

Re: Réponse à la consultation publique “Preparing the Future of Mobile Networks”

Dear Arcep,

IEEE 802 LAN/MAN Standards Committee (LMSC) thanks Arcep for issuing the consultation and the opportunity to provide feedback on “Preparing the future of mobile networks”. The Consultation is an important mechanism for soliciting feedback that will provide the ARCEP with the information necessary.

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 are critical for all networked applications today.

IEEE 802 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 acknowledges and respects that other components of IEEE Organizational Units may have perspectives that differ from, or compete with, those of IEEE 802. Therefore, this submission should not be construed as representing the views of IEEE as a whole¹.

In the past ten years, the IEEE 802 LMSC has overseen the development of standards (including both IEEE Std. 802.11ac-2014 [1] and IEEE Std. 802.11ax-2021 [2]) that operate in unlicensed bands and are capable of providing gigabit throughput, i.e., provide physical layer throughput over 1 Gb/s. The current Wi-Fi 6 and Wi-Fi 6E technologies [3] are developed based on the IEEE Std. 802.11ax-2021 standard. IEEE P802.11be [4] is expected to provide physical layer throughput capacity at gigabit speeds and it is the basis that the upcoming Wi-Fi 7 technologies [5] utilize for development. These IEEE 802 technologies have become an integral part of European citizens’ lives, known best as “the 5 GHz network”. Next generation technologies utilizing both 5 GHz and 6 GHz bands in order to satisfy new requirements in internet of things or lower latency and jitter requirements for applications such as home video, video conferencing or video gaming are already developed and continue to be improved by our hundreds of standards development contributors.

In light of the important role IEEE 802 technologies play in European network ecosystems and as related to “practical need for EU action”, IEEE 802 LMSC would like to highlight the importance of license exempt designation. Developments in Wireless Access Systems (WAS) including Radio Local Area Networks (RLAN) such as Wireless Local Area Networks (WLAN) (IEEE 802.11) and Wireless Specialty Networks (WSN) (IEEE 802.15) technologies are crucial components in realizing the gigabit connectivity targets envisioned in the European *Commission’s 2030 Digital Compass: the European way for the Digital Decade* [6].

This consultation highlights the role of gigabit connectivity in the European digital transition that IEEE 802 LMSC believe IEEE 802 technologies can play an important role. In the following section, IEEE 802 LMSC would like to address selected questions in the consultation listed below.

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.

Question 2. What are the most significant developments brought by Wi-Fi 7? What is the timeline for these developments to become available on networks and devices? If applicable, what new frequency requirements will these developments generate?

Wi-Fi 7 technologies [5] are developed based on the P802.11be standard, which is the focus of the IEEE 802 LMSC's response to this question.

The standard is targeted to deliver a maximum throughput of at least 30 Gb/s to support superb performance, enable innovation, and expand emerging use cases that require a high level of user interactivity, immersion, reliability, and stringent QoS management. Such use cases include Augmented Reality (AR) and Virtual Reality (VR), Industrial Internet of Things (IoT), and emergency services (also known as Emergency Preparedness Communications Service in IEEE 802.11be). Expected deployment of the IEEE P802.11be technologies include applications that require high performance in terms of peak throughput, high network and link efficiency, increased reliability, and low latency and jitter. Target deployments for these applications are commercial/enterprise and consumer/residential deployments including airports, train stations, stadiums, malls, e-education, hospitals, public transportation, citywide Wi-Fi, apartment buildings, home, and office environments.

In order to achieve these target performance measures, IEEE P802.11be introduces advanced features including channel bandwidths of up to 320 MHz, 4K-quadrature amplitude modulation (QAM), multiple resource units (RUs) to a single station (STA), multi-link operation, enhanced quality of service (QoS), improved Target Wake Time (for improved battery life for IoT or other applications), and improved punctured transmission/subchannels to accommodate coexistence with incumbents more effectively and efficiently.

IEEE P802.11be is designed to meet the target application performance requirement and at the same time to scale to meet the requirements of enterprise, commercial and dense deployments when multiple simultaneous sessions of similar or different applications on multiple Wi-Fi networks are coexisting with incumbent services operation. To effectively support this scaling requirement, IEEE P802.11be's global 6 GHz channelization is designed to accommodate multiple 320 MHz and 160 MHz channels throughout the entire 6 GHz band, if available. It is important to note that multiple 320 MHz bands would not be possible if the entire 6 GHz band was not made available for unlicensed technologies.

IEEE 802.11 is currently working on finalization of the IEEE P802.11be standard and plans that the IEEE Standards Association could consider approval of the standard in May 2024 [3].

Question 3. Have you identified other developments in mobile technologies for specific uses that could generate new frequency needs, e.g. communications between devices or broadcasting/multicasting? If so, which and for what uses?

A number of use cases targeted by the IEEE 802.11ax-2021 standard and the upcoming IEEE 802.11be standard include Augmented Reality (AR) and Virtual Reality (VR) that are either optimized or naturally enabled in client to client (C2C) communications or broadcasting/multicasting modes of operation. In many outdoor and indoor venues, such as sport tournaments and entertainments, events are broadcasted via streaming platforms in high definition, with enriched details, requiring high network capacity.

These deployments can be effectively scaled when multiple 320 MHz channels are enabled in IEEE P802.11be. To enable communications between devices, portable modes of operations such as Very Low Power (VLP) and Low Power Indoor (LPI) C2C are already authorized by EU regulations for the lower part of the 6 GHz band. These can be easily extended to the entire 6 GHz band if authorized. The extension to the upper portion of the 6 GHz band would greatly facilitate scaling of services to enterprise and dense deployments.

Question 8. What other expected future applications and features can you identify?

To further expand on the applications listed in Section 1.4 of this consultation, IEEE 802 LSMC would like to highlight the following applications and use cases as expected future applications.

- Remote collaborative systems that utilize Augmented Reality and Virtual Reality
- 4K/8K video streaming as well as video calling and conferencing
- Remote/wireless office including social networking, gaming, e-education
- Multiple X Reality (XR) applications
- Electronic games and esports
- Home mesh to extend range and home coverage
- Medical field applications including mobile health, medical device connectivity, and emergency room at hospitals.

Question 10. Among these applications, are some more likely to develop specifically within a fixed environment, e.g. indoors, or rather in a mobile situation? If so, for what reasons?

IEEE 802.11 standards are designed to support various regulatory modes in EU and globally both indoor (LPI) and outdoor (VLP and Standard Power) in the 6 GHz band. More specifically, IEEE 802.11ax-2021 standard supports, and IEEE P802.11be is expected to support, a messaging protocol to facilitate compliance with various device modes according to local regulatory requirements. Also, support for portability is built into Wi-Fi technology through enabling of C2C LPI and VLP in the 6 GHz band and in general in the 2.4 GHz and 5 GHz bands. Having said that, the majority of the use cases and applications, including many of the applications mentioned in this response, are targeting indoor and fixed or portable environment.

Question 11. If applicable, which new mobile technologies would be needed to cover all of these applications? To cover your applications as a user?

IEEE 802 LMSC believes that IEEE 802.11 technologies complement and play a fundamental role in supporting 5G services today and 6G in the future as a cost effective, critical, and indispensable element for an optimized solution to achieve France's objectives for mid-term and long-term frequency resource allocations and the European Commission's *2030 Digital Compass: the European way for the Digital Decade*.

For the first time, as the result of close collaboration between RLAN industry and regulators globally, a multi-mode regulatory framework (LPI/VLP/SP) and requirement was developed and implemented on the entire 6 GHz band to optimally utilize the spectrum in the 6 GHz band for indoor and outdoor use while optimizing the regulatory requirement for different deployment models. This multi-mode regulatory framework is an efficient vehicle to enable various industry use-cases while allowing multiple Wi-Fi networks coexist with each other while FS and FSS incumbents continue operating and even expanding in the band as primary users. IEEE 802.11 standards support enabling of regulatory requirements through protocol messaging.

Question 12. What new frequency requirements have you identified to enable these applications using existing technologies and, if applicable, with the introduction of new technologies? For what reasons (capacity, speed, coverage...)?

Please refer to responses to other questions including Question 3.

IEEE 802.11 based technologies have already been incredibly successful in the home and enterprise markets where users benefit from a global ecosystem. In the office environment, both IT and service providers have been delivering both best effort and voice/video collaboration services for many years. All of these applications are considered as business critical and require a much tighter degree of control of key performance parameters such as latency, jitter, and reliability. The technologies introduced in the IEEE 802.11ax-2021 standard and the IEEE P802.11be standard are going through an evolution to further address the needs of vertical markets and Industrial IoT.

As mentioned in our response to Question 3, the deployment of new applications targeted by the IEEE 802.11ax-2021 standard and the upcoming IEEE 802.11be standard can be effectively scaled when multiple 320 MHz channels are enabled in IEEE P802.11be. To enable communications between devices, portable modes of operations such as Very Low Power (VLP) and Low Power Indoor (LPI) C2C are already authorized by EU regulations for the lower part of the 6 GHz band and can be easily extended to the entire 6 GHz band if authorized. The extension to the upper portion of the 6 GHz band would greatly facilitate scaling of services for enterprise and dense deployments.

Question 25. What additional frequencies could help satisfy indoor coverage and quality of service needs, and how? In particular: is the 26 GHz band well suited to ad hoc and indoor solutions? Given their propagation properties, could the 450 MHz and 1.4 GHz bands enable indoor coverage gains via mobile networks? What other frequencies could be considered to address this need for improved indoor coverage?

IEEE 802.11ax-2021 and IEEE P802.11be in the 6 GHz band are optimized for high throughput and improved latency for indoor operation in LPI mode. To properly match coverage performance of WAS/RLAN technologies at 5 GHz, while offering gigabit-throughput services, operation in Standard Power mode for indoor environment is required. In order to coexist with in-band and adjacent band incumbents using a dynamic spectrum usage such as frequency coordination, WAS/RLAN technologies need access to the entire 6 GHz band. The reasons are twofold, namely 1) to make sure there are still sufficient SP channels available (especially in urban areas with high density of FS links) after restricting interfering channels and sub-bands into incumbent links, and 2) to spread out the emission over the entire 1200 MHz spectrum in the 6 GHz band to control elevation-of noise.

Question 26. What role does Wi-Fi play in all of the solutions for providing service indoors? If applicable, are there uses for which Wi-Fi is not technologically appropriate, and for what reasons?

As it is stated earlier in this response, Wi-Fi technology based on IEEE 802.11 is designed to optimally support indoor fixed and portable applications. Obviously, similar to any other technology, one can identify use cases that are not supported by Wi-Fi today but, as a vibrant innovative technology, IEEE 802 is thriving on reinventing itself to support the use cases and the requirement needs of day-to-day life of people and businesses. Having said that, scalable, robust and flexible unlicensed frequency and spectrum policies are critical in enabling and facilitating Wi-Fi to innovate for future use cases possibly unknown today.

Question 34. Of all the frequency bands listed above and detailed below, which rank highest for their ability to meet your needs?

Considering adoption of the 6 GHz band for unlicensed use in many countries and regions globally, availability of the IEEE 802.11 standards and the hundreds of IEEE 802.11ax-compliant commercially available devices (capable of utilizing the entire 6 GHz band) of different form factors already in the market, IEEE 802 LMSC believes that the 6 GHz band (5925–7125 MHz) is the single most suitable frequency band to meet the needs in the short to medium term and recommends Arcep support for unlicensed designation of the 6425–7125 MHz band.

Question 37. If applicable, if these frequency bands were used for coexisting mobile and other uses (satellite, fixed link ...), what sharing methods seem advisable to you?

As stated earlier in this response, a multi-mode optimized regulatory framework for the 6 GHz band is developed and already adopted by many countries and regions globally, including EU by the ECC Decision (20)01 based on ECC Report 302.

In this framework, total transmit power level and power spectral density, indoor device category requirements, and a contention based (spectrum sharing) mechanism are specified to enable coexistence with FS and FSS incumbents. For Standard Power mode, IEEE 802 LMSC recommends consideration of Automated Frequency Coordination (AFC) to protect incumbent services when IEEE 802.11-compliant devices are operating indoor and outdoor at higher transmit power than LPI and VLP.

Question 77. What uses do you expect to make of this band [66–71GHz], under this general authorisation framework? Does the introduction of 5G seem advisable? Under what timeline?

WiGig technologies operating in the 66–71 GHz band [7] are developed based on the IEEE 802.11ad-2012 standard, which is the focus of the IEEE 802 LMSC's response to this question.

The IEEE 802.11ad-2012 [8] and IEEE 802.11ay-2021 [9] standards currently use the 57-71 GHz band as unlicensed spectrum and their associated technologies complement the IEEE 802.11ax-2021 and IEEE P802.11be standards and expand the use cases to virtual reality, multimedia streaming, gaming, wireless docking, and enterprise applications requiring high speed, data-intensive connections. Different categories of products that are developed based on IEEE 802.11ad-2012 and/or IEEE 802.11ay-2021 standards, from various device manufacturers including connectivity, computers and accessories, televisions and set-top boxes, gaming, media and music have been introduced to the market. Some popular uses include:

- Wireless docking between devices like smartphones, laptops, projectors, and tablets
- Simultaneous streaming of multiple, ultra-high-definition videos and movies
- More highly immersive gaming, augmented reality and virtual reality experiences
- Fast download of HD movies
- Convenient public kiosk services
- Easier handling of bandwidth intensive applications in the enterprise

Question 91. What is your assessment of the development outlook for these uses (Wi-Fi, IMT16)? Can you identify other uses that are likely to develop in this band [6425 – 7125 MHz (aka 6 GHz)]?

The upper segment of the 6 GHz band (i.e., 6425–7125 MHz) is either already designated as or is a candidate for unlicensed operation in many countries and regions throughout the Americas, EMEA, and APAC. The IEEE 802.11ax-2021 standard is completed, its associated technologies are mature, and there are a growing number of devices in the market.

Various countries have developed regulatory certification programs for IEEE 802.11ax-compliant 6 GHz enabled devices. Countries have already started experiencing socioeconomic benefits of allowing unlicensed operations in the 6 GHz band. While some countries and regions are still debating the results of WRC-23 and IMT studies for 6425–7125 MHz band, the industry is marching toward enabling the second generation of Wi-Fi products based on IEEE 802.11be in the same band soon.

Question 93. Do you think the band is a good candidate for implementing dynamic spectrum sharing to handle the planned uses for it?

IEEE 802 LMSC believes that a dynamic spectrum sharing mechanism such as AFC is appropriate for enabling Standard Power mode in the extension band. AFC system certification planning is already under planning in the US FCC, while Canada ISED and Brazil Anatel are also preparing for enabling similar systems. Similar considerations are also ongoing in other countries, including South Korea, Australia, and Saudi Arabia.

Conclusion

IEEE 802 LMSC thanks the Arcep for providing this invaluable opportunity to provide this submission with our recommendations. IEEE 802 LMSC respectfully requests that these recommendations be considered by the Arcep during the final decision making process.

Respectfully submitted

By: /ss/.

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References:

- [1] 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 Developed by the LAN/MAN Standards Committee of the IEEE Computer Society, IEEE Std 802.11™-2020, December 2020.
- [2] IEEE 802.11ax™-2021 - 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: Enhancements for High Efficiency WLAN, February 2021.
- [3] IEEE P802.11be. https://www.ieee802.org/11/Reports/tgbe_update.htm
- [4] Discover Wi-Fi: Wi-Fi CERTIFIED 6. <https://www.wi-fi.org/discover-wi-fi/wi-fi-certified-6>
- [5] Wi-Fi 7. <https://www.wi-fi.org/who-we-are/current-work-areas#Wi-Fi%207>

- [6] *2030 Digital Compass: the European way for the Digital Decade*, Brussels, 9.3.2021, COM(2021) 118 final <https://eufordigital.eu/library/2030-digital-compass-the-european-way-for-the-digital-decade/>
- [7] Discover Wi-Fi: Wi-Fi CERTIFIED WiGig. <https://www.wi-fi.org/discover-wi-fi/wi-fi-certified-wigig>
- [8] IEEE 802.11ad™-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 Amendment 3: Enhancements for Very High Throughput in the 60 GHz Band, December 2012
- [9] IEEE 802.11ay™-2021 - 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 2: Enhanced Throughput for Operation in License-exempt Bands above 45 GHz, February 2021