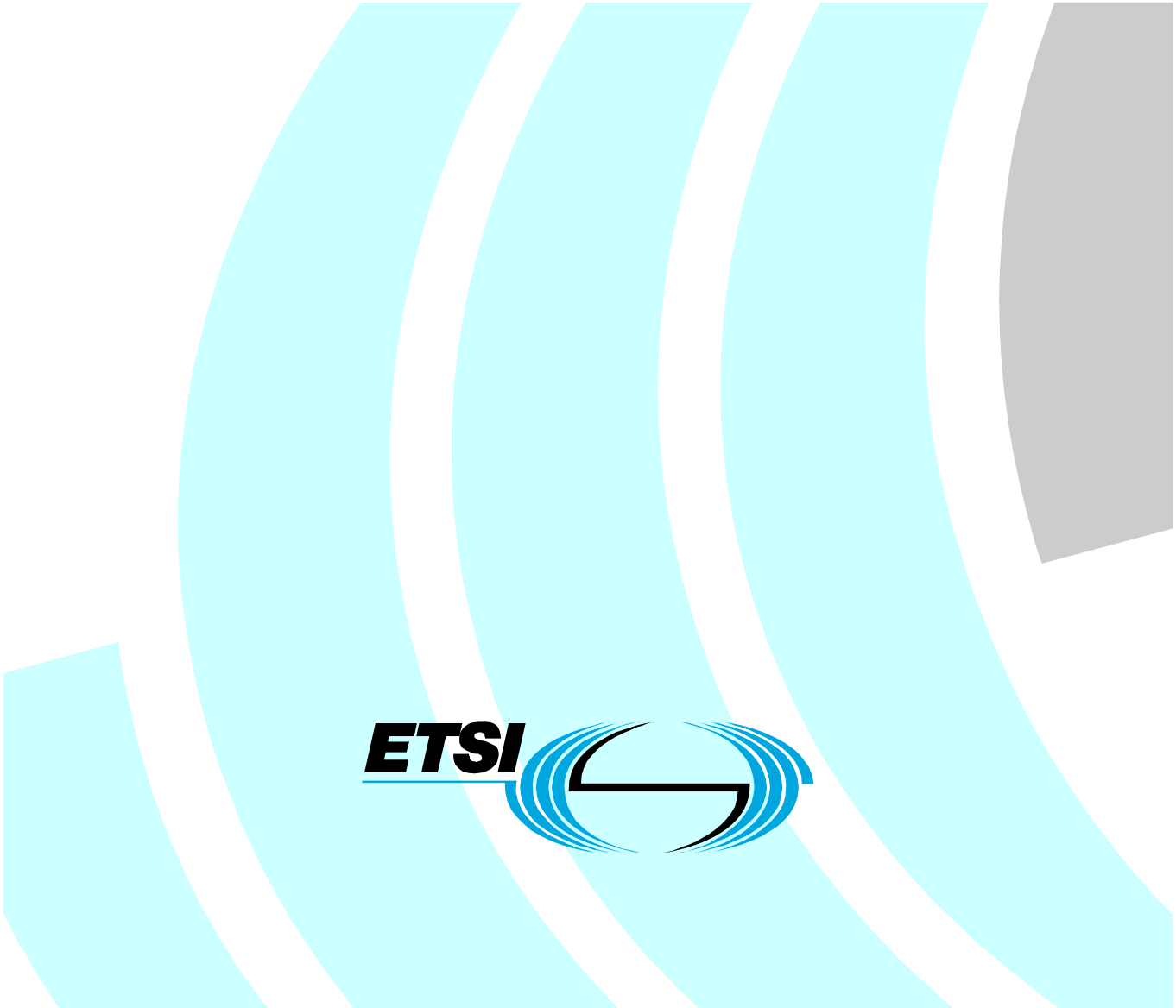
ETSI ES 202 663 V1.1.0 (2010-01)

ETSI Standard

**Intelligent Transport Systems (ITS);
European profile standard for the physical and medium access control layer of Intelligent Transport Systems operating in the 5 GHz frequency band**



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Contents

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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Intelligent Transport System (ITS).

Introduction

Intelligent Transport Systems (ITS) are being developed in all regions by standard institutes, industry initiatives and research activities.

The present document provides the European profile standard for communications in the 5 GHz band. The work is based on the published IEEE standard 802.11 [3] and on developments at IEEE on the amendment 802.11p [i.5].

The functionality specified in the present document is named "ITS-G5" and distinguishes several frequency ranges. It covers the physical layer and parts of the data link layer, i.e. the medium access control sub-layer and extensions to handle parameters of these layers to be used on a per-MSDU basis, including the related management.

1 Scope

The present document specifies the European profile in line with [i.10] of the physical and medium access control sub-layer of 5 GHz intelligent transport systems (ITS) using IEEE 802.11 [3] as the base standard. It covers the frequency ranges:

- ITS-G5A: Operation of ITS-G5 in European ITS frequency bands dedicated to ITS for safety related applications in the frequency range 5,875 GHz to 5,905 GHz.
- ITS-G5B: Operation in European ITS frequency bands dedicated to ITS non- safety applications in the frequency range 5,855 GHz to 5,875 GHz.
- ITS-G5C: Operation of ITS applications in the frequency range 5,470 GHz to 5,725 GHz.

One of the additionally selected functionalities being an essential part of the present document is "communication outside the context of a BSS" as currently being developed by IEEE 802.11 Task Group p [3].

Communication outside the context of a BSS enables exchange of data frames between stations that are not members of a BSS. This type of communication allows for immediate exchange of data frames, avoiding the latency associated with the establishment of a BSS.

The present document covers the following IEEE 802.11 [3] services:

- spectrum management services (DFS, uniform spreading) for ITS-G5C;
- transmit power control;
- traffic differentiation and QoS support;
- selected MAC data services: DCF, EDCA, fragmentation/de-fragmentation (the latter only for ITS-G5C);
- selected MAC control services: ACK, RTS, CTS;
- selected MAC management services: selected action frames (spectrum management action frames);
- OFDM PHY.

The profile excludes the following IEEE 802.11 [3] features:

- association services;
- access control and data confidentiality services;
- higher-layer timer synchronization;
- selected MAC data services, i.e. PCF, HCF HCCA;
- selected MAC control services, i.e. PS-Poll, CF-End, CF-End + CF-Ack, Block Ack Request/Block Ack;
- selected MAC management services, i.e. beacon, ATIM, disassociation, association request/response, re-association request/response, probe request/response, authentication, de-authentication, selected action (measurement request/report);
- power management services.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

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

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] ETSI EN 302 571 (V1.1.1): "Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[2] ETSI EN 301 893 (V1.5.1): "Broadband Radio Access Networks (BRAN); 5 GHz high performance RLAN; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[3] 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".

NOTE: Amendments to this standard are considered in [i.1] and [i.2] which are essential to understand the sources from which some of the functionality in the present document is derived.

[4] IEEE Std 802-2001: "IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture".

[5] ANSI/IEEE Std 802.2:1998: "Information technology -- Telecommunications and information exchange between systems -- Local and metropolitan area networks -- Specific requirements -- Part 2: Logical Link control".

[6] ISO/IEC 7498-1:1994: "Information technology - Open Systems Interconnection - Basic Reference Model: The Basic Model".

[7] ITU-T Recommendation X.691 (2002): "Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)".

[8] IEEE P802.11k (2008): "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 Amendment 1: Radio Resource Measurement of Wireless LANs".

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.3] ETSI TR 102 654 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Co-location and Co-existence Considerations regarding Dedicated Short Range Communication (DSRC) transmission equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range and other potential sources of interference".

[i.4] ETSI EN 300 674 (all parts): "ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Road Transport and Traffic Telematics (RTTT); Technical characteristics and test methods for Dedicated Short Range Communication (DSRC) transmission equipment (500 kbit/s / 250 kbit/s) operating in the 5,8 GHz Industrial, Scientific and Medical (ISM) band".

[i.5] IEEE P802.11pTM/D8.0:2009: "Draft 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; Amendment 7: Wireless Access in Vehicular Environments".

[i.6] ECC/DEC/(08)01: "ECC Decision of 14 March 2008 on the harmonised use of the 5875-5925 MHz frequency band for Intelligent Transport Systems (ITS)".

[i.7] ECC/REC/(08)01: "ECC Recommendation (08)01 on the use of the band 5855-5875 MHz for Intelligent Transport Systems (ITS)".

[i.8] ERC/DEC(99)23: "ERC Decision of 29 November 1999 on the harmonised frequency bands to be designated for the introduction of High Performance Radio Local Area Networks (HIPERLANs)".

[i.9] ECC/DEC(02)01: "ECC Decision of 15 March 2002 on the frequency bands to be designated for the co-ordinated introduction of Road Transport and Traffic Telematic Systems".

[i.10] ETSI ETS 300 406 (edition 1): "Methods for Testing and Specification (MTS); Protocol and profile conformance testing specifications; Standardization methodology".

[i.11] Commission Decision 2005/513/EC of 11 July2005 on the harmonised use of radio spectrum in the 5 GHz frequency band for the implementation of wireless access systems including radio local area networks (WAS/RLANs).

[i.12] Commission Decision 2007/90/EC of 12 February 2007 amending Decision 2005/513/EC on the harmonised use of radio spectrum in the 5 GHz frequency band for the implementation of Wireless Access Systems including Radio Local Area Networks (WAS/RLANs).

[i.13] 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.14] ETSI TS 102 687 (V1.1.1): "Intelligent Transport Systems (ITS); Transmitter Power Control Mechanism for Intelligent Transport Systems operating in the 5 GHz range".

[i.15] ETSI TS 102 723-3: "Intelligent Transport Systems; OSI cross-layer topics; Part 3: Interface between management entity and access layer".

[i.16] ETSI TS 102 665 (V1.1.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Architecture".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in [1], [2], [3], [4], [5], [6], [7], [8], [i.17] and the following apply:

ITS-G5: set of protocols and parameters as specified in the present document

ITS-G5 Control Channel: physical channel as defined in clause 5.3

ITS-G5 Service Channel: any other physical channel than the ITS-G5 Control Channel as defined in clause 5.3

ITS-G5 STA: device that contains an ITS-G5

3.2 Symbols

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

'00101100'b notation used for numeric values presented in binary numeral system

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in [1], [2], [3], [4], [5], [6], [7], [8], [i.18] and the following apply:

DCC Decentralized Congestion Control
G5CC ITS-G5 Control Channel
G5SC ITS-G5 Service Channel

ITS-G5A Frequency band ranging from 5,875 GHz to 5,905 GHz

NOTE: Dedicated to ITS for safety related applications.

ITS-G5B Frequency band ranging from 5,855 GHz to 5,875 GHz

NOTE: Dedicated to ITS non-safety applications.

ITS-G5C Frequency band ranging from 5,470 GHz to 5,725 GHz

NOTE: Used for ITS applications.

4 General requirements

4.1 ITS station reference architecture

Figure 1 shows the part of the ITS AL that is covered by the present document. It is based on the OSI layered communications model with a detailed view of the ITS Access Technology layer.The mapping between the ITS-G5 elements specified in the present document and the ITS AL model is shown in figure 1.

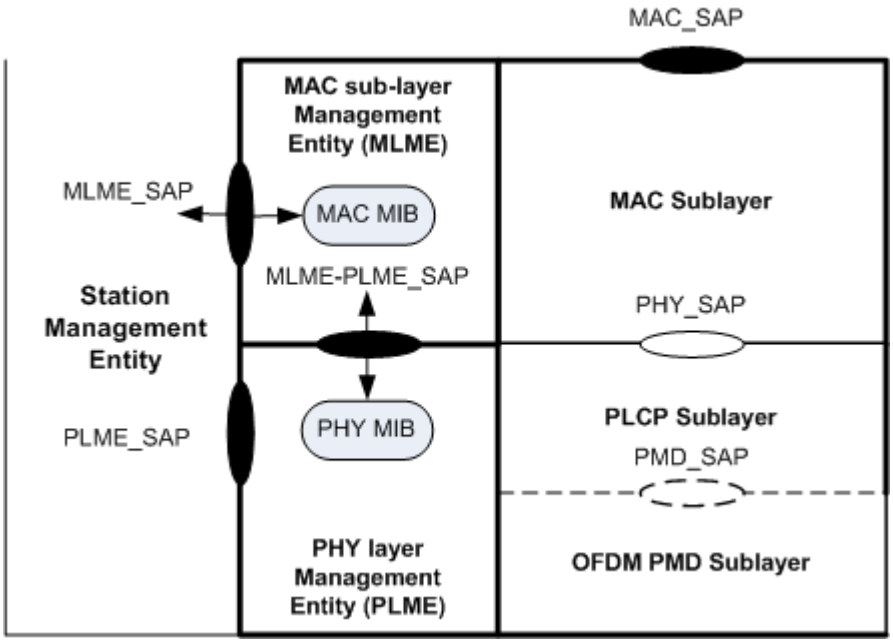

Figure 1: Access layer with ITS-G5 MAC and PHY

The present document specifies the following elements of ITS-G5: a physical layer, a medium access control sub-layer, a MAC sub-layer Management Entity (MLME) and a Physical Layer Management entity (PLME). ITS-G5 also includes the SAPs MAC_SAP and MLME_SAP (depicted in black in figure 1). The internal SAPs PHY_SAP and PMD_SAP (depicted in white in figure 1) are not part of ITS-G5 specification, which implies that an ITS-G5 STA may not implement these SAPs. However, a STA implementing these SAPs in compliance with 802.11 [3] is also considered compliant to ITS-G5.

In figure 1 the ITS-G5 physical layer is composed of the two sub-layers PLCP and PMD. The distinction of the two sub-layers is only presented for homogeneity with [3]. In fact, ITS-G5 only supports the OFDM PHY specification. Consequently, ITS-G5 STAs may not have the two sub-layers PLCP and PMD and, instead, may have one single physical layer.

As compared to [3], ITS-G5 does not provide the SME-PLME_SAP. Consequently, only the MLME can access the PHY MIB via the MLME-PLME_SAP. The MLME-PLME_SAP is therefore part of ITS-G5 (see annex D).

The MLME SAP can be identical to the MI-SAP in [i.16].

NOTE: The general approach is going to be described in TS 102 723-3 [i.15].

ITS-G5 MAC_SAP, MLME_SAP and MLME-PLME_SAP shall be compliant with the correspondent SAPs of IEEE 802.11 [3] with restrictions and amendments as specified in the present document. In particular, the present document specifies amendments to the MAC_SAP (see annex C), whereas the ITS-G5 MLME_SAP (see annex D) is a subset of the IEEE 802.11 [3] MLME_SAP. No amendments nor subset are specified for the MLME-PLME_SAP.

With respect to the ITS AL model depicted in figure 1, ITS-G5 MLME_SAP is the subset of the IM-SAP that represents the management SAP for ITS-G5 interfaces. The MAC_SAP is not matched by a correspondent SAP in the ITS AL model. The MAC_SAP is used by the ITS-G5 LLC layer that is out of scope of the present document.

4.2 ITS-G5 mode of operation

An ITS-G5 STA shall operate outside the context of a BSS.

NOTE: The mode of operation outside the context of a BSS is drafted in [i.5]. Consequently, the MAC services SCAN, JOIN, ASSOCIATE, AUTHENTICATE are not applicable.

All ITS-G5 STAs operating on ITS-G5A and ITS-G5B are treated equally as peer stations, disregard whether they are fixed or mobile.

For operation in ITS-G5C, a distinction between fixed and mobile ITS-G5 STAs is made in order to apply spectrum management based on DFS. Mobile ITS-G5 STAs act as DFS slaves and fixed ITS-G5 STAs as DFS masters.

4.3 Operations in ITS-G5C

The Commission Decisions [i.11] and [i.12] regulate the usage of the 5 GHz frequency band for wireless access systems and radio local area networks. Operation in the RLAN band, see figure 2 and [2], requires Transmit Power Control (TPC), a procedure for Dynamic Frequency Selection (DFS) and uniform spreading to detect signals from radar systems and avoid co-channel operation with these systems; provide on aggregate a near-uniform loading of the spectrum, i.e. uniform spreading.

NOTE: RLAN also is referred to as WLAN. These requirements apply to all types of RLAN devices regardless of the type of communication between these devices.

In order to comply with these regulatory requirements [2], it is foreseen for operation in ITS-G5C to allow communications only between a fixed ITS-G5 STA at the roadside as DFS master device, and the mobile ITS-G5 STA in the vehicles as DFS slave devices. Consequently, communication between mobile ITS-G5 STAs in ITS-G5C is not possible.

The DFS master shall be in charge of service advertisement, transmission control and selection of the G5SC. DFS slave devices being in an active session with a DSF master device shall be instructed by the DSF master device in the active G5SC about a required change of frequency of the G5SC.

DFS slave devices are restricted to have a maximum EIRP of 200 mW and do not have to implement radar detection [2].

4.4 Distributed congestion control

ITS applications, in particular safety-related applications, have high requirements on the reliability and the latency of the data transmission. Considering the limited bandwidth of ITS-G5A, data load on the wireless channels can exceed the available capacity in some situations.

Distributed Congestion Control (DCC) is going to be specified in TS 102 687 [i.14] as an essential component to maintain network stability, throughput efficiency and fair resource allocation to ITS-G5 STAs. DCC requires mechanisms on all layers of the protocol stack and a harmonization of these mechanisms among the layers. Examples of DCC are the collision avoidance mechanism of the CSMA in the MAC layer and Transmit Power Control (TPC) and Transmit Rate Control (TRC) on the network layer. Typically, higher layer DCC mechanisms need support at the MAC layer and the PHY layer.

The present document specifies how DCC mechanisms external to ITS-G5 can set parameters of ITS-G5 on a per-MSDU basis.

NOTE: At time of writing the present document the following parameters are identified to be set on a per-MSDU basis:

- adjustment of transmit power (Transmit Power Control: TPC);
- adjustment of data rate in the wireless link;
- adjustment of packet rate.

4.5 Quality of service based on user priority

ITS-G5 supports MSDUs with up to 8 levels of user priority (UP) as specified in [3]. The user priority (UP) shall be used to set the parameters to contend for medium access using Enhanced Distributed Channel Access (EDCA) functionality specified in [3].

5 Physical layer

5.1 General requirements

The physical layer of ITS-G5 shall be compliant with the profile of IEEE 802.11 - orthogonal frequency division multiplexing (OFDM) PHY specification for the 5 GHz band [3], as specified in the present document.

5.2 Frequency allocation

Table 1 shows the frequency ranges and related regulatory requirements and harmonized standards.

Table 1: Frequency allocation in the European Union

Frequency range	Usage	Regulation	Harmonized standard
5 905 MHz to 5 925 MHz	Future ITS applications	ECC Decision [i.9]	EN 302 571 [1]
5 875 MHz to 5 905 MHz	ITS road safety	ECC Decision [i.9], Commission Decision [i.13]	
5 855 MHz to 5 875 MHz	ITS non-safety applications	ECC Recommendation [i.7]	
5 470 MHz to 5 725 MHz	RLAN (BRAN, WLAN)	ERC Decision [i.8] Commission Decisions [i.11] and [i.12]	EN 301 893 [2]

Figure 2 illustrates the requirements for spectral power density in the 5 GHz range for the frequency bands listed in table 1. It also shows the European bands for Dedicated Short Range Communication (DSRC).

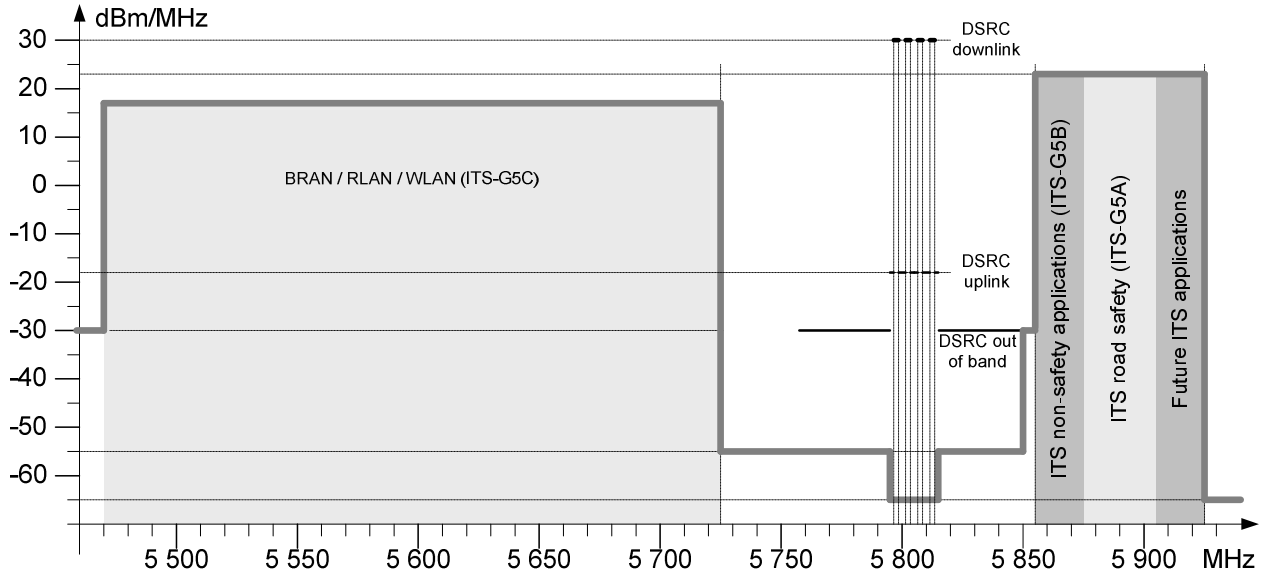

Figure 2: Maximum limit of mean spectral power density (EIRP)

NOTE 1: Figure 2 only shows the maximum limits. Further restrictions apply as specified in the harmonized standards [1], [2] and in the present document.

NOTE 2: Figure 2 also contains information on the DSRC bands located around 5,8 GHz because DSRC is widely used in Europe for road toll collection. Special protection of DSRC was considered in the process of developing the harmonized standard [1]. Further investigations on coexistence of DSRC and ITS-G5 are conducted at ETSI ITS, see [i.3]. DSRC is regulated by the ECC Decision [i.9] and by the harmonized standard EN 300 674 [i.4].

NOTE 3: Interference from DSRC roadside units or onboard units to ITS-G5 are not expected.

5.3 Channel allocation

Channel allocation shall be as specified in table 2. One physical channel is allocated as a G5CC. Four fixed and one variable physical channels are identified as G5SCs.

Table 2: European channel allocation

Channel type	Centre frequency	IEEE [3] channel number	Channel spacing	Default data rate	TX power limit	TX power density limit
G5CC	5 900 MHz	180	10 MHz	6 Mbit/s	33 dBm EIRP	23 dBm/MHz
G5SC2	5 890 MHz	178	10 MHz	12 Mbit/s	23 dBm EIRP	13 dBm/MHz
G5SC1	5 880 MHz	176	10 MHz	6 Mbit/s	33 dBm EIRP	23 dBm/MHz
G5SC3	5 870 MHz	174	10 MHz	6 Mbit/s	23 dBm EIRP	13 dBm/MHz
G5SC4	5 860 MHz	172	10 MHz	6 Mbit/s	0 dBm EIRP	-10 dBm/MHz
G5SC5	As required in [2] for the band 5 470 MHz to 5 725 MHz		several	dependent on channel spacing	30 dBm EIRP (DFS master)	17 dBm/MHz
					23 dBm EIRP (DFS slave)	10 dBm/MHz
NOTE: With respect to emission limits (power limit / power density limit), the more stringent requirement applies.						

Usage of G5CC and G5SC1 to G5SC5 are dedicated for the following usage:

- The G5CC shall be used for road safety and traffic efficiency applications and may be used for ITS service announcements of services operated on G5SC1 to G5SC5.
- G5SC1 and G5SC2 shall be used for ITS road safety and traffic efficiency applications.
- Other ITS user applications G5SC3, G5SC4 and G5SC5.

When not transmitting on ITS-G5A or ITS-G5B, all ITS-G5 STAs, except those not supporting safety applications, shall be able to always receive on the G5CC. All ITS-G5 STAs, including those not supporting safety applications, shall be capable of transmitting on the G5CC.

NOTE 1: The previous statement implies that ITS-G5 STAs operating on both the G5CC and one of the G5SCs have to be able to simultaneously receive on both channels except whilst transmitting in any one of these channels.

Table 3 shows MCSs and corresponding data rates for different values of channel spacing as specified in [3]. ITS-G5 STAs shall support MCSs for a 10 MHz channel. ITS-G5 STAs operating on ITS-G5C shall support MCSs for 10 MHz and 20 MHz channels. The MCS and channel spacing currently used by a ITS-G5 STA shall be coded in the MIB attributes `ITSg5MCS` and `ITSg5ChannelSpacing`, respectively (see clause A.2). Default values of MCS shall be:

- MCS = 2 for G5CC and G5SC1
- MCS = 4 for other G5SCs

NOTE 2: Deviations from a default MCS-value are allowed.

Table 3: Data rates and channel spacing

Modulation coding scheme (MCS)	0	1	2	3	4	5	6	7
Data rate in Mbit/s 40 MHz channel	12	18	24	36	48	72	96	108
Data rate in Mbit/s 20 MHz channel	6	9	12	18	24	36	48	54
Data rate in Mbit/s 10 MHz channel	3	4,5	6	9	12	18	24	27
RATE of OFDM PLCP as specified in [3] R1 … R4	'1101'	'1111'	'0101'	'0111'	1001'	'1011'	'0001'	'0011'
Modulation scheme	BPSK	BPSK	QPSK	QPSK	16-QAM	16-QAM	64-QAM	64-QAM
Coding rate R	½	¾	½	¾	½	¾	2/3	¾

5.4 Transmit power control

TPC limits shall be as specified in [1] for ITS-G5A and ITS-G5B, and as specified in [2] for ITS-G5C. Additional TPC requirements are provided by the DCC which are outside of the scope of the present document. These additional requirement for ITS-G5A and ITS-G5B are encompassed in [i.14].

Settings of the transmit power by means of parameter `ITSg5TXpower` shall be in steps of 0,5 dB.

Change requests shall modify the transmit power monotonically. The integer value stored in `ITSg5TXpower` shall indicate the requested actual transmit power EIRP relative to the maximum transmit power as implemented and as allowed by regulation.

Modifications of `ITSg5TXpower` shall be done by the congestion control manager, see also clause 4.4.

5.5 Receiver performance

In addition to the requirements set up by regulation [2] and [1], additional requirements are needed in order to ensure a minimum performance of ITS-G5.

The minimum receiver sensitivity shall be as specified in [3].

In order to support DCC techniques the receiver sensitivity of ITS-G5 shall be set in the MIB attribute `ITSg5RXSensitivity`.

NOTE 1: It has been recognized that most existing implementations of [3] already offer a better receiver sensitivity than the minimum values required by the standard.

The integer value stored in `ITSg5RXSensitivity` shall contain the sensitivity levels in steps of 0,5 dBm.

EXAMPLE: `ITSg5RXSensitivity` = 170 indicates a receiver sensitivity of -85 dBm.

In order to support DCC techniques the setting of the MIB attribute `dot11TIThreshold` is specified in [i.14].

NOTE 2: DCC techniques require the CCA threshold (`dot11TIThreshold`) to be equal within a certain tolerance interval for each station. [3] does not specify a default value for `dot11TIThreshold` but only requires it to be equal or greater than the receiver minimum input sensitivity.

In addition to the minimum requirements in [1], the Listen Before Talk (LBT) threshold for ITS-G5C shall not exceed the receiver sensitivity for MCS=0 within the 10 MHz channel spacing, see table 3.

The requirements specified in [3] for adjacent channel rejection and non-adjacent channel rejection shall apply for all values of channel spacing except 10 MHz, see minimum values in table 4. Table 4 also shows optional enhancements for adjacent channel rejection.

Table 4: Receiver performance requirements for 10 MHz channel spacing

MCS (see table 3)	Adjacent channel rejection			Non-adjacent channel rejection		
	Minimum Required [3] (dB)	Enhanced 1 (optional) [i.5] (dB)	Enhanced 2 (optional) (dB)	Minimum Required [3] (dB)	Enhanced 1 (optional) [i.5] (dB)	Enhanced 2 (optional) (dB)
0	16	28	34	32	42	44
1	15	27	33	31	41	43
2	13	25	31	29	39	37
3	11	23	29	27	37	35
4	8	20	26	24	34	36
5	4	16	22	20	30	32
6	0	12	18	16	26	28
7	-1	11	17	15	25	27

6 Medium access control sub-layer

6.1 General requirements

The medium access control sub-layer of the ITS-G5 shall be compliant with the profile of IEEE 802.11 [3] as specified in clause 6.5.

An ITS-G5 STA shall transmit and receive data outside the context of a BSS.

NOTE: Operation outside the context of an BSS is specified by IEEE Task Group p in [i.5]. The previous requirement is equivalent to setting the MIB parameter `dot11OCBEnabled` to "True".

All ITS-G5 STAs shall apply QoS to all types of frames.

6.2 Frame format

A MAC frame shall consist of the following basic components:

- a MAC header;
- a frame body of variable length;
- and a frame check sequence (FCS).

Details of these components are specified in [3].

6.3 MAC header

6.3.1 Header structure

Figure 3 shows the MAC header as specified in [3].

Frame Control	Duration / ID	Address 1	Address 2	Address 3	Sequence Control	Address 4	QoS Control
2 octets	2 octets	6 octets	6 octets	6 octets	2 octets	6 octets	2 octets

Figure 3: MAC header

Elements of the MAC header are further detailed in the following clauses.

6.3.2 Frame control field

6.3.2.1 Structure

Figure 4 shows the MAC frame control field as specified in [3] as used in the MAC header presented in figure 3.

Protocol Version	Type	Subtype	To DS	From DS	More Frag	Retry	Pwr Mgt	More Data	PrF	Order
2 bits	2 bits	4 bits	1 bit	1 bit	1 bit	1 bit	1 bit	1 bit	1 bit	1 bit

Figure 4: MAC frame control field

6.3.2.2 Type and subtype

The fields "Type" and "Subtype" shall be set in accordance with [3].

The following combinations of "Type" and "Subtype" shall be supported.

Table 5: MAC frame types

"Type"	"Subtype"	Remarks
Management frame	Action	Used for channel switch announcement
Control frame	ACK	As requested by the service class parameter in the MA-UNITDATA.request service primitive.
	RTS	Usage of RTS/CTS as defined in [3]
	CTS	
Data frame	QoS Data	All ITS stations shall support QoS data frames for all types of MAC addressing, i.e. broadcast, multicast and unicast.

6.3.2.3 To DS and From DS

The fields "To DS" and "From DS" shall be set to '0'b in accordance with [3].

NOTE: A Distribution System (DS) and the element "Address 4" in the MAC header are not used in the present document. Thus the value contained in the fields "To DS" and "From DS" is '0'b each.

6.3.2.4 Fragmentation

Fragmentation at the MAC layer shall not be used in ITS-G5A and ITS-G5B. Unexpected transmission requests which would result in a frame length exceeding the maximum allowed frame length shall be discarded.

NOTE: Upper OSI layers are responsible to ensure proper limitation of packet size and optional application of fragmentation.

6.3.2.5 Power management

Power save mode shall be prohibited, thus the value in the field "Pwr Mgt" shall be '0'b.

NOTE: Power save mode would conflict with requirements set up in clause 5.3.

6.3.2.6 Protected frame

In ITS-G5 data transmission outside the context of a BSS, encryption is not performed at MAC layer but at higher layers. Therefore the field "PrF" shall be set to zero.

NOTE: The field "PrF" is used in data and management frames of subtype authentication only. The field "PrF" being set to '1'b indicates that the frame body of the MAC frame has been encrypted.

6.3.3 Address fields

ITS-G5 shall use standard IEEE 802.11 MAC addressing [3] as applicable for operation outside the context of a BSS.

NOTE: As specified by IEEE Task Group p [i.5], operation outside the context of an BSS poses two requirements: First, an ITS-G5 STA transmitting data frames does not use the BSSID coded in "Address 3" for filtering or address matching during the reception operation of a data frame. Second, the value in "Address 3" for transmitting data frames is set to the wildcard value, i.e. all bits set to '1'b.

6.3.4 QoS control field

The value of the field "QoS control field" follows the specification in IEEE standard 802.11 [3] with the refinements presented in table 6.

Table 6: QoS control field

Bit positions	Element	Value	Explanation
3 to 0	TID	0 to 7	User Priority (UP)
		8 to 15	Values prohibited as a consequence of selecting EDCA as access policy.
4	EOSP	1	Selects meaning of bit positions 15 to 8.
6 to 5	Ack Policy	'00'b (Normal acknowledge) '10'b (No acknowledge)	Optional. To be selected by means of the service class parameter in the MA-UNITDATA.request service primitive.
7	reserved	'0'b	As specified in [3].
15 to 8	Queue Size	in integer multiples of 256 byte	As specified in [3].
NOTE: Value requested in [i.5].			

NOTE 1: ITS-G5 does not use traffic streams and the "TID" always corresponds to a traffic class "TC".

NOTE 2: The element "Queue Size" in the QoS control field indicates the size of only the one queue referenced by the TID value indicated in the QoS control field.

6.4 MAC addressing

ITS-G5 shall support unicast MAC addresses, the broadcast MAC address and multicast MAC addresses with the restriction that MAC multicast addresses shall be prohibited in ITS-G5A.

An ITS-G5 shall continuously monitor whether a peer station is using the same MAC address. In case of a detected conflict, the ITS-G5 station shall generate new MAC address to resolve this conflict, as appropriate.

NOTE: The locally administered MAC address may change at any time. Assuring the uniqueness of MAC addresses is outside the scope of the present document.

6.5 Quality of service

Since ITS-G5 STAs always operate outside the context of a BSS, mechanisms such as Point Coordination Function (PCF) and hybrid coordination function (HCF) controlled channel access (HCCA) are not applicable.

Enhanced Distributed Channel Access (EDCA) shall be applied. The set of EDCA parameters as specified in table 7 must not be negotiated over the air link, but shall be statically set.

Table 7: EDCA parameters

AC	Contention window CWmin	Contention window CWmax	Arbitration interframe space number AIFSN	MSDU lifetime	TXOP Limit OFDM PHY
AC_BK	aCWmin	aCWmax	9	see below	0
AC_BE	(aCWmin + 1) / 2 - 1	aCWmin	6		
AC_VI	(aCWmin + 1) / 4 - 1	(aCWmin + 1) / 2 - 1	3		
AC_VO	(aCWmin + 1) / 4 - 1	(aCWmin + 1) / 2 - 1	2		

NOTE 1: The values of aCWmin = 15 and aCWmax = 1 023 are specified in [3], see table 17-15.

The values of MSDU lifetime, see parameter `dot11EDCATableMSDULifetime` shall be initialized with the default value specified in [3] and may be subject to dynamic adjustments via the MLME SAP.

NOTE 2: Dynamic adjustment of MSDU lifetime may be performed, e.g. by DCC.

As traffic streams are not supported, `dot11EDCATableMandatory` shall be set to "False".

6.6 Dynamic frequency selection

Dynamic frequency selection (DFS) is required for communications in the RLAN band [2] and [i.8], see figure 2. Only a DFS master/slave mode of operation shall be supported. A fixed ITS-G5 STA operating as a service provider shall provide the DFS master functionality. Mobile ITS-G5 STAs operating as a service client shall provide the DFS slave function functionality.

The frequency band inside ITS-G5C actually to be used as the G5SC shall be announced in the service advertisement frame broadcasted in the G5CC.

7 Management

7.1 General requirements

The management of ITS-G5 shall be compliant with the profile of IEEE 802.11 [3] as specified in the present document.

NOTE: The operation outside the context of an BSS is specified by IEEE Task Group p in [i.5]. Thus the following management and control functionalities are not supported: scanning, authentication, and association.

7.2 Management information base

The management information base of ITS-G5 shall be based on [3] and shall contain also the additional attributes as specified in the present document.

7.2 Management service access points

The MLME_SAP of [3] is extended as a profile by the present document as specified in annex D.

7.3 Regulatory domain

ITS-G5 STAs shall always operate according locally valid regulatory requirements.

7.4 Power management

An ITS-G5 STAs shall never go to POWER_SAVE mode, see parameter `dot11PowerManagementMode` in clause A.1.

NOTE: Procedures specified in [3] to wake up an 802.11 STA from sleep mode thus are not applicable.

8 Conformance and test methods

Declaration of conformity of the ITS-G5 physical layer with European Harmonized Standards shall be done according to [2] and [1].

Conformance and test methods for the ITS-G5 communication protocols are not specified in the present document.

Annex A (normative): Parameters

A.1 IEEE802dot11-MIB attribute values

Table A.1 defines the values of the MAC and PHY MIB attributes specified in [3] that shall be used by ITS-G5 STAs.

Table A.1: IEEE802dot11-MIB Attributes Values

Name	Initial value	Value may be changed	Remark
dot11ACRType	2	Yes	See table 4. Enhanced Adjacent and NonAdjacent Channel Rejection requirements shall apply. 1 = minimum required 2 = enhanced 1 3 = enhanced 2
dot11EDCATable	see table 7		See [3].
dot11EDCATableMandatory	False	No	See [3].
dot11MultiDomainCapabilityEnabled	False	No	Optional, see [3]. Set to True in [i.5].
dot11OCBEnabled	True	No	Specified in [i.5]. When True, operation outside the context of a BSS applies.
dot11PowerManagementMode	active(1)	No	Mandatory mode.
dot11RadioMeasurementEnabled	False	No	Specified in [8].
dot11RegulatoryClassesRequired	True	No	See [3]. Set to True in [i.5].
dot11SpectrumManagementRequired	False	No	See [3]. Set to True in [i.5].
dot11TIThreshold	-	Yes	The threshold is used to detect a busy medium. Value to be defined according to distributed TPC techniques.
dot11WAVEEnabled	False	No	Optional Specified in [i.5].
dot11RTSThreshold	1000	Yes	Unicast packages larger than 1 000 octets are sent using RTS / CTS handshake.

A.2 ITS-G5 specific MIB attribute types

Table A.2 specifies new PHY and MAC MIB types of attributes that shall be supported by ITS-G5 STAs.

Table A.2: ITS-G5 MIB attribute types

Type	Default / initial value of MIB attribute	Remark
ITSg5ChannelSpacing	10 MHz (1) for ITS-G5A 10 MHz (1) for ITS-G5B 20 MHz (2) for ITS-G5C	Channel spacing, see table 2.
ITSg5MCS	2 for ITS-G5A 4 for ITS-G5B 4 for ITS-G5C	Modulation Coding Scheme, see table 3.
ITSg5RXSensitivity	As specified in [3], table 17-13.	Value to be defined according to distributed TPC techniques.
ITSg5TXpower	-	The attribute indicates the amount the maximum allowed EIRP is above the current EIRP in units of 0,5 dB.

A.3 ITS-G5 specific MIB attributes

Table A.3 specifies new PHY and MAC MIB attributes that shall be supported by ITS-G5 STAs in addition to the PHY and MAC MIB attributes defined in [3].

NOTE: Specification of the MIB is not finished in this version of the present document.

Table A.3: ITS-G5 MIB attributes

MIB attribute	Default / initial value	Remark
iTSg5ESversion	ES1.1.1	Version of the present document.
oidES202663	{ (0) (4) (0) (5) (4) (202663) }	Universal unique identifier of ITS-G5 MIB.

Annex B (normative): ASN.1 modules

B.1 Modules

B.1.1 IEEE 802.11

IEEE 802.11 [3] specifies the ASN.1 module **IEEE802dot11-MIB {iso(1) member-body(2) us(840) ieee802dot11(10036)}.** For the purpose of the present document, this MIB shall apply.

NOTE: 802.11p [i.5] will extend this MIB once it is released as an amendment to 802.11 [3].

B.1.2 ES 202 663

The main ASN.1 module of the present document is **ITSG5 { itu-t(0) identified-organization(4) etsi(0) itsDomain(5) wg4(4) itsg5(202663)}** as specified below. The encoding shall be packet encoding rules (PER) as specified in [7].

```
ITSG5 { itu-t(0) identified-organization(4) etsi(0) itsDomain(5) wg4(4) itsg5(202663)}
DEFINITIONS::=BEGIN

-- Types
ITSg5ChannelSpacing ::= ENUMERATED{
    cs5mhz  (0),
    cs10mhz (1),
    cs20mhz (2),
    cs40mhz (3) }

ITSg5MCS ::= INTEGER(0..7)

ITSg5RXSensitivity ::= INTEGER(0..255)

ITSg5TXpower ::= INTEGER(0..255)

-- Values
iTSg5ESversion UTF8String (SIZE(7))::= "ES1.1.1" -- version 1.1.1 of this ES

oidES202663 OBJECT IDENTIFIER::={ itu-t(0) identified-organization(4) etsi(0) itsDomain(5)
wg4(4)itsg5(202663)}

END
```

Annex C (informative): MAC data services

C.1 Semantics of the data service primitives

Information is given on the data services and data service primitives as in IEEE 802.11 [3]. The semantics of the data service primitives are extended in order to present a possible approach to support the per-packet selection such as the transmit power and the data rate.

C.2 MA-UNITDATA.request

This data service primitive requests transmission of an MSDU. The parameters of the service primitive are as follows:

```
MA-UNITDATA.request
        (
        source address, -- MAC address of transmitter which transmits the frame
        destination address, -- MAC address of destination
        routing information,
        data, -- LPDU,
        priority, -- 802.11 User Priority (UP) 0 … 7, used in TID field
        service class, -- "QoSAck" or "QoSNoAck"
        txparameters (optional) -- used to set transmit parameters on a per-MSDU basis
        )
```

The txparameters parameter specifies transmission parameters to be applied for the MSDU transfer. If supplied, the txparameters parameter specifies e.g. the transmit output power, whether RTS should be used for the current packet and/or the MCS parameter with which the MSDU is requested to be transmitted.

The transmit output power parameter is an unsigned integer value denoting the transmit output power in multiples of 0,5 dBm units. The allowed values of the power parameters depends on the channel in use and are specified in table 2. If the power parameter is not supplied, the transmit output power specified by `ITSg5TXpower` is be applied. If supplied, the MCS parameter specifies the modulation coding scheme. The allowed values of MCS are specified in table 3. If the MCS parameter is not supplied, the value specified by `ITSg5MCS` is be applied.

C.3 MA-UNITDATA.indication

This data service primitive indicates the reception of an MSDU. The parameters of the service primitive are as follows:

```
MA-UNITDATA.indication
        (
        source address, -- MAC address of source
        destination address, -- MAC address of receiving station or broadcast / multicast MAC address
        routing information,
        data, -- LPDU
        reception status, -- (always indicating "success")
        priority, -- 802.11 User Priority (UP) 0 … 7, taken from TID field
        service class, -- "QoSAck" or "QoSNoAck", taken from QoS Control field
        rxparameters (optional) -- used to indicate receive parameters on a per-MSDU basis
        )
```

The rxparameters parameter indicates e.g. the power and / or the MCS with which the MSDU specified by the data parameter was received.

The received power parameter is a signed integer value denoting the power in multiples of 0,5 dBm units. The MCS parameter specifies the modulation coding scheme that was used to transmit the MDSU specified by the data parameter. The allowed values of MCS are specified in table 3.

C.4 MA-UNITDATA.confirm

This data service primitive of local significance supplies status information for corresponding preceding MA-UNITDATA.request primitive. The parameters of the primitive are as follows:

```
MA-UNITDATA.confirm
        (
        source address, -- MAC address of transmitter which transmits the frame
        destination address, -- MAC address of destination
        transmission status,
        provided priority, -- 802.11 User Priority (UP) 0 … 7, used in TID field
        provided service class, -- "QoSAck" or "QoSNoAck"
        txparameters (optional)
        )
```

The following values for transmission status are added to those specified in [3]:

- Undeliverable: unavailable power.
- Undeliverable: unavailable MCS.

The provided txparameter parameter specifies e.g. the transmit power and MCS that was used for the associated MSDU transfer.

Annex D (informative): Management SAP

D.1 General

The management SAP of ITS-G5 is based on the MLME_SAP interface defined in [3] with the restrictions and amendments described in this clause. The PLME_SAP is not exposed to the SME but only to the MLME. Consequently, the PHY MIB is directly accessed only by the MLME and the SME can only modify the PHY MIB attributes values via the MLME_SAP primitives.

D.2 MLME-SAP

ITS-G5 MLME_SAP is based on 802.11 MLME_SAP [3] with the restrictions and amendments described in this clause.

The ITS-G5A, ITS-G5B and ITS-G5C MLME_ SAP primitives have the same generic GET/SET semantics as the 802.11 MLME_SAP primitives described in IEEE 802.11 [3].

The MLME-RESET.request primitive is used to change the parameters of the MAC and PHY sublayers as well as change the MAC address or change the MIB attributes. After the MAC sublayer is reset or MIB attributes are changed, MAC and PHY sublayer operation resumes with the appropriate MIB attributes in less than 2 TU.

The MLME_SAP primitives defined in [8] for synchronization purposes are not supported by ITS-G5A, ITS-G5B and ITS-G5C stations.

Since an ITS-G5A station may only operate outside the context of a BSS, only the primitives defined in IEEE 802.11 [3] that apply when `dot11OCBEnabled` is true are supported by ITS-G5.

Additionally, the following primitives are not supported by ITS-G5. The complete list of MLME_SAP primitives defined in IEEE 802.11 [3] that are not supported by an ITS-G5A station is as follows:

- MLME-GETTSFTIME
- MLME-GETTSFTIME
- MLME-TIMING_ADVERTISEMENT

Annex E (informative): Bibliography

- Car to Car Communication Consortium (C2C-CC): "CAR 2 CAR Communication Consortium; Manifesto; Overview of the C2C-CC System".

History

Document history		
V1.1.0	November 2009	Membership Approval Procedure MV 20100110: 2009-11-11 to 2010-01-11
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