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Intelligent Transport Systems (ITS);
ITS-G5 Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band

Reference
REN/ITS-0040191

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Foreword

This European Standard (EN) has been produced by ETSI Technical Committee Intelligent Transport Systems (ITS).

National transposition dates	
Date of adoption of this EN:	23 December 2019
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Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 September 2020
Date of withdrawal of any conflicting National Standard (dow):	30 September 2020

Modal verbs terminology

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Introduction

The present document outlines the two lowest layers - physical layer and data link layer - in the protocol stack for supporting vehicle-to-vehicle communications in an *ad hoc* network to be used at the 5,9 GHz frequency band allocated in Europe in compliance with Commission Decision 2008/671/EC [i.1], ECC/DEC/(08)01 [i.2] and ECC/REC/(08)01 [i.3]. The two lowest layers are termed access layer according to ETSI EN 302 665 [i.4] in the present document and the technology specified for the access layer is collectively called ITS-G5. The ITS-G5 access layer technology is using already existing standards for communications. The data link layer is divided into two sublayers; medium access control and logical link control. The physical layer and the medium access control layer are covered in IEEE 802.11-2016 [1]. The logical link control is based on the IEEE/ISO/IEC 8802-2-1998 [2]. The ITS-G5 standard also adds features for Decentralized Congestion Control (DCC) methods ETSI TS 102 687 [3] to control the network load.

By setting the Management Information Base (MIB) parameter `dot11OCBActivated` to true in IEEE 802.11-2016 [1] a new capability is introduced namely the possibility to communicate outside the context of a Basic Service Set (BSS), which is the smallest building block of an 802.11 network. Communication outside the BSS implies that neither authentication/association procedures nor security mechanisms are supported. Further, no access point functionality is present. The disable of these features also affects other built-in features of IEEE 802.11-2016 [1]. The requirement that nodes should share a common clock is no longer valid while `dot11OCBActivated` is true. Further, scanning of available frequency channels for joining a BSS is also disabled implying that communication outside the context of the BSS requires that a node is configured for a predetermined frequency channel where more information about other available frequency channels can be obtained.

1 Scope

The present document defines the two lowest layers, physical layer and the data link layer, grouped into the access layer of the ITS station reference architecture ETSI EN 302 665 [i.4].

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

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The following referenced documents are necessary for the application of the present document.

[1] IEEE 802.11™-2016: "IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks-Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

[2] IEEE/ISO/IEC 8802-2-1998: "Information technology -- Telecommunications and information exchange between systems -- Local and metropolitan area networks -- Specific requirements -- Part 2: Logical Link Control".

[3] ETSI TS 102 687 (V1.2.1): "Intelligent Transport Systems (ITS); Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part".

[4] IEEE 802™-2014: "IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture".

[5] ETSI EN 302 571 (V2.1.1): "Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU".

[6] ETSI TS 102 792 (V1.2.1): "Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range".

2.2 Informative references

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Commission Decision 2008/671/EC of 5 August 2008 on the harmonised use of radio spectrum in the 5 875-5 905 MHz frequency band for safety-related applications of Intelligent Transport Systems (ITS).

[i.2] ECC/DEC/(08)01: "ECC Decision (08)01 on the harmonised use of the band 5875-5925 MHz for Intelligent Transport Systems (ITS)".

[i.3] ECC/REC/(08)01: "ECC Recommendation (08)01 on the use of the band 5855-5875 MHz for Intelligent Transport Systems (ITS)".

[i.4] ETSI EN 302 665 (V1.1.1): "Intelligent Transport Systems (ITS); Communications Architecture".

[i.5] IEEE 802.11p™-2010: "IEEE Standard for Information technology - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 6: Wireless Access in Vehicular Environments".

[i.6] IEEE 802.11™-2012: "IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks-Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

[i.7] IEEE 802.11a™-1999: "IEEE Standard for Telecommunications and Information Exchange Between Systems - LAN/MAN Specific Requirements - Part 11: Wireless Medium Access Control (MAC) and physical layer (PHY) specifications: High Speed Physical Layer in the 5 GHz band".

[i.8] IEEE 802.11e™-2005: "IEEE Standard for Information technology - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications - Amendment: Medium Access Method (MAC) Quality of Service Enhancements".

[i.9] ANSI/IEEE 802.1D-1998: "IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Common specifications - Part 3: Media Access Control (MAC) Bridges".

[i.10] IEEE Registration Authority.

NOTE: Available at https://standards.ieee.org/content/ieee-standards/en/products-services/regauth/index.html.

[i.11] List of assigned EtherTypes at the IEEE Registration Authority.

NOTE: Available at http://standards-oui.ieee.org/ethertype/eth.txt.

[i.12] ETSI EN 302 636-4-1 (V1.3.1): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality".

[i.13] ETSI TS 103 175 (V1.1.1): "Intelligent Transport Systems (ITS); Cross Layer DCC Management Entity for operation in the ITS G5A and ITS G5B medium".

[i.14] IEEE 802.11™-2007: "IEEE Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

ethertype: identifier to the network protocol above the data link layer

ITS-G5 access layer: access layer technology to be used in frequency bands dedicated for European Intelligent Transport Systems (ITS)

3.2 Symbols

For the purposes of the present document, the following symbols apply:

aCWmax	Maximum value of Contention Window
aCWmin	Minimum value of Contention Window
AIFS	Arbitration InterFrame Space
AIFSN	Arbitration InterFrame Space Number
aSIFSTime	Short InterFrame Space defined by the physical layer
aSlotTime	A slot time defined by the physical layer
CW	Contention Window
CW_{max}	Maximum value of Contention Window
CW_{min}	Minimum value of Contention Window
T_{busy}	period of time the channel is busy
T_{CBR}	period of time

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Access Category
AC_BE	Access Category Best Effort
AC_BK	Access Category Background
AC_VI	Access Category Video
AC_VO	Access Category Voice
ACK	Acknowledgment
AIFS	Arbitration InterFrame Space
AIFSN	Arbitration InterFrame Space Number
AP	Access Point
BE	Best Effort
BK	Background
BPSK	Binary Phase Shift Keying
BSS	Basic Service Set
BSSID	Basic Service Set Identification
CBR	Channel Busy Ratio
CEN	European Committee for Standardization
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
CW	Contention Window
DCC	Decentralized Congestion Control
DCF	Distributed Coordination Function
DIFS	Distributed InterFrame Space
DSRC	Dedicated Short-Range Communication
DUT	Device Under Test
ECC	Electronic Communication Committee
EDCA	Enhanced Distribution Coordination Access
EE	Excellent Effort
EN	European Norm
EPD	EtherType Protocol Discrimination
GPS	Global Positioning System
HalfBT	Half Bathtub
HDR	High Data Rate
IBSS	Independent Basic Service Set
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transport Systems
LLC	Logical Link Control
LOS	Line-Of-Sight

MAC	Medium Access Control
MCS	Modulation and Coding Scheme
MIB	Management Information Base
MPDU	MAC Protocol Data Unit
NC	Network Control
NLOS	Non Line-Of-Sight
OFDM	Orthogonal Frequency Division Multiplexing
PDU	Protocol Data Unit
PER	Packet Error Rate
PHY	Physical layer
PLCP	Physical Layer Convergence Protocol
PPDU	PLCP Protocol Data Unit
PSDU	PLCP Service Data Unit
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
SNAP	SubNetwork Access Protocol
TDL	Tapped Delay Line
TS	Technical Specification
TX	Transmitter
UP	User Priority
VI	Video
VO	Voice
WLAN	Wireless Local Area Network

4 Access layer requirements

4.1 Introduction

The access layer bundles the data link layer and the physical layer and it is situated at the bottom of the ITS protocol stack, see Figure 1. The ITS station reference architecture and the definition of an ITS station are outlined in ETSI EN 302 665 [i.4].

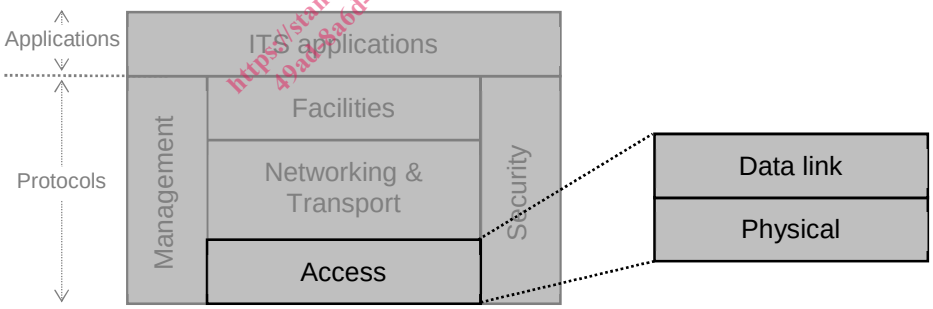

Figure 1: ITS station reference architecture

The access layer technology consists of IEEE 802.11-2016 [1], IEEE/ISO/IEC 8802-2-1998 [2], IEEE 802-2014 [4] and ETSI TS 102 687 [3], see Figure 2. An introduction to IEEE 802.11-2016 [1] with the MIB parameter `dot11OCBActivated` set to true is provided in informative Annex C. Interfaces between access layer and management entity and access layer and networking & transport layer are found in Annex B.

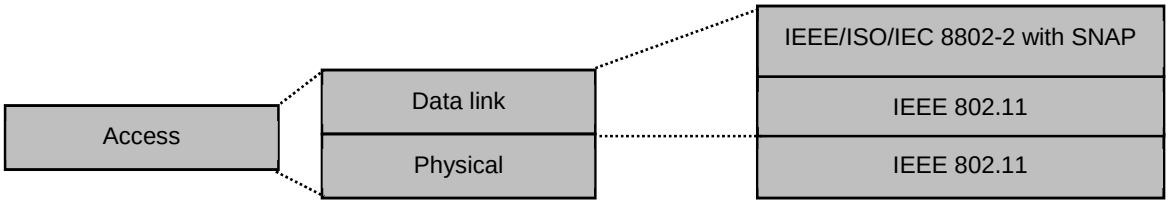

Figure 2: Protocols comprising the access layer

4.2 Physical layer

The physical layer of ITS-G5 shall be the orthogonal frequency division multiplexing (OFDM) "half-clocked" operation using 10 MHz frequency channels as outlined in IEEE 802.11-2016 [1], clause 17. Mandatory transfer rates are 3 Mbit/s, 6 Mbit/sand 12 Mbit/s.

The limits for static receiver sensitivity shall be as outlined in Table 1.

Table 1: Static receiver sensitivity

Transfer rate (Mbit/s)	Modulation	Coding rate	Minimum sensitivity for 10 MHz channel spacing (dBm)
3	BPSK	1/2	-91
4,5	BPSK	3/4	-90
6	QPSK	1/2	-88
9	QPSK	3/4	-86
12	16-QAM	1/2	-83
18	16-QAM	3/4	-79
24	64-QAM	2/3	-75
27	64-QAM	3/4	-74

The limits for dynamic receiver sensitivity (i.e. the receiver sensitivity in the presence of interference) shall be as outlined in Table 2.

Table 2: Dynamic receiver sensitivity

Transfer rate (Mbit/s)	Modulation	Coding rate	Minimum sensitivity for 10 MHz channel spacing (dBm)
6	QPSK	1/2	-85

The limits for receiver adjacent channel rejection and alternate adjacent channel rejection shall be as outlined in Table 3.

Table 3: Limits for receiver adjacent channel rejection and alternate adjacent channel rejection

Transfer rate (Mbit/s)	Modulation	Coding rate	Adjacent channel rejection (dB)	Alternate adjacent channel rejection (dB)
3	BPSK	1/2	28	42
4,5	BPSK	3/4	27	41
6	QPSK	1/2	25	39
9	QPSK	3/4	23	37
12	16-QAM	1/2	20	34
18	16-QAM	3/4	16	30
24	64-QAM	2/3	12	26
27	64-QAM	3/4	11	25