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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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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.

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2   Normative references (standards.iteh.ai)

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)*

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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.
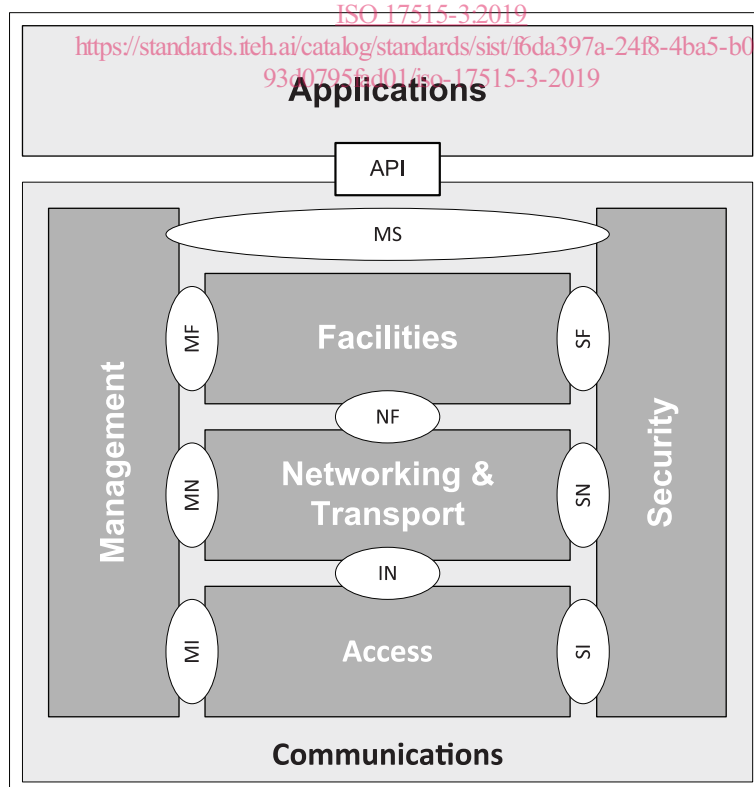
Figure 1 — ITS station architecture