure are outside the scope of this International Standard.

8.3.3.4 Effect on receipt

The effect on IN-UNITDATA-STATUS.indication by the ITS-S networking & transport layer depends on the network protocol addressed.

8.4 Priority

Parameter priority carries the user priority. Priority checking and managing for all TX-VCIs of a CI shall be medium-specific either in the CAL or the MAE.

Values for the priority parameter are in the range from 0 to 255, where 0 indicates lowest priority. The choice of priority values depends on ITS-S applications served by the communication system, and related ITS-S messages.

Mapping of MAC sub-layer priorities to user priorities and vice versa shall be subject to the CI as specified in the related standard.

A VCI may require a minimum user priority as an access prerequisite. Packets offered to a VCI for transmission with a user priority below the minimum user priority according to I-Parameter 22 "MinimumUserPriority", see Annex A, shall be deleted. The ITS-S management shall be notified by means of MI-REQUEST "Events". The default priority value shall indicate lowest priority.

Pending packets of same priority shall be stored in a first-in first-out queue. As soon as a queue is filled up above an alert threshold presented in I-Parameter 25 "QueueAlarmThreshold" defined in the standard of the access technology (medium), or defined by implementation, the ITS-S management shall be notified by means of MI-REQUEST "Events". As soon as a queue is emptied below an alert-threshold presented in I-Parameter 24 "QueueLowThreshold" defined in the standard of the access technology (medium), or defined by implementation. the ITS-S management shall be notified by means of MI-REQUEST "Events".

If the queues for pending packets can store no further packets, the ITS-S management shall immediately be notified by means of MI-REQUEST "Events". The packets of the new request may be deleted.

Packets pending in a VCI shall not be sent once the lifetime of these packets has expired, if applicable.

Priority management across CIs may be a somewhat slow process which requires involvement of the ITS-S management for every packet to be prioritized. A packet to be transmitted may be recognized in CIs that are not in charge of transmitting it by means of a dummy transmission request. Details are specified in 6.4.11.

For protection, see 6.4.12.

8.5 Access parameters

The access_parameters parameter,

- used in IN-UNITDATA.request, allows requesting settings of access layer parameters for the given packet prior to transmission of the packet;
- used in IN-UNITDATA.indication, allows reporting about access layer transmit parameters from the sender of the packet, and access layer receive parameters from the receiver of the packet.
- used in IN-UNITDATA-STATUS.indication,
  - present the value used for transmission of the related IN-UNITDATA.request in case of success indicated by the parameter transmission_status,
  - is identical to the one in the related IN-UNITDATA.request service primitive in case of failure.

Details of the access_parameters values depend on the access technology of the selected CI.

8.6 Transmission status

The transmission_status parameter identifies success or failure of a previous transmission attempt. Possible status values are presented in Table 10.

Table 10 — Transmission status

Mnemonic	Value	Comment
SUCCESS	0	The related IN-UNITDATA.request was successfully processed at the access layer
QUEUE_FULL	1	The related IN-UNITDATA.request could not be processed at the access layer as the waiting queue was full
UNSPECIFIED_FAILURE	255	The related IN-UNITDATA.request could not be processed at the access layer due to an unspecified failure
[A1⟩ TIMEOUT	2	Lifetime of pending packet expired prior to transmission of the packet
PRIORITY	3	Priority of the packet is smaller than the minimum required priority given in I-Parameter “MinimumUserPriority” ⟨A1]

9 Management SAP

The services

— MI-GET and MI-SET to read and write values of I-Parameters,

— MI-COMMAND and MI-REQUEST to command actions,

and the related service primitives of the management SAP (MI-SAP) shall be as specified in ISO 24102-3.

10 Conformance

Implementation conformance statements (ICS) are specified in ETSI TS 102 760-1.

11 Test methods

The test suite structure and test purposes (TSS&TP) are specified in ETSI TS 102 760-2.

An abstract test suite (ATS) for conformance tests will be specified in a future document [1].

1) ETSI TS 102 760-3.

Annex A
(normative)

I-Parameters

CI parameters also are referred to as I-Parameters.

Table presents the relation between parameter number "I-Param.No" and parameter name as used in the services MI-SET and MI-GET, and provides a short description of the I-Parameters. A more detailed description is provided in A.2.

I-Parameter 2 "CommProfile" shows which I-Parameters may be part of the communication profile.

"Access" specifies the possible access to the I-Parameter:

— R: Read by ITS-S management only, includes notify by CI/VCI;

— W: Write by ITS-S management only;

— RW: Read and write;

— N: Notify by CI only;

— NW: Notify by CI and Write by ITS-S management;

— x: to be defined by standard of the access technology (medium).

"Owner" specifies the owner of the I-Parameter:

— VCI: a VCI;

— CI: a CI;

— x: to be defined by standard of the access technology (medium).

NOTE An I-Parameter may apply only for specific media.

Table A.1 — I parameters

I-Param No	I-Parameter name / ASN.1 Type	Comm-Profile	Access	Description	Owner
0	Errors / `Errors`	No	N	Virtual parameter indicating errors in MI-GET.confirm. Not to be used in MI-SET and in MI-GET.request.	
[A1) *Text deleted* (A1]					
2	CommProfile / `CommProfile`	No	R	Communication profile. Contains the set of parameter values that define the actual communication properties of a VCI. A default profile shall be defined for each access technology (medium). The column CommProfile of this table indicates which parameters may be part of the Communication profile.	VCI
3	Properties / `Properties`	No	R	Properties of a CI. List of all communication profile parameters defined for the CI showing the complete range of values. Note 1 The same value of I-Param.No may appear several times if the related parameter may take on different values. Note 2 The SEQUENCE shall be ordered firstly according to I-Param.No and secondly according to the value of Param.Value, both in ascending order.	CI
4	ManufacturerDeviceID / `PrintableString`	No	R	Text string to be defined by manufacturer, clearly identifying the CI.	CI
5	ITS-SCU-ID / `ITS-scuId`	No	RW	Unique identifier of the ITS-SCU in an ITS-S unit.	CI
6	MedID / `MedID`	No	RW	Indicates uniquely a CI within an ITS-SCU	CI
7	LocalCIID / `EUI64`	No	R	Identifier of local CI. E.g. 48-bit MAC address encapsulated in EUI-64 field.	CI
8	TimeoutRegister / `INTEGER(0..255)`	No	RW	Time out to be used during registration of a CI. Shall be set to a random value at time of integration of the CI. May be set by the ITS-S management to a value as appropriate in an implementation.	CI
9	MACaddress / `MACaddress`	Yes	R	Globally assigned MAC address of CI.	CI
10	MACaddrTemp / `MACaddress`	Yes	RW	Actually used MAC address of CI/VCI.	VCI
11	CIclass / `CIclass`	Yes	R	Communications interface class.	CI

I-Param No	I-Parameter name / ASN.1 Type	Comm-Profile	Access	Description	Owner
12	CIaccessClass / `CIaClass`	Yes	R	CI access class.	CI
13	CIstatus / `CIstatus`	No	R	Status of CI.	CI
A1 *Text deleted* A1					
16	Notify / `Notify`	No	R	List of I-Parameter numbers indicating I-Parameters for automatic notification.	VCI
17	MedType / `MedType`	Yes	R	Indicates type of access technology (medium).	CI
18	RegulatoryInformation / `RegInfo`	No	RW	RI data structure containing either the actually valid regulatory information, or a statement that no regulation is known or applicable.	CI
19	Connect / `Connect`	Yes	R	Flag indicating whether CI will connect automatically or manually upon request.	CI
20	SIMpin / `SimPin`	No	W	PIN needed to access a SIM card.	CI
21	ProviderInfo / `ProviderInfo`	No	W	Access information for a provider: Name of provider Name of access point Log-in name of user Password for log-in	CI
22	MinimumUserPriority / `UserPriority`	Yes	RW	Minimum value of user priority needed to use the VCI. NOTE Default value zero defined.	VCI
23	QueueLevel / `QueueLevel`	No	N	Actual level in a transmit queue for a specific priority.	CI
24	QueueLowThreshold / `QueueValue`	No	RW	Threshold indicating the maximum level of usage of a transmit queue in a CI below which the ITS-S management shall be notified. 0: Transmit queue is empty. 255: Transmit queue is full (100 %)	CI

I-Param No	I-Parameter name / ASN.1 Type	Comm-Profile	Access	Description	Owner
25	QueueAlarmThreshold / `QueueValue`	No	RW	Threshold indicating the minimum level of usage of a transmit queue in a CI above which the ITS-S management shall be notified. 0: Transmit queue is empty. 255: Transmit queue is full (100 %)	CI
26	DistancePeer / `Distance`	No	R	Distance in 1/10 m to peer station measured by the CI	VCI
27	CommRangeRef / `Distance`	Yes	R	Estimate of size of communication zone in 1/10 m. NOTE Value is derived from TXpower, RXsensitivity and the properties of the reference station. To be calculated by the MAE.	VCI
28	TimeOfLastReception / `GeneralizedTime`	No	R	Time when last frame was successfully received. Resolution shall be one microsecond. Shall be initialized with time of creation of the VCI.	VCI
29	InactivityTimeLimit / `INTEGER(0..65535)`	No	RW	Maximum allowed idle time of an RX-VCI with respect of a specific peer station, i.e. maximum allowed time without proper reception of a frame. 0: No limit. >0: Limit in milliseconds. The time limit counter shall start on reception of every frame received.	VCI
30	MediumUsage / `MediumUsage`	No	R	Percentage of active usage of access technology (medium) for receive and transmit channel. 0: 0 %. 255: 100 %	CI
31	MedUseObservationTime / `MedUseObsTime`	No	RW	Observation time used to calculate MediumUsage. 0: No observation. >0: Size of gliding window for measurement of I-Parameter 30 "MediumUsage". Note: An access technology (medium) can use the nearest available value and can change this parameter accordingly.	CI
32	PeerMAC / `MACaddress`	No	RW	MAC address of peer station related to the VCI. Set to zero if no relation to a peer station exists. Only applicable for UC-VCIs.	VCI

I-Param No	I-Parameter name / ASN.1 Type	Comm-Profile	Access	Description	Owner
33	VirtualCI / `VirtualCIs`	No	R	RemoteCIID values of all VCIs of the selected CI being alive.	CI
34	MinPrioCrossCI / `UserPriority`	No	RW	Minimum required user priority in order to be able to request cross-CI prioritization.	CI
35	RXsensitivity / `INTEGER(0..255)`	Yes	RW	Medium-specific reference number of RX sensitivity. NOTE In [5] this is RX-CLASS (1-11).	VCI
36	TXpower / `INTEGER(0..255)`	Yes	RW	Medium-specific reference number of TX power. NOTE In [5] this is TX-CLASS (1-16).	VCI
37	TXpowMax / `TxPowMax`	Yes	R	Medium-specific reference number of maximum allowed transmit power.	VCI
38	PeerRXpower / `PeerRXpower`	No	R	Medium-specific reference number of RX power as estimated at the peer station.	VCI
39	DataRate / `DataRate`	Yes	RW	Data rate in the link in units of 100 bit/s.	VCI
40	DataRateNW / `DataRate`	Yes	R	Estimate of average data rate available at the IN-SAP in 100 bit/s. NOTE 1 The value of this parameter is based on the assumption of a reliable, error-free communications link. NOTE 2 The value of this parameter may depend on the actual operational load of the CI, e.g. in the case of a TDMA scheme and multiple simultaneous users. NOTE 3 In a TDMA scheme this value depends on the number of timeslots (= peer devices) served in a single TDMA frame.	VCI
41	DataRatesNW / `DataRatesNW`	Yes	R	Minimum and maximum possible value of DataRateNW.	VCI
42	DataRateNWreq / `DataRate`	No	RW	Minimum required value of DataRateNW. This value defines the possible number of time slots (= peer stations) served in a TDMA scheme.	CI
43	Directivity / `Directivity`	Yes	R, RW	Characteristics of beam. NOTE CI parameter: Read only VCI parameter: Read/Write See e.g. [5] for more details.	CI, VCI
44	BlockLength / `INTEGER(0..65535)`	Yes	RW	Maximum length of LPDU in octets	VCI
45	FreeAirTime / `INTEGER(0..255)`	Yes	RW	Gap between subsequent TDMA frames in milliseconds. See e.g. [5] for more details.	VCI

I-Param No	I-Parameter name / ASN.1 Type	Comm-Profile	Access	Description	Owner
46	FrameLengthMax / `INTEGER(0..255)`	Yes	RW	Maximum length of a TDMA frame in milliseconds. See e.g. [5] for more details.	VCI
47	KinematicVectorIn / `KineVectIn`	No	W	Kinematic vector of ITS station as provided to CI. Date and universal time Latitude: ± π/2, resolution 10-8 rad Longitude: ± π, resolution 10-8 rad Altitude: Resolution 0,1 m Ground speed: Resolution 0,01 m/s True track angle: Resolution 0,1°	CI
48	KinematicVectorOut / `KineVectOut`	No	R	Kinematic vector of ITS station as estimated by CI. Date and universal time Latitude: ± π/2, resolution 10-8 rad Longitude: ± π, resolution 10-8 rad Altitude: Resolution 0,1 m Ground speed: Resolution 0,01 m/s True track angle: Resolution 0,1°	CI
49	Cost / `MediumCost`	No	R	Price information. Cost of communication in terms of money, e.g. Cost information is temporarily unavailable. Free of any charge. Fixed flat rate. Price per time unit. Price per amount of data. General variable cost according to contract. Will be specified in [15].	VCI
50	Reliability / `INTEGER(0..255)`	No	R	Real-time measure of reliability of CI. 0 to 100: Percentage. Value zero indicates unreliable access technology (medium). Value 100 indicates best reliability. 101 to 255: Reserved for future use.	VCI
51	LogicalChannels / `LogicalChannels`	Yes	RW	Property of physical channels	VCI

[A1] Annex B
(normative)

ASN.1 definitions

B.1 Use of modules

The ASN.1 modules specified in Annex B.2 shall be used. ASN.1 BASIC-PER, UNALIGNED, as specified in ISO/IEC 8825-2, shall apply.

In order to achieve octet alignment enabling cheap implementations, "fill" bits were defined. All fill bits shall be set to the value '0'b.

B.2 ASN.1 modules

```
CALMllsap {iso(1) standard(0) calm-ll-sap(21218) asnm-1 (1)} DEFINITIONS AUTOMATIC
TAGS::=BEGIN


-- EXPORTS;

IMPORTS

ITS-scuId FROM CALMmanagement { iso (1) standard (0) calm-management (24102) local (1)
asnm-1 (1)}


ErrStatus, COMMUPDOWN FROM CALMmsap { iso (1) standard (0) calm-management (24102) msap
(3) asnm-1 (1)}


MediumCost FROM CITSapplReq {iso(1) standard(0) cits-applReq (17423) asnm-1 (1)}

LogicalChannelType FROM CITSapplMgmtComm {iso(1) standard(0) cits-applMgmt (17419) comm

(3)}
;

-- End of IMPORTS

Alt::=INTEGER(0..65535) -- Resolution 0,1 m.

CIaClass::=INTEGER{
     unknown            (0),
     ciac-1             (1),
     ciac-2             (2),
     ciac-3             (3)
     } (0..255)

CIclass::=INTEGER{
     unknown            (0),
     cic-l1             (1),
     cic-l2             (2),
     cic-l3             (3),
     cic-l4             (4),
     cic-l5             (5),
     cic-il1            (254),
     cic-il2            (255)
     } (0..255)

Link-ID::=SEQUENCE{                              -- Link-ID
     remoteCIID         EUI64,                   -- CI in peer ITS-S(s)
     localCIID          EUI64                    -- Unique ID of local CI
     }
```

[A1]

```
A1) CIstatus::=INTEGER{
     not-existent       (0),
     existent           (1),
     unknown            (2),
     registered         (4),
     active             (8),
     connected          (16),
     suspended          (64),
     inactive           (128)
     } (0..255)

CommProfile::=SEQUENCE (SIZE(0..255)) OF I-Param

Connect::=INTEGER{
     automatic          (0),
     manual             (255)
     } (0..255)

IN-SAPaddress::=INTEGER(0..255)

DataRate::= INTEGER(0..4294967295)             -- in 100 bit/s

DataRatesNW::=SEQUENCE{                        -- available to the appl.
     minimum          DataRate,                -- minimum possible value
     maximum          DataRate                 -- maximum possible value
     }

Directivity::=SEQUENCE{
     mode        DirMode,
     dirPredef   INTEGER(0..255),              -- 0: see dirVar
                    -- >0: predefined direction
     fill        BIT STRING (SIZE(7)),
     dirVar      SEQUENCE (SIZE(0..1)) OF DirVar
     }

DirMode::=INTEGER{
     fixed              (0),
     tracking           (255)
     } (0..255)

DirVar::=SEQUENCE{
     bsAzimuth          INTEGER(−32768..32767), -- −180 - +180
     bsElevation        INTEGER(−128..127),     -- −90 - +90
     openHorizontal     INTEGER(0..255),        -- 0 - 180
     openVertical       INTEGER(0..255)         -- 0 - 180
     }

TxPowMax::=INTEGER(0..255) -- unit, minimum value and step size defined by access
technology (medium)

Errors::=SEQUENCE (SIZE(0..255)) OF SingleError

SingleError::=SEQUENCE{
     paramNo            INTEGER(0..255), -- ref number of parameter
     errStatus          ErrStatus        -- IS24102-3
     }

Gs::=INTEGER(0..65535) -- Resolution 0,01 m/s.

KineVectIn::=SEQUENCE{
     dut               Time48IAT, -- date and universal time
     lat               Lat, -- latitude
     lon               Lon, -- longitude
     alt               Alt, -- altitude / elevation
     gs                Gs, -- ground speed
     tta               Tta -- true track angle
     }                                                                      (A1
```

```
A1) KineVectOut::=SEQUENCE{
      dut               Time48IAT, -- date and universal time
      fill              BIT STRING (SIZE(5)), -- used for octet alignment in PER
      options           SEQUENCE (SIZE(0..5)) OF KineVectOptions -- options
      }

KineVectOptions::=CHOICE{
      Lat               Lat, -- latitude
      lon               Lon, -- longitude
      alt               Alt, -- altitude
      gs                Gs, -- ground speed
      tta               Tta -- true track angle
      }

Lat::=INTEGER(-2147483648..2147483647) -- equals ± pi/2

Lon::=INTEGER(-2147483648..2147483647) -- equals ± pi

LLserviceAddr::=SEQUENCE{
      csap              IN-SAPaddress,
      linkID            Link-ID
      }


MACaddress::=OCTET STRING (SIZE(6))

MediumUsage::=SEQUENCE{
      receive           INTEGER(0..255),
      transmit          INTEGER(0..255)
      }

MedType::=INTEGER{
      unknown           (0),
      any               (1),
      iso21212          (2), -- 2G
      iso21213          (3), -- 3G
      iso21214          (4), -- IR
      iso21215          (5), -- M5
      iso21216          (6), -- MM
      iso25112          (7), -- 802.16e
      iso25113          (8), -- HC-SDMA
      iso29283          (9), -- 802.20
      iso17515          (10), -- LTE
      iso15628          (128), -- DSRC
      can               (254),
      ethernet          (255)
      } (0..255)

MedUseObsTime::=SEQUENCE {
      value         INTEGER(0..1023), -- valid parameter number (10 bits in PER)
      unit    TimeUnit
      } -- 2 octets in PER

TimeUnit::=INTEGER{
      microseconds      (0),
      milliseconds      (1),
      seconds           (2),
      minutes           (3),
      hours             (4),
      days              (5),
      weeks             (6),
      months            (7),
      years             (8)
      }(0..63) -- 6 bits in PER

Notify::=SEQUENCE (SIZE(0..255)) OF INTEGER(0..255) -- valid parameter number    (A1
```

```
PeerRXpower::=INTEGER(0..255)

PARAMS::= CLASS {
      &paramRef INTEGER(0..255),
      &Parameter
     }

IPARAM::= PARAMS

I-Params IPARAM::={errors | commProfile | properties | manuDeviceID | iTS-scuId | medID |
localCIID | timeoutReg | macAddress | macAddrTemp | ciClass | ciaClass | ciStatus | notify
| medType | regInfo | connect | simPin | providerInfo | minUserPriority | queueLevel |
queueLowTh | queueAlarmTh | distancePeer | commRangeRef | timeOfLastRecep | inactTimeLimit
| mediumUsage | medUseObsTime | peerMAC | virtualCIs | minPrioCrossCI | rxSens | txPower |
txPowMax | peerRXpower | dataRate | dataRateNW | dataRatesNW | dataRateNWreq | directivity
| blockLength | freeAirTime | frameLengthMax | kineVectIn | kineVectOut | cost |
reliability | logicalChannel, ...}


I-Param::=SEQUENCE{
     paramNo   IPARAM.&paramRef({I-Params}),
     parameter IPARAM.&Parameter({I-Params}{@paramNo})
     }

errors              IPARAM::={&paramRef 0, &Parameter Errors}
commProfile         IPARAM::={&paramRef 2, &Parameter CommProfile}
properties          IPARAM::={&paramRef 3, &Parameter Properties}
manuDeviceID        IPARAM::={&paramRef 4, &Parameter UTF8String}
iTS-scuId           IPARAM::={&paramRef 5, &Parameter ITS-scuId}
medID               IPARAM::={&paramRef 6, &Parameter MedID}
localCIID           IPARAM::={&paramRef 7, &Parameter EUI64}
timeoutReg          IPARAM::={&paramRef 8, &Parameter INTEGER(0..255)}
macAddress          IPARAM::={&paramRef 9, &Parameter MACaddress}
macAddrTemp         IPARAM::={&paramRef 10, &Parameter MACaddress}
ciClass             IPARAM::={&paramRef 11, &Parameter CIclass}
ciaClass            IPARAM::={&paramRef 12, &Parameter CIaClass}
ciStatus            IPARAM::={&paramRef 13, &Parameter CIstatus}
notify              IPARAM::={&paramRef 16, &Parameter Notify}
medType             IPARAM::={&paramRef 17, &Parameter MedType}
regInfo             IPARAM::={&paramRef 18, &Parameter RegInfo}
connect             IPARAM::={&paramRef 19, &Parameter Connect}
simPin              IPARAM::={&paramRef 20, &Parameter SimPin}
providerInfo        IPARAM::={&paramRef 21, &Parameter ProviderInfo}
minUserPriority     IPARAM::={&paramRef 22, &Parameter UserPriority}          -- DEFAULT 0
queueLevel          IPARAM::={&paramRef 23, &Parameter QueueLevel}
queueLowTh          IPARAM::={&paramRef 24, &Parameter QueueValue}
queueAlarmTh        IPARAM::={&paramRef 25, &Parameter QueueValue}
distancePeer        IPARAM::={&paramRef 26, &Parameter Distance}
commRangeRef        IPARAM::={&paramRef 27, &Parameter Distance}
timeOfLastRecep     IPARAM::={&paramRef 28, &Parameter Time48IAT}
  -- 1 ms resolution
inactTimeLimit      IPARAM::={&paramRef 29, &Parameter INTEGER(0..65535)}
  -- milliseconds
mediumUsage         IPARAM::={&paramRef 30, &Parameter MediumUsage}
medUseObsTime       IPARAM::={&paramRef 31, &Parameter MedUseObsTime}
peerMAC             IPARAM::={&paramRef 32, &Parameter MACaddress}
virtualCIs          IPARAM::={&paramRef 33, &Parameter VirtualCIs}
minPrioCrossCI      IPARAM::={&paramRef 34, &Parameter UserPriority}
rxSens              IPARAM::={&paramRef 35, &Parameter INTEGER(0..255)}
txPower             IPARAM::={&paramRef 36, &Parameter INTEGER(0..255)}
txPowMax            IPARAM::={&paramRef 37, &Parameter TxPowMax}
peerRXpower         IPARAM::={&paramRef 38, &Parameter PeerRXpower}
dataRate            IPARAM::={&paramRef 39, &Parameter DataRate}
dataRateNW          IPARAM::={&paramRef 40, &Parameter DataRate}
dataRatesNW         IPARAM::={&paramRef 41, &Parameter DataRatesNW}
dataRateNWreq       IPARAM::={&paramRef 42, &Parameter DataRate}
directivity         IPARAM::={&paramRef 43, &Parameter Directivity}
```

```
A1) blockLength          IPARAM::={&paramRef 44, &Parameter INTEGER(0..65535)}
    freeAirTime          IPARAM::={&paramRef 45, &Parameter INTEGER(0..255)}
      -- measured in milliseconds
    frameLengthMax       IPARAM::={&paramRef 46, &Parameter INTEGER(0..255)}
      -- measured in milliseconds
    kineVectIn           IPARAM::={&paramRef 47, &Parameter KineVectIn}
    kineVectOut          IPARAM::={&paramRef 48, &Parameter KineVectOut}
    cost                 IPARAM::={&paramRef 49, &Parameter MediumCost}
    reliability          IPARAM::={&paramRef 50, &Parameter INTEGER(0..255)}
    logicalChannel       IPARAM::={&paramRef 51, &Parameter LogicalChannels}

    Time48IAT::= INTEGER { utcStartOf2004(0), oneMillisecAfterUTCStartOf2004(1) }
    (0..281474976710655) -- International Atomic Time with one millisecond steps

    I-ParamNo::=INTEGER{
         errors           (0),
         commProfile      (1),
         properties       (2),
         manuDeviceID     (3),
         iTS-scuId        (4),
         medID            (5),
         localCIID        (6),
         timeoutReg       (7),
         macAddress       (8),
         macAddrTemp      (9),
         ciClass          (10),
         ciaClass         (11),
         ciStatus         (12),
         notify           (13),
         medType          (14),
         regInfo          (15),
         connect          (16),
         simPin           (17),
         providerInfo     (18),
         minUserPriority  (19),
         queueLevel       (20),
         queueLowTh       (21),
         queueAlarmTh     (22),
         distancePeer     (23),
         commRangeRef     (24),
         timeOfLastRecep  (25),
         inactTimeLimit   (26),
         mediumUsage      (27),
         medUseObsTime    (28),
         peerMAC          (29),
         virtualCI        (30),
         minPrioCrossCI   (31),
         rxSens           (32),
         txPower          (33),
         txPowMax         (34),
         peerRXpower      (35),
         dataRate         (36),
         dataRateNW       (37),
         dataRatesNW      (38),
         dataRateNWreq    (39),
         directivity      (40),
         blockLength      (41),
         freeAirTime      (42),
         frameLengthMax   (43),
         kineVectIn       (44),
         kineVectOut      (45),
         cost             (46),
         reliability      (47),
         logicalChannel   (51)
         } (0..255)

    SimPin::=OCTET STRING

    LogicalChannels::=SEQUENCE (SIZE(0..255)) OF LogicalChannelType

    Distance::=INTEGER(0..65535)        -- measured in 1/10 m               (A1
```

```
MedID::=INTEGER(0..255)

Properties::=SEQUENCE (SIZE(0..255)) OF I-Param -- only selected parameters

ProviderInfo::=SEQUENCE{
     provName          OCTET STRING (SIZE(0..255)), -- Name of provider
     apn               OCTET STRING (SIZE(0..255)), -- Name of access point
     username          OCTET STRING (SIZE(0..255)), -- Log-in name of user
     password          OCTET STRING (SIZE(0..255)) -- Password for log-in
     }

QueueLevel::=SEQUENCE{
     priority          UserPriority,
     level             QueueValue
     }

QueueValue::=INTEGER(0..255)

RegInfo::=SEQUENCE{
     status             RegInfoStatus,
     limits             RegulatoryScheme
     }

RegInfoStatus::=INTEGER{
     notApplicable     (0),
     invalid           (1),
     new               (254),
     valid             (255)
     } (0..255)



REGULSCHEME::=CLASS {
     &regID       INTEGER(0..255),
     &RegInfo
     }


RegulatoryScheme::=SEQUENCE{
     reguIdent  REGULSCHEME.&regID({RegulSchemes}),
     reguInfo   REGULSCHEME.&RegInfo({RegulSchemes}{@reguIdent})
     }

RegulSchemes REGULSCHEME::={nullRegScheme, ...} -- to be filled

nullRegScheme REGULSCHEME::={&regID 0, &RegInfo NULL}

Tta::=INTEGER(0..65535) -- Resolution 0,1°.

UserPriority::=INTEGER(0..255)

VirtualCIs::=SEQUENCE (SIZE(0..65535))OF RemoteCIID

INSAP::= COMMUPDOWN

INsapspsdown INSAP::={inUnitdataRq | inDataAckRq | inReplyAckRq | inReplyUpdateRq, ...}

INsapPrimitivesDown::=SEQUENCE{
     spRef           INSAP.&primitiveRef({INsapspsdown}),
     servPrimitive   INSAP.&Primitive({INsapspsdown}{@spRef})
     }

inUnitdataRq            INSAP::={&primitiveRef 0, &Primitive IN-UNITDATA-request}
inDataAckRq             INSAP::={&primitiveRef 1, &Primitive IN-DATA-ACK-request}
inReplyAckRq            INSAP::={&primitiveRef 2, &Primitive IN-REPLY-ACK-request}
inReplyUpdateRq         INSAP::={&primitiveRef 3, &Primitive IN-REPLY-UPDATE-request}
```

```
A1> IN-UNITDATA-request::=SEQUENCE{
      source-addr       LLserviceAddr,
      dest-addr         LLserviceAddr,
      data              INdata,
      priority          UserPriority,
      accessParams      AccessParameters
      }

    IN-DATA-ACK-request::=SEQUENCE{
      source-addr       LLserviceAddr,
      dest-addr         LLserviceAddr,
      data              INdata,
      priority          UserPriority,
      serviceClass      MACServiceClass
      }

    IN-REPLY-ACK-request::=SEQUENCE{
      source-addr       LLserviceAddr,
      dest-addr         LLserviceAddr,
      data              INdata,
      priority          UserPriority,
      serviceClass      MACServiceClass
      }

    IN-REPLY-UPDATE-request::=SEQUENCE{
      source-addr       LLserviceAddr,
      data              INdata
      }

    INSAPUP::= COMMUPDOWN

    INsapspsup INSAP::={inUnitdataInd | inUnitdataStatusInd | inDataAckInd | inDataAckSta-
    tusInd | inReplyInd | inReplyStatusInd | inReplyUpdateStatusInd, ...}

    INsapPrimitivesUp::=SEQUENCE{
      spRef           INSAP.&primitiveRef ({INsapspsup}),
      servPrimitive   INSAP.&Primitive ({INsapspsup}{@spRef})
      }

    inUnitdataInd            INSAP::={&primitiveRef 0, &Primitive IN-UNITDATA-indication}
    inUnitdataStatusInd      INSAP::={&primitiveRef 1, &Primitive IN-UNITDATA-STATUS-indica-
    tion}
    inDataAckInd             INSAP::={&primitiveRef 2, &Primitive IN-DATA-ACK-indication}
    inDataAckStatusInd       INSAP::={&primitiveRef 3, &Primitive IN-DATA-ACK-STATUS-indica-
    tion}
    inReplyInd               INSAP::={&primitiveRef 4, &Primitive IN-REPLY-indication}
    inReplyStatusInd         INSAP::={&primitiveRef 5, &Primitive IN-REPLY-STATUS-indication}
    inReplyUpdateStatusInd   INSAP::={&primitiveRef 6, &Primitive IN-REPLY-UPDATE-STATUS-indi-
    cation}

    IN-UNITDATA-indication::=SEQUENCE{
      source-addr       LLserviceAddr,
      dest-addr         LLserviceAddr,
      data              INdata,
      priority          UserPriority,
      accessParams      AccessParameters
      }

    IN-UNITDATA-STATUS-indication::=SEQUENCE{
      source-addr       LLserviceAddr,
      dest-addr         LLserviceAddr,

      data              INdata,
      priority          UserPriority,
      accessParams      AccessParameters,
      txStatus          INtxStatus
      }                                                                               <A1
```

```
(A1) IN-DATA-ACK-indication::=SEQUENCE{
     source-addr       LLserviceAddr,
     dest-addr         LLserviceAddr,
     data              INdata,
     priority          UserPriority,
     serviceClass      MACServiceClass
     }

IN-DATA-ACK-STATUS-indication::=SEQUENCE{
     source-addr       LLserviceAddr,
     dest-addr         LLserviceAddr,
     data              INdata,
     priority          UserPriority,
     serviceClass      MACServiceClass,
     status            INtxStatus
     }

IN-REPLY-indication::=SEQUENCE{
     source-addr       LLserviceAddr,
     dest-addr         LLserviceAddr,
     data              INdata,
     priority          UserPriority,
     serviceClass      MACServiceClass
     }

IN-REPLY-STATUS-indication::=SEQUENCE{
     source-addr       LLserviceAddr,
     status            INtxStatus
     }

IN-REPLY-UPDATE-STATUS-indication::=SEQUENCE{
     source-addr       LLserviceAddr,
     data              INdata,
     priority          UserPriority,
     accessParams      AccessParameters,
     txStatus          INtxStatus
     }

INdata::=OCTET STRING (SIZE(0..65535))

ACCPARAM::= PARAMS

nullAP ACCPARAM::={&paramRef 0, &Parameter NullType}

AccessParameters::=SEQUENCE{
     apRef         ACCPARAM.&paramRef ({AccParams}),
     aParameter    ACCPARAM.&Parameter ({AccParams}{@apRef})
     }

AccParams ACCPARAM::={nullAP, ...}

NullType::=NULL

MACServiceClass::=INTEGER{
     macAckNotUsed   (0),
     macAckUsed      (255)
     } (0..255)

INtxStatus::=INTEGER{
     success         (0),
     queueFull       (1),
     timeout         (2),
     unspecFailure   (255)
     } (0..255)

VCIserialNumber::=INTEGER(0..65535)

EUI64::=OCTET STRING (SIZE(8))                                    (A1)
```



```
A1) LegacyCIID::=SEQUENCE{
      selector1          OneOCTETones,
      iTS-scuId          ITS-scuId,
      selector2          TwoOCTETones,
      medID              MedID,
      vciSerialNumber    VCIserialNumber
      }

RemoteCIID::=EUI64

OneOCTETones::=INTEGER{
      all     (255)
      } (0..255)

TwoOCTETones::=INTEGER{
      all     (65535)
      } (0..65535)

EUI64MAC48::=SEQUENCE{
      oui          MACoui,
      selector2    TwoOCTETones,
      ext     MACext
      }

MACoui::=SEQUENCE{
      uoi1          INTEGER(0..63),
      ulBit         BOOLEAN,
      igBIT         BOOLEAN,
      uoi2          OCTET STRING (SIZE(2))
      }

MACext::=OCTET STRING (SIZE(3))

MACmcID::=SEQUENCE{
      ucgc         INTEGER(0..63),
      mc           INTEGER{all (3)} (0..3),
      serial       OCTET STRING (SIZE(2))
      }


-- Values

version INTEGER(0..255)::= 2 – insert version value

/*
   The ASN.1 specification has been checked for conformance to the ASN.1
   standards by OSS ASN.1 Syntax Checker, and by OSS ASN-1STEP
*/

END                                                              (A1
```

Annex C
(normative)

Extended universal 64 bit identifier

C.1 EUI-64 format

The IEEE defined 64-bit extended unique identifier (EUI-64) is illustrated in Figure.

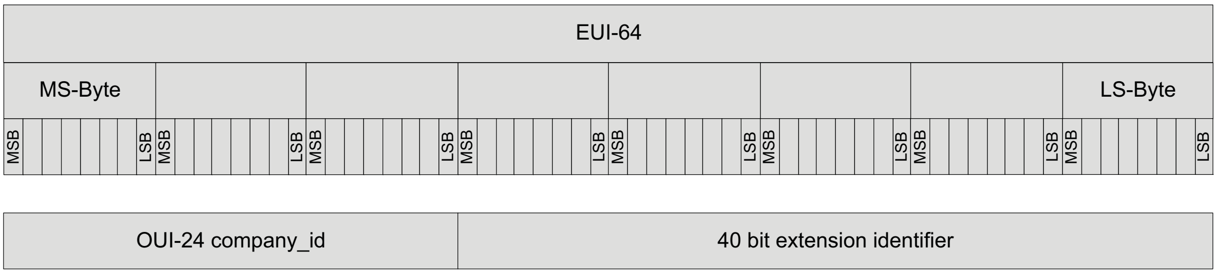

Figure C.1 — EUI-64 format

EUI-64 is given by the concatenation of two parts:

— 24 bit "Universal Object Identifier" (OUI-24) company_id,

— 40 bit extension identifier.

The "Distinct Null Identifier" (DNI) is given by all bits in EUI-64 being set to '1', i.e. the value FF-FF-FF-FF-FF-FF-FF-FF_{16}.

IEEE_RA administers the assignment of OUI-24 values.

The following values are prohibited as EUI-64 values in order to enable encapsulation of EUI-48 numbers and 48-bit MAC addresses in the EUI-64 field:

a) cc-cc-cc-FF-FE-ee-ee-ee

b) cc-cc-cc-FF-FF-ee-ee-ee

where the letters 'c' and 'e' represent hexadecimal digits. The reserved pattern FF-FE_{16} identifies encapsulation of an EUI-48 value in an EUI-64 field. The reserved pattern FF-FF_{16} identifies encapsulation of a 48-bit MAC address in an EUI-64 field.

[A1⟩ According to [16] common practice in IPv6 is to use the reserved pattern FF-FE_{16} to identify encapsulation of a 48-bit MAC address in an EUI-64 field. ⟨A1]

C.2 Encapsulation of 48-bit MAC addresses

[A1⟩ The encapsulation of 48-bit MAC addresses in an EUI-64 field as specified in [16] is illustrated in Figure C.2. ⟨A1]

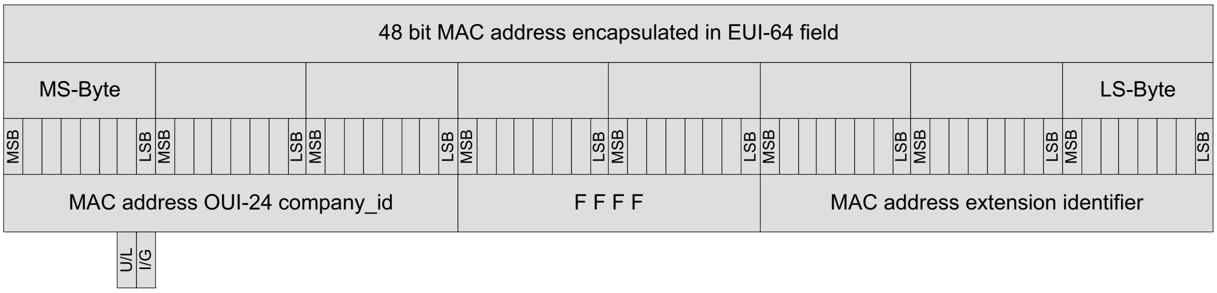

Figure C.2 — Encapsulation of 48-bit MAC address in EUI-64 field

The "U/L"-bit indicates, whether the MAC address is

— a universal address (globally unique), indicated by the value '0',

— or a locally administered address, indicated by the value '1'.

The "I/G"-bit indicates, whether the MAC address is

— an individual address (for unicast communication), indicated by the value '0',

— or a group address (for broadcast or multicast communication), indicated by the value '1'.

[A1⟩ With “U/L” set to ‘0’, all remaining bits of the MAC address may be used to distinguish locally administered addresses. ⟨A1]

[A1⟩ *Text deleted* ⟨A1]

C.3 Encapsulation of identifiers specific to ITS

Identifiers for usage in Link-ID (RemoteCIID, LocalCIID) being specific to ITS-S are needed for CIs which do not support 48-bit MAC addresses. Such identifiers are referred to as LegacyCIID. The approach is illustrated in Figure.

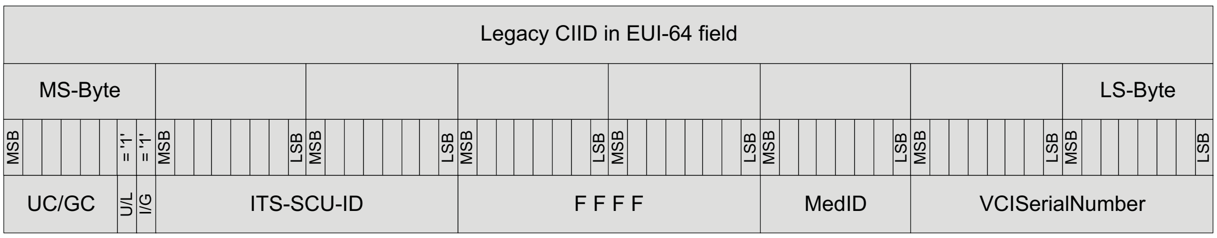

Figure C.3 — Encapsulation of identifiers specific to ITS

The encapsulated LegacyCIID shall be constructed as follows:

a) A1⟩ Set the U/L bit to ‘0’$_2$ and the I/G bit to ‘1’$_2$ indicating the encapsulation mode specified here. ⟨A1

b) Set the U/L bit and the I/G bit to '1'$_2$ indicating the encapsulation mode specified here.

c) A1⟩ The next two bytes shall contain reserved pattern FF-FE$_{16}$, identifying an encapsulated MAC address field. ⟨A1

d) The next two bytes shall contain reserved pattern FF-FF$_{16}$, identifying an encapsulated MAC address field.

e) The next byte shall contain a CI identifier (MedID) being unique in an ITS-SCU.

f) The remaining two bytes shall contain a serial number (VCISerialNumber).

— The "VCISerialNumber" FFFF$_{16}$, shall be used to identify broadcast communication. Any other value shall be used if multicast communication is selected by the UC/GC field.

— If unicast communication is selected by the UC/GC-field, any number may be selected to identify a UC-VCI, except the number zero. The value zero shall indicate the CI. It shall be ensured, that the number assignment for UC-VCIs shall be unique in a CI.

The multicast identifier of ASN.1 type `MACmcID` specified in Annex B is given by the concatenation of the MS-Byte and the VCISerialNumber field presented in Figure as illustrated in Figure.

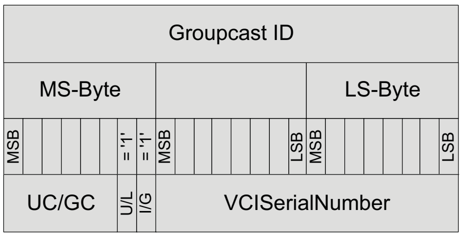

Figure C.4 — Format of Multicast ID

NOTE Further details on how to identify multicast groups are not specified in this International Standard

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A1 [16] RFC 4291, *IP Version 6 Addressing Architecture* A1

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