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Intelligent transport systems — Evolved-universal terrestrial radio access network —

Part 3: LTE-V2X

Systèmes intelligents de transport) — Réseau d'accès à la radio terrestre universelle évoluée (E-UTRAN) —

Partie 3: LTE-V2X

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Foreword

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

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

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

A list of all parts in the ISO 17515 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Localized communications are an essential component of hybrid communications in Intelligent Transport Systems (ITS). Various access technologies are suited for localized communications. An increasing interest of ITS stakeholders for "Cooperative ITS" and "Urban ITS" is in the access technology known under the acronym of LTE. LTE refers to a packet switched cellular network technology specified by 3GPP. Beside the "traditional" features of cellular networks, LTE also supports device-to-device communications, e.g. for public safety applications, and vehicle-to-everything communications (LTE-V2X) especially designed for ITS.

This document provides complements to LTE-V2X specifications from 3GPP needed to operate it as an ITS access technology in an ITS station unit specified in ISO 21217. An implementation of this document is referred to as an ITS-LTE-V2X communication interface (CI).

ITS-LTE-V2X CIs are able to

— operate with support of an LTE base station, and

— operate without support of an LTE base station, e.g. outside LTE coverage areas

as specified by 3GPP.

Intelligent transport systems — Evolved-universal terrestrial radio access network —

Part 3:
LTE-V2X

1 Scope

This document provides specifications related to the ITS-S access layer for a communication interface (CI) named "ITS-LTE-V2X".

ITS-LTE-V2X CIs are based on the evolved-universal terrestrial radio access (E-UTRA) vehicle-to-everything (LTE-V2X) technology standardized at 3GPP.

This document enables usage of the LTE-V2X technology as an ITS access technology in an ITS station by reference to respective specifications from 3GPP, and by specifying details of the "Communication Adaptation Layer" (CAL) and the "Management Adaptation Entity" (MAE) of communication interfaces specified in ISO 21218.

2 Normative references

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

ISO/IEC 8824-1:2015, *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation — Part 1*

ISO/IEC 8825-2:2015, *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 21218, *Intelligent transport systems — Hybrid communications — Access technology support*

ISO 24102-1, *Intelligent transport systems — ITS station management — Part 1: Local management*

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

3GPP TS 23.285, *3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Architecture enhancements for V2X services (Release 14)*

3GPP TS 24.334, *3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Proximity-services (ProSe) User Equipment (UE) to ProSe function protocol aspects; Stage 3 (Release 14)*

3GPP TS 24.386, *3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; User Equipment (UE) to V2X control function; protocol aspects; Stage 3 (Release 14)*

3GPP TS 36.300, *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (Release 14)*

3GPP TS 36.331, *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (Release 14)*

3 Terms and definitions

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

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

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

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

3.1
layer-2 ID
identifier at the OSI layer 2 functionally similar to an IEEE 802 MAC address

3.2
V2X application server
server hosting ITS applications within the LTE networks as specified by 3GPP

4 Symbols and abbreviated terms

CI	Communication Interface [SOURCE: ISO 21217]
eNB	Evolved Node B (Fixed station of a mobile network that directly interacts with UEs); generally called a "cell tower"
E-UTRA	Evolved Universal Terrestrial Radio Access
E-UTRAN	Evolved Universal Terrestrial Radio Access Network
ITS-SU	ITS station unit [SOURCE: ISO 21217]
LGW	Local Gateway
LTE	Long Term Evolution
LTE-D2D	LTE Device-to-Device
LTE-V2X	LTE Vehicle-to-Everything communication
ITS-LTE-V2X	Name of the communication interface specified in this document
eMBMS	Evolved Multimedia Broadcast Multicast Service
MBMS	Multimedia Broadcast Multicast Service
n.a.	not applicable
PC5	ProSe communication 5
PDN GW	Packet Data Network Gateway
PPPP	ProSe Per-Packet Priority

ProSe	Proximity-based Service
SC-PTM	Single-cell Point-to-Multipoint
UE	(LTE) User Equipment (mobile LTE device)
Uu	Radio interface between the UE (user equipment) and the eNB
V2I	Vehicle-to-Infrastructure (3GPP definition. In ITS terms this means vehicle-to-roadside)
V2N	Vehicle-to-Network (3GPP definition. In ITS terms this means vehicle-to-central office)
V2P	Vehicle-to-Pedestrian (3GPP definition. In ITS terms this means vehicle-to-personal device)
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-everything [SOURCE: 3GPP TS 24.386]
VCI	Virtual CI [SOURCE: ISO 21218]

NOTE Some of the terms used in this document are ambiguous in a global context due to the fact that different SDOs use different definitions. For the purpose of this document, definitions from ISO TC 204 are applicable.

5 Usage of LTE in ITS

5.1 LTE features used in ITS

The LTE network is a packet-switched cellular network specified by 3GPP. It provides features that may be used in ITS station units (ITS-SUs) as:

— general access to the Internet as described in 5.2;

— device-to-device communications (D2D) as described in 5.3;

and provides features that are dedicated to ITS:

— vehicle-to-everything communications (V2X) as described in 5.4.

NOTE Usage of IPv6 in the context of an ITS station (ISO 21217), used, e.g. for accessing the Internet and for localized communications, is specified in ISO 21210[7].

Implementation guidelines are presented in 5.5. An LTE mobile device is referred to as User Equipment (UE) in 3GPP. This term is used in this document if the ITS term CI is not appropriate, e.g. for LTE management communications.

5.2 General access to the Internet

General access to the Internet is supported with the LTE-Uu based architecture reference model specified in 3GPP TS 23.285. In this reference model, a UE accesses the Internet via the PDN GW or LGW using IPv4 or IPv6. Detailed operational procedures for connection establishment and management over LTE-Uu are specified in 3GPP TS 23.401[20].

Details on how to establish general access to the Internet in an ITS-SU via an LTE interface are specified in ISO 17515-1[3].

5.3 Device-to-device communications (D2D)

Details on how to perform LTE-D2D communications in an ITS-SU are specified in ISO 17515-2[4].

5.4 Vehicle-to-everything communications (V2X)

V2X communications in LTE (LTE-V2X) are possible via two different LTE interfaces:

— the LTE PC5 communications interface, and

— the LTE Uu communications interface.

The initial primary purpose of LTE-V2X communications identified so far by 3GPP is dissemination of ITS information from an ITS-SU to other ITS-SUs, see e.g. 3GPP TR 22.885[17] and 3GPP TR 22.185[16], where these ITS-SUs can be either vehicle ITS-SUs, roadside ITS-SUs, central ITS-SUs, or personal ITS-SUs as specified in ISO 21217.

NOTE 1 The 3GPP definitions of "Vehicle-to-Infrastructure (V2I)", "Vehicle-to-Network (V2N)", and "Vehicle-to-Pedestrian (V2P)" differ from those used in ITS, see e.g. ISO 21217. The ITS meaning of "3GPP V2I" is "vehicle-to-roadside station", of "3GPP V2N" is "vehicle-to-central station", and of "3GPP V2P" is "vehicle-to-personal station".

In PC5 communications (see 6.1.2.2) information dissemination goes directly from a vehicle station to other stations; unicast sessions are not supported for V2X. In Uu communications (see 6.1.2.3) information dissemination goes from a vehicle to a V2X application server via the LTE network acting as a kind of "relay", and from there to other vehicle stations.

NOTE 2 The Uu interface also supports unicast communications.

NOTE 3 The V2X application server is not part of the LTE network.

NOTE 4 The V2X application server is selected by the LTE network. Consequently, there can be only one single V2X application server for the indicated ITS application selected by the network at a specific location of the UE, i.e. provision of this service by various service providers is not possible using LTE-V2X Uu communications.

PC5 communications is also referred to as SideLink communications. Two operational modes of SideLink communications exist:

— operator managed;

  — with dynamic scheduling of resources;

  — without dynamic scheduling of resources;

— non-operator managed.

The non-operator managed mode is applicable in case the LTE network cannot be reached, and thus pre-configured communication resources apply.

In the operator managed mode an LTE base station manages allocation of communication resources, which adds flexibility in resource allocation. In operator managed mode.

— the eNB may dynamically schedule communication resources for SideLink communications, and thus collisions in the subsequent scheduled communications are avoided;

— otherwise communication resources are taken from a resource pool configured by the eNB.

NOTE 5 Currently there are no globally applicable means for harmonized resource pool allocation in scenarios without network coverage.

NOTE 6 At time of writing the present document no 3GPP rules were identified on the issue of resource pool information created by an LTE network in a given regulatory domain, whilst respective SideLink communications are being performed in a different regulatory domain.

In Uu communications, ITS packets are encapsulated in IP packets for forwarding from UE to the V2X application server like ordinary IP traffic, and from the V2X application server to UE.

5.5 Implementation guidelines

Both PC5 and Uu communications are designed for time-critical applications with requirements for very low latency. PC5 communications without dynamic scheduling of resources preferably are to be selected for time-critical applications with requirements for very low latency, whilst PC5 communications with scheduling of resources and Uu communications may be used for applications that are not as time-critical. However, this is not a requirement and the guideline may be revised once better knowledge about the operational facts is available.

The medium-specific I-Parameter OperationalMode of ASN.1 type `OperationalMode` specified in ISO 21218 is used to indicate the currently valid operational mode of LTE-V2X. The LTE-specific details of OperationalMode are given by the ASN.1 type `LTE-OperationalMode` specified in D.2, i.e. a named Integer variable with the following identified named values:

— 0: unknown operational mode;

— 1: SideLink communication;

— 2: Uu communication.

Further modes may be specified, e.g. in ISO 17515-1[3] and ISO 17515-2[4].

6 General requirements

6.1 LTE basics

6.1.1 LTE-V2X

An implementation of an ITS-LTE-V2X communication interface is based on relevant specifications from 3GPP.

NOTE 3GPP specifications related to LTE-V2X are e.g. [19], [21], [22], [23], [24], [25], [26], [27], [28], [29].

6.1.2 Supported LTE modes of operation

6.1.2.1 Overview

Either one or both of the following two modes of operation shall be supported by an LTE-V2X CI, see also 5.4 and 5.5:

a) PC5 interface communications (SideLink communication):

   — operator managed;

   — non-operator managed;

b) Uu interface communications with

   — unicast uplink (UE to eNB);

   — unicast downlink (eNB to UE);

   — broadcast downlink with

i) Multimedia Broadcast Multicast Service (MBMS),

ii) Single-cell Point-to-Multipoint (SC-PTM).

6.1.2.2 PC5 interface communications

In the operator-managed mode, the UE may either use resources scheduled by the LTE network or select autonomously resources from resource pools which are configured by the LTE network; these resources are for data communications of the LTE-V2X CI.

In the non-operator managed mode, the UE may on its own select resources from resource pools which are pre-configured.

6.1.2.3 Uu interface communications

The data to be transmitted by an LTE-V2X CI is firstly delivered to the eNB (base station of the LTE network) in unicast mode, where the eNB forwards the data to an V2X application server. This V2X application server then forwards the originally received data, or the pre-processed data to the appropriate eNB, which itself unicasts or broadcasts the data via Multimedia Broadcast Multicast Service (MBMS) or Single-cell Point-to-Multipoint (SC-PTM) specified by 3GPP to the respective UE within coverage of this eNB.

6.2 ITS station

6.2.1 Station and communication architecture

The ITS station architecture specified in ISO 21217 is presented in Figure 1. The ITS-LTE-V2X CI is allocated in the ITS-S access layer of the ITS station architecture.

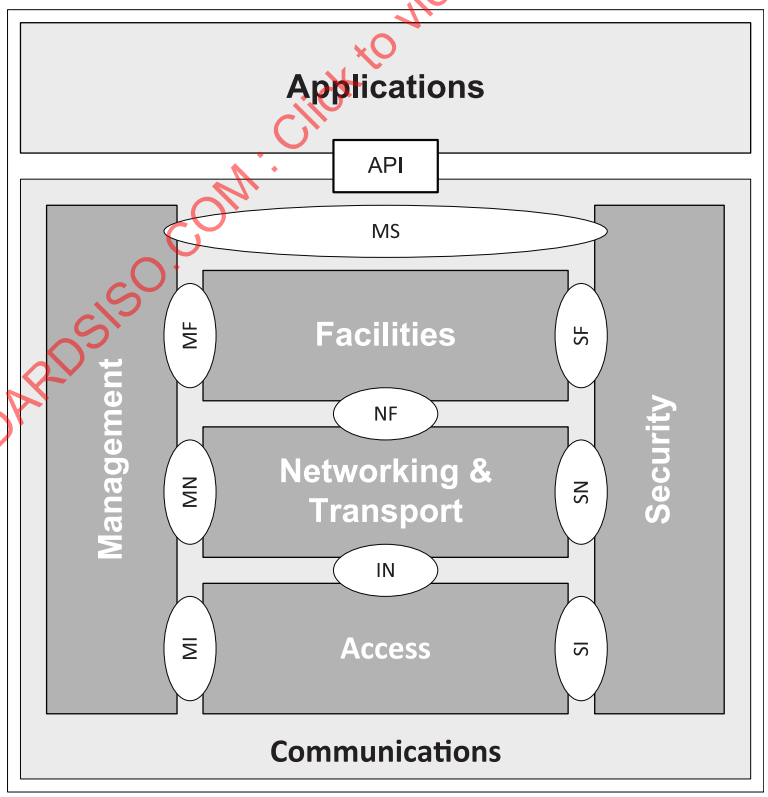

Figure 1 — ITS station architecture

Figure 2 shows the architecture diagram of an ITS-LTE-V2X CI communications interface (CI) embedded in the general ITS station architecture.

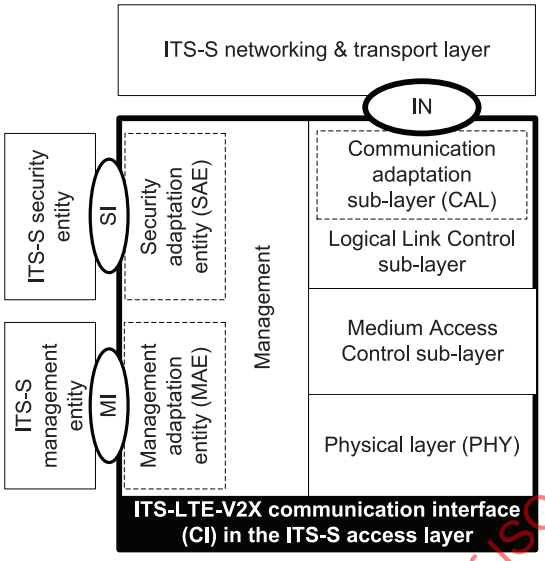

Figure 2 — LTE-V2X CI architecture

As 3GPP also specified the network and transport layer of LTE, related parts of the LTE-V2X specifications might be provided in the ITS-S networking & transport layer as illustrated in Figure 3. Details are out of scope of this document.

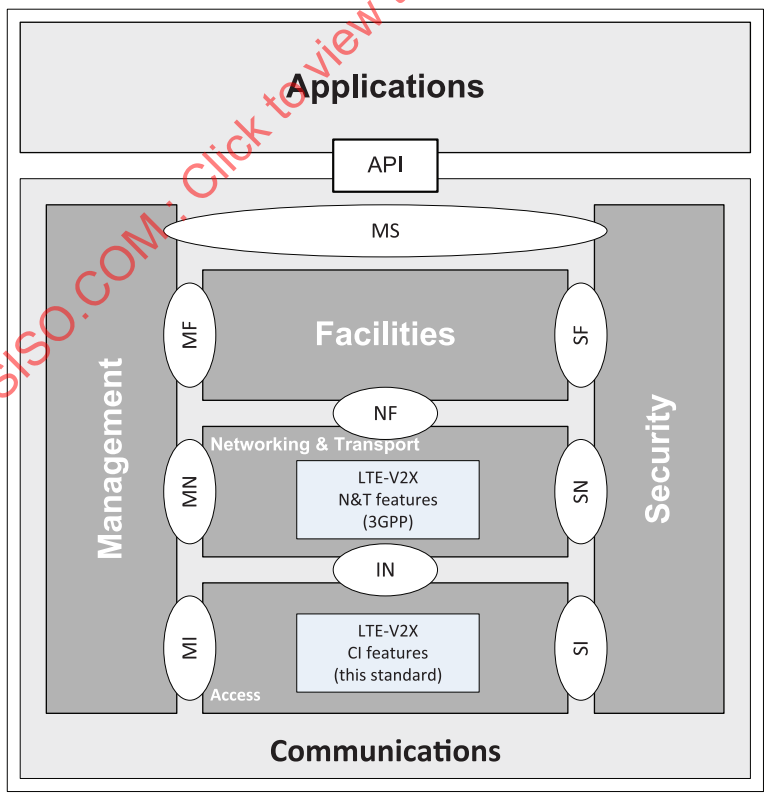

Figure 3 — LTE-V2X functionality in an ITS station

The communication protocol layers of the ITS-LTE-V2X CI specified by 3GPP are:

a) Physical layer (PHY);

b) Data link layer (DLL).

An ITS-LTE-V2X CI as specified in this document is an ITS wireless CI

— of MedType `c-ITSatt-iso17515` specified in ISO 17419[1];

— of CI class CIC-l6 specified in ISO 21218 for one-to-many communications either with support of a base station of a cellular network or without support of the base station;

— of CI access class CIAC-3 specified in ISO 21218.

An ITS-LTE-V2X CI provides the functionality of the IN-SAP specified in ISO 21218, and uses the functionality of an MI-SAP, and an SI-SAP specified in ISO 24102-3.

NOTE 1 Service primitive functions for the SI-SAP are not identified so far.

NOTE 2 Multiple ITS-LTE-V2X CIs per ITS station unit (ITS-SU) are possible, regardless of whether the CIs belong to the same ITS-SCU or to different ITS-SCUs of the same ITS-SU; see ISO 21217 for the specifications of ITS-SU and ITS-SCU.

6.2.2 Service access points

6.2.2.1 General

NOTE As Service Access Points (SAPs) per definition describe functional behaviour only, SAPs can be implemented in different ways. Requirements set up in this document to support SAPs and the related service primitives thus mean to support the functionality. This support can be implemented either in a strict meaning, i.e. using the ASN.1 definitions of the service primitives as "PDU" definitions, or in an abstract meaning, allowing for proprietary solutions.

6.2.2.2 Communications service access points

An ITS-LTE-V2X CI shall support the IN-SAP functionality specified in ISO 21218.

6.2.2.3 Management service access points

An ITS-LTE-V2X CI shall support the MI-SAP functionality of ISO 24102-3 with details specified in ISO 21218.

6.2.2.4 Security service access points

An ITS-LTE-V2X CI shall support the SI-SAP functionality of ISO 24102-3 with details specified in ISO 21218.

NOTE So far no service primitives are identified for the SI-SAP.

6.2.3 Hybrid communications support

An ITS-LTE-V2X CI for an ITS-SU supporting hybrid communications shall be compliant with ISO 21218 and ISO 24102-1. It is suggested that path and flow management as specified in ISO 24102-6[9] is applied.

7 Communication interface protocol stack

7.1 Physical layer

The basic behaviour of the LTE-V2X CI physical layer shall be as specified in the respective LTE standards from 3GPP, see 6.1.1.

7.2 Data link layer

7.2.1 Basic behaviour

The basic behaviour of the LTE-V2X CI data link layer shall be as specified in the respective LTE standards from 3GPP, see 6.1.1.

7.2.2 Data link layer communication addresses

LTE-V2X SideLink communication does not use 48 bit MAC addresses, but uses 24 bit Layer-2 Identifiers (Layer-2 ID) for identifying source and destination, see 3GPP TS 36.300.

LTE-V2X Uu unicast communication does not use Layer-2 IDs, as communication is always from the UE to the available LTE base station.

7.2.3 Identification of higher layer protocols

LTE-V2X uses the concept of a "Layer-3 protocol data unit types" and the concept of "V2X message family" specified in 3GPP TS 24.386 for identifying the type of payload. This information is contained in LTE-V2X frames.

"Layer-3 protocol data unit types" and corresponding EtherType values are presented in Table 1.

Table 1 — LTE-V2X Layer-3 protocol data unit type

Value	Protocol type	EtherType
0[a]	IPv6 IPv4	0x86.DD 0x08.00
1	Allocation and retention priority	n.a.
2	PC5 signaling	n.a.
3	Non-IP	"V2X message family"; see the LTE-V2X Non-IP Header
4 - 7	Reserved	n.a.

[a] IPv4 and IPv6 can both be supported by Uu communications whilst IPv4 is not supported for SideLink communications so far. Selection of the appropriate EtherType value at the CAL requires inspection of the IP header. Details on the usage of IPv6 in ITS are specified in ISO 21210[7].

If "Non-IP" is indicated in "Layer-3 protocol data unit types", further details are presented in the field "Non-IP Header". The non-IP protocol types (indicated in the "Non-IP Header" and corresponding EtherType values are presented in Table 2.

Table 2 — LTE-V2X Non-IP Header of "V2X message family"

Value	Non-IP protocol type	EtherType
0	Reserved	n.a.
1	WSMP specified in IEEE 1609.3[13]	0x88.DC
2	FNTP specified in ISO 29281-1[11]	0x89.50
3	GeoNetworking specified in ETSI EN 302 636[14]	0x89.47
4 – 255	Reserved	n.a.

NOTE Ethertype addresses are assigned by the IEEE Registration Authority, and are used to identify the protocol employed directly above the ITS-S access layer. This method of addressing is named "EtherType Protocol Discrimination" (EPD) specified in IEEE Std 802™, 2014. Allocations of EtherType values are published at http://standards.ieee.org/develop/regauth/ethertype/eth.txt. Values in the range 0 through 1 535 (0x05.FF) are not allowed as EtherType addresses, as these numbers provide length information.

7.3 Communication adaptation sub-layer

The communication adaptation sub-layer (CAL) is introduced in ISO 21218. The major task of CAL is to provide the IN-SAP. ASN.1 details of the IN-SAP IN-UNITDATA service primitives are specified in ISO 21218.

ITS-LTE-V2X CIs in accordance with ISO 21218 shall use an EtherType value in the IN-UNITDATA service primitives to identify the applicable ITS-S networking & transport layer protocol. Thus the information on type of payload presented in 7.2 shall be converted into an Ethertype in support of ISO 21218.

In other implementation contexts, the EtherType value shall be used in the applicable service access point primitives that exchange service data units between ITS-LTE-V2X and the network layer entity; details are outside the scope of this document.

The IN-SAP service primitives of DL-UNITDATA contain the parameter "priority", which is the user priority specified in ISO 21218. The relation between user priority and LTE ProSe Per-Packet Priority (PPPP) for LTE-V2X SideLink communication shall be a linear mapping as illustrated in Tables 3 and 4. The value zero of User Priority means "lowest priority", whilst the value zero of PPPP means "highest priority".

Table 3 shows the mapping of user priority values to PPPP values on the basis of the PPPP definition in 3GPP TS 24.334 as applied in the transmit path. Once the number range of PPPP changes, the linear mapping shall be adapted in the spirit illustrated in Table 3.

Table 3 — Mapping of user priority values to PPPP values

User priority	PPPP[a]
—	0 (not used)
255 - 224	1 (highest priority used)
223 - 192	2
191 - 160	3
159 - 128	4
127 - 96	5
95 - 64	6
63 - 32	7
31 - 0	8 (lowest priority used)
—	9 - 255 (not used)

[a] Although PPPP is specified as a one octet unsigned Integer, only the values 1 through 8 are used in 3GPP TS 24.334.

Table 4 shows the mapping of PPPP values to user priority values on the basis of the PPPP definition in 3GPP TS 24.334 as applied in the receive path. Once the number range of PPPP changes, the linear mapping shall be adapted in the spirit illustrated in Tables 4.

Table 4 — Mapping of PPPP values to user priority values

PPPP[a]	User priority
0 (not used)	—
1 (highest priority used)	255
2	223
3	191
4	159
5	127
6	95

[a] Although PPPP is specified as a one octet unsigned Integer, only the values 1 through 8 are used in 3GPP TS 24.334.

Table 4 *(continued)*

PPPP[a]	User priority
7	63
8 (lowest priority used)	31
9 - 255 (not used	—

[a] Although PPPP is specified as a one octet unsigned Integer, only the values 1 through 8 are used in 3GPP TS 24.334.

8 Communication interface management

8.1 General management

The basic management of an LTE-V2X CI shall be as specified in the respective LTE standards from 3GPP, see 6.1.1.

8.2 Management adaptation entity

8.2.1 LTE-V2X parameters and I-Parameters

In implementations in accordance with ISO 21218, the following rules apply:

— LTE-V2X parameters that have an equivalent I-Parameter defined in ISO 21218 shall be mapped on I-Parameters as specified in Annex A.

— LTE-V2X parameters which are relevant for ITS-LTE-V2X and do not have an equivalent I-Parameter defined in ISO 21218 shall be made visible to the ITS station management by means of medium-specific I-Parameters as specified in Annex A.

— I-Parameters which are relevant for ITS-LTE-V2X but cannot be mapped on an LTE-V2X parameters shall be implemented in the MAE as specified in ISO 21218 with details specified in Annex A.

8.2.2 LTE-V2X management commands and MI-SAP commands and requests

In implementations in accordance with ISO 21218 and ISO 24102-3, the following rules apply:

— LTE-V2X management commands that have an equivalent MI-COMMAND/MI-REQUEST defined in ISO 24102-3 shall be mapped on these MI-COMMAND/MI-REQUEST as specified in Annex B and Annex C.

— LTE-V2X management commands that are relevant for an implementation of ITS-LTE-V2X and do not have an equivalent MI-COMMAND/MI-REQUEST defined in ISO 24102-3 shall be made accessible in an implementation specific way.

— MI-COMMANDs/MI-REQUESTs which are relevant for ITS-LTE-V2X but cannot be mapped on LTE-V2X management commands are implemented in the MAE as specified in ISO 24102-3 with details specified in Annex B and Annex C.

9 Procedures

9.1 Communication interface procedures

9.1.1 Transmit procedure

Upon reception of a transmission request service primitive, i.e. an IN-UNITDATA.request service primitive specified in ISO 21218, CAL shall

a) use the operational mode as indicated in the I-Parameter "Operational Mode",

b) perform settings of LTE-V2X transmit parameters as being applicable,

c) for LTE-V2X SideLink communications, determine the LTE-V2X PPPP value from the user priority presented in the parameter "priority" of the IN-UNITDATA.request service primitive as specified in Table 3,

NOTE 1 For LTE-V2X Uu communications usage of user priority is not defined; priority values are defined in 3GPP TS 23.203[18].

d) create the LTE-V2X "Non-IP Header" and the "LTE-V2X Layer-3 protocol data unit type" according to the EtherType value presented in the parameter "nt_protocol_id" of the IN-UNITDATA.request service primitive,

e) request transmission of the resulting frame (ITS-APDU specified in ISO 21217) to the destination presented in the parameter "destination_address" of the IN-UNITDATA.request service primitive considering the determined PPPP.

9.1.2 Receive procedure

Upon reception of a frame, CAL shall

a) calculate the user priority from the PPPP value associated with the received SideLink frame as specified in Table 4,

NOTE 1 Usage of PPPP and the related user priority at higher layers is not defined; priority values are defined in 3GPP TS 23.203[18].

NOTE 2 Usage of user priority at higher layers is not defined for Uu communications; priority values are defined in 3GPP TS 23.203[18].

b) derive the EtherType value from the LTE-V2X Layer-3 protocol data unit type and from the LTE-V2X Non-IP Header,

c) present the received packet (ITS-NTPDU) to the ITS-S networking & transport layer, i.e. using the IN-UNITDATA.indication service primitive specified in ISO 21218.

9.2 Management procedures

9.2.1 Cross-CI prioritization

A basic "Cross-CI prioritization procedure" is specified in ISO 21218. For ITS-LTE-V2X operating in the frequency band 5 800 MHz ± $DSRC_{BW}$, with $DSRC_{BW}$ = 200 MHz the option "CI protection" shall be applied for all implementations with a CEN MDR-DSRC OBU, or HDR-DSRC OBU, (5,8 GHz backscatter technology) being part of the ITS station unit.

NOTE The value of the single-sided protection bandwidth $DSRC_{BW}$ depends on the result of investigations on mitigation techniques for avoiding harmful interference on MDR-DSRC and HDR-DSRC.

9.2.2 Operational mode

Any change of the operational mode by the LTE network shall be stored in the I-Parameter "OperationalMode". Any change of the value of the I-Parameter "OperationalMode" not requested by the ITS station management shall be notified to the ITS station management with MI-REQUEST {Event21218Notification {E21218-5} } specified in ISO 21218.

9.2.3 LTE-V2X MAC address mapping

9.2.3.1 LTE-V2X SideLink communication

LTE-V2X SideLink communication uses Layer-2 identifiers of size 24 bits instead of 48 bit MAC addresses; distinction is made between a source Layer-2 ID and destination Layer-2 ID, see 7.2.

1) Destination Layer-2 ID:

   i) In the 3GPP Release 14 of LTE-V2X it is indicated that an LTE-V2X Sidelink destination Layer-2 ID points to an ITS service. It is further suggested that this service identified by a registered value of the ITS application identifier ITS-AID. ITS-AID is specified in ISO 17419[1]. The mapping of ITS-AIDs on LTE-V2X destination Layer-2 ID is not yet standardized.

   ii) If this concept of generating an LTE-V2X SideLink destination Layer-2 ID is precisely specified, the applicable value of ITS-AID can be provided as "transmit access parameter" in the "access parameters" parameter of the IN-UNITDATA.request service primitive specified in ISO 21218.

2) Source Layer-2 ID:

   An LTE-V2X SideLink source Layer-2 ID is self-assigned. An initial value may be provided by the LTE network.

The LTE-V2X SideLink source Layer-2 ID is managed as a pseudonym, i.e. values are locally assigned and replaced by new values upon request by the ITS station management. So far no specific update rate or update condition is specified. It shall be possible to change LTE-V2X SideLink source Layer-2 ID upon request by the ITS station management with MI-COMMAND {ChangePseudonymMACaddress}.

For IP based communications the LTE-V2X CI auto-configures a link local IPv6 source address (prefix: fe80::/10) as specified in TS 23.303, clause 4.5.3; privacy regulations may require change of the IP source address simultaneously with the change of the source Layer-2 ID.

The mapping of LTE-V2X Layer-2 IDs onto the EUI-64 format used in Link-ID (LocalCIID and Remote CIID) specified in ISO 21218 shall use the basic format for encapsulation of identifiers specific to ITS specified in ISO 21218:2018, C.3:

1) LocalCIID:

   As specified in ISO 21218, i.e. the LTE-V2X SideLink source Layer-2 ID is mapped to the "VCISerialNumber" value zero in combination with "UC/GC" set to '000000'$_2$.

2) RemoteCIID:

   As specified in ISO 21218, i.e. the LTE-V2X SideLink source Layer-2 ID is mapped to the "VCISerialNumber" value 65535 in combination with "UC/GC" set to '111111'$_2$, i.e. indication broadcast communications.

NOTE The VCISerialNumber is not necessarily subject to privacy regulations, as it is designed as a station-internal number. Thus changing the pseudonym LTE-V2X source Layer-2 ID does not necessarily result in a change of Link-ID. Applying IPv6 communications, the Link-ID can appear in the wireless link.

9.2.3.2 LTE-V2X Uu communication

Either LTE-V2X Uu CIs and VCIs are identified by a 48 bit MAC address assigned by the vendor of the CI, or the LTE-V2X Uu CI and VCI identification shall be as follows, see also ISO 21218:

1) LocalCIID: Same as for LTE-V2X SideLink communication, see 9.2.3.1.

2) RemoteCIID:

   i) The "VCISerialNumber" 65535 in combination with "UC/GC" set to '000000'$_2$ is used to identify unicast communications to the LTE base station.

   ii) The "VCISerialNumber" 65535 in combination with "UC/GC" set to '111111'$_2$ is used to identify broadcast communications from the LTE base station.

   iii) The rules for the fields "ITS-SCU-ID", and "MedID" are as specified in ISO 21218.

9.2.3.3 Overview

Table 5 summarizes the LTE-V2X MAC address mapping specified in 9.2.3.1 and 9.2.3.2.

Table 5 — LTE-V2X MAC address mapping

UC/GC MSB					LSB	VCISerialNumber	Comment
0	0	0	0	0	0	0	LocalCIID identifying local CI (SideLink and Uu communications)
0	0	0	0	0	0	65535	RemoteCIID identifying unicast communications to the LTE base station (Uu communications)
1	1	1	1	1	1	65535	RemoteCIID identifying broadcast communications from the LTE base station (Uu communications), and SideLink broadcast communications.

9.2.4 CI connection procedure

When the CI state is “active” and I-Parameter Connect is set to “automatic” (0), or upon reception of the MI-COMMAND “CIstateChange” with the value “connect”, the LTE V2X CI shall execute the LTE V2X connection procedure specified by 3GPP.

9.2.5 CI state management

CI state management specified in ISO 21218 (view of CI) and ISO 24102-1 (view of ITS station management) shall be supported.

The CI state-machine is needed in support of

— hybrid communications introduced in 6.2.3 and related self-interference management specified in 9.2.1,

— path and flow management specified in ISO 24102-6[9].

The mapping of LTE-V2X connection states on CI states and the transition events between CI states is presented in the informative Annex E.

10 Conformance

Conformance testing of ITS-LTE-V2X is fully specified only in combination with applicable requirements specified in ISO 21218.

Implementation conformance statements (ICS) complementing those from ISO 21218 are not specified in this document.

Conformance tests for regional related features, e.g. interference mitigation techniques, are also applicable.

11 Test methods

The test suite structure and test purposes (TSS&TP) and an abstract test suite (ATS) for conformance tests is specified in a separate document. TSS&TP and ATS for ITS-LTE-V2X are based on TSS&TP and ATS for ISO 21218.

Conformance testing may use upper tester access in the System Under Test (SUT) applying ITS station-internal management communications specified in ISO TS 20026[5], ISO 24102-4[8], and ISO 24102-3.

Annex A
(normative)

Communication interface parameters

A.1 General

Communication interface parameters (I-Parameters) are generally specified in ISO 21218 for all access technologies. This normative annex provides details specific to ITS-LTE-V2X.

A.2 I-Parameters specific to ITS-LTE-V2X

I-Parameters are specified in ISO 21218. Table 6 specifies details of I-Parameters that are specific to ITS-LTE-V2X.

Table 6 — I-Parameters specific to ITS-LTE-V2X

I-ParamNo	I-Parameter name/ ASN.1 Type	Description/range/values
8	LLaddress / `LLaddress`	These addresses are presented in the EUI64 format identified by the reference value `c-ITSatt-iso17515` as specified in 9.2.3.
9	LLaddressTemp / `LLaddressTemp`	
29	LLaddressPeer / `LLaddressPeer`	
15	RegulatoryInformation / `RegulatoryScheme`	RI data structure is presented in the format identified by the reference value `c-RegScheme-iso17515` with valid regulatory information, or a statement that no regulation is known or applicable. The specific format is not yet specified[a].
17	SimPin / `SimPin`	Access credential for LTE-V2X such as PIN for the SIM card are presented in the format identified by the reference value `c-ITSatt-iso17515`. The specific format is not yet specified[a].
32	RXsensitivity / `RxSens`	The receiver sensitivity is presented in the format identified by the reference value `c-ITSatt-iso17515`. The specific format is not yet specified[a].
33	TXpower / `TxPower`	The transmit power EIRP is presented in the format identified by the reference value `c-ITSatt-iso17515`. The specific format is not yet specified[a].
34	TXpowMax / `TxPowerMax`	
35	PeerTXpower / `PeerTXpower`	
36	LinkDataRate / `DataRateLink`	The LTE-V2X link data rate is presented in the format identified by the reference value `c-ITSatt-iso17515`. The specific format is not yet specified[a].
53	PhysicalChannelIdentifier / `PhysicalChannelIdentifier`	The LTE-V2X identifier of a physical communication channel is presented in the format identified by the reference value `c-ITSatt-iso17515`. The specific format is not yet specified[a].

[a] I-Parameters of which the ASN.1 format is not yet specified either are not used, or the format may be specified in a later version of this document.

Table 6 *(continued)*

I-ParamNo	I-Parameter name/ ASN.1 Type	Description/range/values
54	OperationalMode / `OperationalMode`	The operational mode is presented in the format identified by the reference value `c-ITSatt-iso17515` and specified in Annex D.
56	QoSrequirement / `QoSrequirement`	Quality of Service requirements are presented in the format identified by the reference value `c-ITSatt-iso17515`. The specific format is not yet specified[a].

[a] I-Parameters of which the ASN.1 format is not yet specified either are not used, or the format may be specified in a later version of this document.

A.3 Default values of I-Parameters

Table 7 defines default values of I-Parameters applicable for ITS-LTE-V2X.

Table 7 — Default values of I-Parameters of LTE-V2X

I-ParamNo	I-Parameter name/ ASN.1 Type	Default values/Comments
4	ITS-SCU-ID / `ITS-scuId`	10 (allowed is the range 5 through 65534)
6	LocalCIID / `LocalCIID`	As pre-configured by LTE network (source Layer-2 ID presented in format specified in 9.2.3)
7	TimeoutRegister / `TimeoutRegistration`	100 ms
8	LLaddress / `LLAddress`	LTE-V2X Source Layer-2 ID presented in format specified in 9.2.3
9	LLaddressTemp / `LLAddressTemp`	Same as LLaddress.
10	CIclass / `CIclass`	CIC-l6
11	CIaccessClass / `CIaClass`	CIAC-3
12	CIstatus / `CIstatus`	0: not-existent
13	Notify / `Notify`	CIstatus, LLaddressTemp
14	MedType / `ITSatt`	`c-ITSatt-iso17515` = 10: ISO 17515
15	RegulatoryInformation / `RegInfo`	For intented region of operation. Not yet defined in ASN.1.
16	Connect / `Connect`	255: manual
19	MinimumUserPriority / `MinimumUserPriority`	0: smallest possible value (default in ISO 21218).
20	QueueLevel / `QueueLevelActual`	{priority, 0}
21	QueueLevelThreshold / `QueueLowThreshold`	{priority, 85}
22	QueueAlarmThreshold / `QueueAlarmThreshold`	{priority, 170}
25	TimeOfLastReception / `TimeOfLastReception`	IAT set to 0

Table 7 *(continued)*

I-ParamNo	I-Parameter name/ ASN.1 Type	Default values/Comments
26	InactivityTimeLimit / `InactTimeLimit`	0: no limit
27	MediumUsage / `MediumUsage`	{receive:0, transmit: 0}
28	MedUseObservationTime / `MedUseObsTime`	1 second
31	MinPrioCrossCI / `MinimumCrossCiPriority`	0: smallest possible value
32	RXsensitivity / `RxSens`	Reference sensitivity. Not yet standardized, thus to be defined by implementation.
33	TXpower / `TxPower`	Reference power. Not yet standardized, thus to be defined by implementation.
34	TXpowMax / `TxPowerMax`	As required by regulation, otherwise 0: reference power.
36	LinkDataRate / `DataRateLink`	Default as required by regulation, or minimum possible value
37	DataRateNW / `DataRateNetwork`	Equal to average of DataRatesNW.minimum and DataRatesNW.maximum
38	DataRatesNW / `DataRatesNetwork`	{minimum: minimum possible value if known, otherwise 0, maximum: maximum possible value if known, otherwise 0}
39	DataRateNWreq / `DataRateNetworkRequired`	Same as DataRateNW
40	Directivity / `Directivity`	{fixed, 0, 0, 0, 360, 40} - omnidirectional, or not supported
46	Cost / `MediumCost`	CostClass 0: "tempUnavailable"
47	Reliability / `Reliability`	255: unknown
48	LogicalChannels / `LogicalChannels`	Mappings for all supported physical channels and logical channels. Default as required by regional regulation
52	LimitChannelAccess / `LimitChannelAccess`	{default channel, 200, 0}: no limitation
53	PhysicalChannelIdentifier / `PhysicalChannelIdentifier`	Default as required by regional regulation
54	OperationalMode / `OperationalMode`	0: unknown

Annex B
(normative)

MI-COMMANDs

B.1 General

The management service primitives MI-COMMAND.request and MI-COMMAND.confirm and some of the functions of MI-COMMAND.request are specified in ISO 24102-3. Further functions are specified e.g. in ISO 21218 and in ISO 24102-6.

B.2 Required functionality

The functionality of MI-COMMANDs shall be supported as specified in Table 8.

Table 8 — MI-COMMANDs

COMMAND	Description	Requirement
SimIUTcmd	See ISO/TS 20026[5] and ISO 24102-3	Mandatory if ISO/TS 20026[5] is supported, otherwise optional.
EchoTest	See ISO 24102-3	
CIstateChange	Change of CI status.	Mandatory if path and flow management specified in ISO 24102-6[9] is supported, or mandatory if ISO 21218 is supported, otherwise optional.
MonitorIparameters	Command to request monitoring of parameters.	
ChangePseudonymMACaddress	Command to request change of MAC address or other type of layer 2 address, e.g. LTE Layer-2 ID, which is visible in a link to a peer station. This may be due to privacy regulations.	Mandatory if privacy regulations require it, otherwise optional.
ManufacturerCommand	Allows for manufacturer-specific access to the CI. Used e.g. for test and maintenance purposes.	Optional
PrioritizedRequestToSend	Information on an intended prioritized transmission of a victim CI presented to interferer CIs.	Mandatory if cross-CI prioritization specified in ISO 21218 and ISO 24102-1 is supported
RegulatoryInformation	Provisioning of regulatory information.	If this functionality is performed by the LTE network, this command is not applicable; otherwise mandatory
VCImanagement	Command to request creation, reset or deletion of a VCI. Setting of parameters different to the default values for a newly created VCI has to be done in subsequent MI-SET commands.	Mandatory if ISO 21218 is supported, otherwise optional.

Annex C
(normative)

MI-REQUESTs

C.1 General

The management service primitives MI-REQUEST.request and MI-REQUEST.confirm and some of the functions of MI-REQUEST.request are specified in ISO 24102-3. Further functions are specified, e.g. in ISO 21218 and in ISO 24102-6[9].

C.2 Required functionality

The functionality of MI-REQUESTs shall be supported as specified in Table 9.

Table 9 — MI-REQUESTs

REQUEST	Description	Requirement
SimIUTreq	See in ISO/TS 20026[5] and ISO 24102-3	Mandatory if ISO/TS 20026[5] is supported, otherwise optional.
TestMIEcho	See ISO 24102-3	
EventNotification	Notification of an event.	Mandatory if ISO 21218 is supported, otherwise optional.
PositionUpdate	Requests to receive position updates with update interval as indicated in milliseconds/cancels the request.	Optional
PrioritizationRegistration	Registration of a victim CI for Cross-CI Prioritization.	Mandatory if Cross-CI prioritization specified in ISO 21218 and ISO 24102-1 is supported, otherwise not applicable
PrioritizationRequest	Real-time request of a victim VCI to get prioritization.	
RegistrationCI	Request to register the CI.	Mandatory if dynamic registration specified in ISO 21218 and ISO 24102-1 is supported, otherwise not applicable.

Annex D
(normative)

ASN.1 definitions

D.1 Overview

The ASN.1 basic notation is specified in ISO/IEC 8824-1:2015. The following ASN.1 module is specified in D.2:

— ITSltev2x {iso (1) standard (0) lte (17515) v2x (3) version0 (0)}

D.3 also provides ASN.1 type and value specifications to be registered in the registry of ISO 21218.

In case the ASN.1 specifications given in this Annex are not in accordance with illustrations or specifications provided elsewhere in this document, the specifications given in this Annex shall prevail.

Updates of these ASN.1 specifications will be published on http://standards.iso.org/iso/17515/-3/ed-1/en.

Applicable encodings of the types and values defined in this document depend on the usage. ASN.1 BASIC-PER, UNALIGNED, as specified in ISO/IEC 8825-2:2015, shall apply if no other explicit requirement on encoding is given.

D.2 Module ITSltev2x

```
ITSltev2x {iso (1) standard (0) lte (17515) v2x (3) version0 (0)}
DEFINITIONS AUTOMATIC TAGS ::= BEGIN

IMPORTS
-- From EN ISO 17419-1
EUI64 FROM CITSdataDictionary1 {iso(1) standard(0) cits-applMgmt (17419)
dataDictionary (1) version1 (1)}
; -- End of IMPORTS

-- Medium-specific I-Parameter
LTE-OperationalMode::=INTEGER{
    unknown                     (0),
    sideLinkV2X                 (1), -- ISO 17515-3
    uuV2X                       (2), -- ISO 17515-3
    generalInternet             (3), -- ISO 17515-1 (Uu interface)
    d2d                         (4) -- ISO 17515-2
    } (0..255) -- used as a bit field, e.g. "12" means support of
"generalInternet" and "d2d"

-- Link Layer Address
LTE-Layer2Address::=EUI64 -- Layer-2 Identifier encapsulated in EUI64

/* Formats of I-Parameters to be specified later, if applicable
-- RegulatoryScheme
LTE-V2X-RegulatoryScheme::=LTE-RegulatoryScheme

LTE-RegulatoryScheme::=

--SimPin
LTE-V2X-SimPin ::=LTE-SimPin

LTE-SimPin::=

-- RXsensitivity
LTE-V2X-RXsensitivity ::=LTE-RXsensitivity
```