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IEEE802

FIRST INTERNATIONAL STANDARD OPERATING IN THE FREQUENCY RANGE 252 GHZ TO 325 GHZ

1. Introduction

IEEE 802 LAN/MAN Standards Committee (IEEE 802 LMSC) is a leading consensus-based industry standards body, producing standards for wireless networking devices, including wireless local area networks (“WLANs”), wireless specialty networks (“WSNs”), wireless metropolitan area networks (“Wireless MANs”), and wireless regional area networks (“WRANs”). We also produce standards for wired Ethernet networks, and technologies produced by implementers of our standards, which are critical for all networked applications today.

IEEE 802 LMSC is a committee of the IEEE Standards Association and Technical Activities, two of the Major Organizational Units of the Institute of Electrical and Electronics Engineers (IEEE). IEEE has about 400,000 members in over 160 countries. IEEE’s core purpose is to foster technological innovation and excellence for the benefit of humanity. In submitting this document, IEEE 802 LMSC acknowledges and respects that other components of IEEE Organizational Units may have perspectives that differ from, or compete with, those of IEEE 802 LMSC. Therefore, this submission should not be construed as representing the views of IEEE as a whole¹.

At APG23-5 meeting held on February 2023, one possible WRC-27 agenda item which considers new allocations to fixed service (FS), mobile service (MS), radio astronomy service (RAS) and Earth exploration-satellite service (EESS) (passive) in the frequency range 275 GHz to 325 GHz on a co-primary basis in the Table of Frequency Allocations was proposed and carried forward to APG23-6 for further study. The purpose of this agenda item is shown as follows:

- (1) To extend the frequency range of the Table of Frequency Allocations of the Radio Regulations (RR) up to 325 GHz and add a new allocation table for four radiocommunication services in the frequency range 275 GHz to 325 GHz.
- (2) To coexist between active services (FS and MS) and passive services (RAS and EESS (passive)) in the frequency range 275 GHz to 325 GHz.
- (3) To update RR Nos. **5.138, 5.149, 5.340, 5.564A** and **5.565** consequently.

¹ This document solely represents the views of IEEE 802 LMSC and does not necessarily represent a position of either the IEEE or the IEEE Standards Association.

(4) To support future worldwide utilization of IEEE802.15.3d devices.

This document reflects the IEEE 802 LMSC's position on this possible agenda item.

2. Overview of THz work in IEEE 802 LMSC

2.1 Background

IEEE 802 LMSC has been working on THz Communications since 2008, when an Interest Group (IG) THz was formed in the IEEE 802.15 Working Group for Wireless Specialty Network, followed by transiting the Interest Group to the current IEEE 802.15 Standing Committee THz (SC THz). As a spin-off of the activities of the IEEE 802.15 IG THz group, IEEE 802 LMSC published IEEE Std 802.15.3dTM-2017 in 2017 - an amendment to IEEE Std 802.15.3TM-2016, which defines physical layer (PHY) at the frequency range between 252 GHz and 325 GHz for switched point-to-point links and defines two PHY modes that enables data rates of up to 100 Gb/s using eight different bandwidths between 2.16 GHz and 69.12 GHz. Applications targeted with this standard comprise wireless backhaul/fronthaul links, wireless links in data centers as well as short-range applications such as kiosk downloading, intra-device and close-proximity communication. In 2022, IEEE 802 LMSC initiated a project to revise IEEE Std 802.15.3TM-2016, which also includes the integration of amendment IEEE Std 802.15.3dTM-2017 into the main standard IEEE Std 802.15.3TM-2016 and an extension of the channel plan up 450 GHz covering the spectrum, that has been identified by WRC-19 in RR No. 5.564A.

2.2 Use cases supported by IEEE Std 802.15.3dTM-2017

The standard defines a wireless switched point-to-point physical layer operating at PHY data rates of 100 Gb/s with fallback solutions at lower data rates. The standard provides low complexity, low cost, low power consumption, and high data rate wireless connectivity among devices. The supported data rates are expected to satisfy a set of consumer multimedia industry needs, and to support emerging wireless switched point-to-point applications. Five use cases supported by this standard are shown below and the detailed information is provided in Application Requirement Document².

- Intra-device communication
- Close proximity P2P applications (e.g. kiosk downloading and file exchange)
- Wireless backhaul/fronthaul
- Data centers
- Touchless gate systems³

2.3 Technical requirements for IEEE Std 802.15.3dTM-2017

² See <https://mentor.ieee.org/802.15/dcn/14/15-14-0304-16-003d-applications-requirement-document-ard.docx>

³ This use case was standardized using 60 GHz band and published as IEEE Std 802.15.3eTM-2017. See IEEE Xplore <https://ieeexplore.ieee.org/document/7856917>

The requirements to define a wireless switched point-to-point physical layer operating at a nominal PHY data rate of 100 Gb/s with fallbacks to lower data rates as needed in terms of minimum data rates, required BER and required transmission distances depending on the specific use cases are shown in Table 1.

Table 1 Required performance for different use cases

Use case	Minimum Data Rate in Gb/s	Required BER after error correction	Required Transmission Distance (m)
Intra-Device Communication	1	10^{-12}	0.03
Close Proximity Communication	1	10^{-6}	0.1
Wireless Fronthauling	10^4	10^{-12}	200
Wireless Backhauling	10	10^{-12}	500
Wireless Data Center	1	10^{-12}	100

The standard shall also comply with the regulatory requirements taking into account the specific situation for carrier frequencies beyond 275 GHz. However, it would be preferable for IEEE 802.15.3d devices to use the whole range of the operational frequency 252 GHz to 325 GHz. The channel arrangement of IEEE Std 802.15.3dTM-2017 is shown in Figure 1. The maximum channel bandwidth is 69.12 GHz could be in worldwide operation if the regulations allow IEEE 802.15.3d devices to radiate transmission power in the whole range of the frequency in Regions 1, 2, and 3. The further information on technical requirements is provided in Technical Requirement Document⁵.

⁴ 10 Gb/s is the maximum data rate available today in CPRI. Hence, this shall be the minimum data rate targeted in the amendment.

⁵ See <https://mentor.ieee.org/802.15/dcn/14/15-14-0309-20-003d-technical-requirements-document.docx>

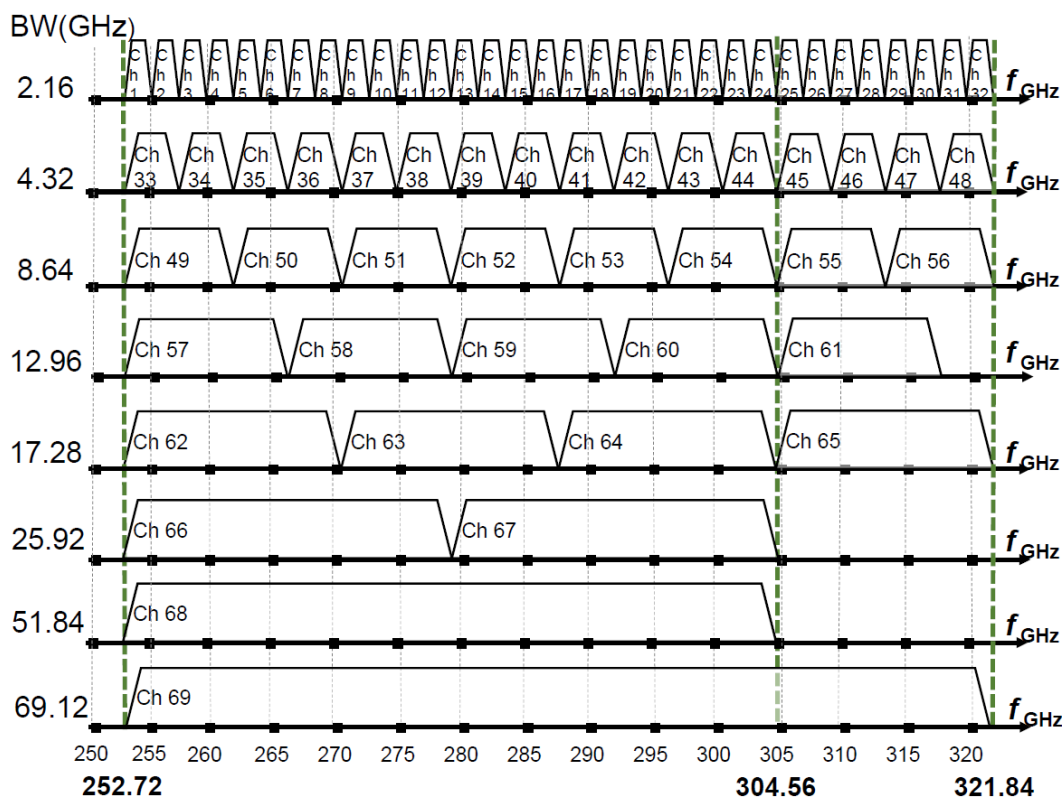


Figure 1 Channel arrangement in the frequency range 252 GHz to 325 GHz

2.4 Channel modeling for IEEE Std 802.15.3dTM-2017

The propagation characteristics and channel models in Line-of-Sight (LoS) and Non-Line-of-Sight (NLoS) operational environments relevant for each use case are provided in the Channel Model Document⁶. Antenna characteristics are also provided for the system simulation and evaluation by the proponents.

3. IEEE 802 LMSC's position

Three important documents for IEEE Std 802.15.3dTM-2017 are briefly introduced including five use cases and some technical requirements. IEEE Std 802.15.3dTM-2017 can be downloaded from IEEE Xplore⁷. Since this standard utilizes a vast amount of spectrum resources and extremely wide range of channel bandwidths, data rates up to 100 Gb/s are feasible using simple modulation schemes which can make it possible to develop compact and cost-effective transceivers. Further increase of data rates could be expected if multi-level modulation scheme and MIMO technologies are introduced⁸.

⁶ See <https://mentor.ieee.org/802.15/dcn/14/15-14-0310-19-003d-channel-modeling-document.docx>

⁷ See IEEE Xplore <https://ieeexplore.ieee.org/document/8066476>

⁸ See <https://mentor.ieee.org/802.15/dcn/15/15-15-0109-07-003e-technical-guidance-documnet-3e.docx>

This standard has a great potential to increase not only data rates but also number of applications of use cases. A number of IEEE 802.15.3d devices is expected to be used in worldwide under proper regulations. Therefore, the study for new allocations to FS and MS including RAS and EESS (passive) in the frequency range 275 GHz to 325 GHz in the RR by WRC-27 is important to support the development and deployment of IEEE802.15.3d devices to meet worldwide demand for short-range devices. APG is invited to take into account the current international standard operating in the frequency range 252 GHz to 325 GHz to address a WRC-27 agenda item under WRC-23 agenda item 10.