IEEE P802.18
Radio Regulatory Technical Advisory Group (RR-TAG)

Draft response to EU RSPG's questionnaire on long-term vision for the upper 6 GHz band				
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This document drafts a proposed response to EU Radio Spectrum Policy Group (RSPG)'s questionnaire on long-term vision for the upper 6 GHz band

Electronic filing August 20, 2024

Re: Questionnaire on long-term vision for the upper 6 GHz band

Dear Radio Spectrum Policy Group,

IEEE 802 LAN/MAN Standards Committee (LMSC) thanks the Radio Spectrum Policy Group (RSPG) for issuing the consultation "Questionnaire on long-term vision for the upper 6 GHz band" and for the opportunity to provide feedback on this important topic.

IEEE 802 LAN/MAN Standards Committee (IEEE 802 LMSC) is a leading consensus-based open standards development committee for networking standards that are used by industry globally. It produces standards for networking devices, including wired and wireless local area networks ("LANs" and "WLANs"), wireless specialty networks ("WSNs"), wireless metropolitan area networks ("Wireless MANs"), and wireless regional area networks ("WRANs"). Technologies produced by implementers of our standards are a critical element for all networked applications today.

IEEE 802 LMSC is a committee of the IEEE Standards Association and of Technical Activities, two of the Major Organizational Units of the IEEE. IEEE has about 400,000 members in over 160 countries and its core purpose is to foster technological innovation and excellence for the benefit of humanity. IEEE is also a major accredited standards development organization whose standards are recognized worldwide. 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 whole[1].

Please find below the IEEE 802 LMSC's comments on this questionnaire. IEEE 802 LMSC provides standards for both WAS/RLAN (Wi-Fi) and UWB technologies. Our responses to Sections A and B address the separate questions for the respective technologies.

Respectfully submitted

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[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 or the IEEE Technical Activities.

Section A: WAS/RLAN

I) Explain the demand for MFCN or WAS/RLAN in the upper 6GHz band before and beyond 2030

Wi-Fi is the indoor wireless connectivity technology of choice for people in Europe. According to BNetzA[2] and Ofcom[3], the majority of internet use occurs over fixed networks primarily delivered through Wi-Fi. A recent survey also finds that the vast majority (93.9%) of the European Union's enterprises use fixed broadband connections to access the Internet via Wi-Fi[4].

The volume of Wi-Fi traffic is growing much faster than the volume of traffic carried over mobile networks. BNetzA reports that the increase in the volume of fixed traffic in 2023 was more than 4 times the increase in the volume of mobile traffic in the same year[5]. According to Arthur D Little[6], it forecasts that the growth in fixed data traffic (and therefore Wi-Fi traffic) in Europe between 2022 and 2030 is similar to past elevated levels, and the total volume of fixed data traffic is significantly more than that of the mobile data traffic over the same period of time. The estimated significant increase in the volume of fixed data traffic is supported by two recently released marketing reports from the FTTH Council Europe[7,8] that the number of FTTH/FTTB (Fiber-To-The-Home or Building) services is expected to increase from 121 million in 2023 to 201 million by 2029, and the number of homes equipped with FTTH/FTTB will be increased from 244 million in 2023 to 312 million in 2029 as telcos lay more fiber in the ground.

Currently available Wi-Fi 6/6E products based on the IEEE Std 802.11ax-2021 standard[9] and Wi-Fi 7 products based on the IEEE P802.11be project[10] are already capable of operating in the entire 6 GHz band. By enabling Wi-Fi operation in the upper 6 GHz band, a significant number of large bandwidth (i.e., 160 MHz and 320 MHz) channels will be available that in turn enable high traffic requirement applications like Extended Reality (XR). The upper 6 GHz band is also crucial for enabling deployments of wireless mesh networks in 6 GHz, since out-of-band channels are

[2] See Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen: Jahresbericht Telekommunikation 2023, 16 May 2024, https://data.bundesnetzagentur.de/Bundesnetzagentur/SharedDocs/Mediathek/Berichte/2023/240515_JB_TK_23_web.pdf [accessed: 9 August 2024]

[3] See Ofcom: Communications Market Report 2024, 18 July 2024, https://www.ofcom.org.uk/phones-and-broadband/service-quality/communications-market-2024/ [accessed: 9 August 2024] ("Seventy-one per cent of broadband connections were provided using fibre technologies at the end of 2023.")

[4] See eurostat: Fixed internet connection in 94% of EU enterprises, 25 January 2024, https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20240125-2 [accessed: 9 August 2024].

[5] See Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen: Press release of Jahresbericht Telekommunikation 2023, 16 May 2024, https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2024/20240516_JB_TK2023.html?nn=659670 [accessed: 9 August 2024] ("In 2023, a total data volume of around 132 billion GB was transmitted in fixed networks in Germany. This corresponds to an average data volume of around 287 GB per connection per month. Compared to 2022, the data volume transmitted in fixed networks in Germany increased by around 11 billion GB.") and ("According to surveys by the Federal Network Agency, the data volume transmitted via mobile networks in Germany in 2023 amounted to 9,118 million GB, compared to 6,714 million GB in 2022.")

[6] See: Arthur Little: The evolution of data grow in Europe, https://www.adlittle.com/en/insights/report/evolution-data-growth-europe [accessed 9 August 2024] ("We expect average fixed data consumption to grow from approximately 225 GB/month in 2022 to 900 GB/month per home by 2030, accounting for an overall annual growth rate of 20%, similar to past elevated levels.") and ("We expect Europe's mobile data consumption per user to continue growing in the coming years, increasing from the 2022 level of approximately 15 GB/month to 75 GB/month by 2030, creating an annual growth rate of 25%.")

[7] See FTTH Council Europe: European FTTH/B Market Panorama 2024, https://www.ftthcouncil.eu/committees/market-intelligence/2043/european-ftth-b-market-panorama-2024 [accessed: 9 August 2024].

[8] See FTTH Council Europe: FTTH Market Forecast 2023-2029, https://www.ftthcouncil.eu/committees/market-intelligence/2046/ftth-market-forecasts-2023-2029 [accessed: 9 August 2024].

[9] "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," in IEEE Std 802.11ax-2021 (Amendment to IEEE Std 802.11-2020), vol., no., pp.1-767, 19 May 2021, doi: 10.1109/IEEESTD.2021.9442429.

[10] See "IEEE 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: Enhancements for Extremely High Throughput (EHT)," in IEEE P802.11be/D6.0, May 2024, vol., no., pp.1-1075, 17 May 2024.

required to establish wireless backhaul links between infrastructure and Wi-Fi access points (in addition to existing wireless links between Wi-Fi access points and client devices).

Projections[11] forecasts that real-time locating services are expected to grow by almost 15% a year between 2021 and 2030, and there is an increasing importance of real-time location and sensing services with high (sub-meter) accuracy. By allocating the upper 6 GHz band for license-exempt operation, the above-mentioned large bandwidth channels enable Wi-Fi based location and sensing services with sub-meter positioning and sensing accuracy based on IEEE Std 802.11az-2023[12] and IEEE P802.11bk[13].

II.1) Provide information about the sustainability of the above explained demand, especially the environmental impact assessment

The European Union has been investing heavily in its full-fibre upgrades[14] to meet the above explained demand in 2030. It has been remarked in several studies produced by or for European institutions that networks using IEEE 802 wireless technologies, in combination with wired backhaul over long distances, are the current leaders in terms of energy efficient networks[15,16,17].

Wi-Fi provides a highly efficient way to deliver high-speed connectivity indoors. For example, Wi-Fi 6/6E specification built on IEEE Std 802.11ax-2021 standard introduces a new feature, namely broadcast Target Wake Time (TWT)[18], as an energy-efficient scheduling mechanism for transmissions between an AP and a wireless client. Wi-Fi 7 specification built on IEEE P802.11be project specifies multi-link operation (MLO), which defines an energy-efficient way for an AP to manage and coordinate traffic over several bands with a multi-link device (MLD)[19].

Delivering high-speed and responsive connectivity, Wi-Fi 6/6E and Wi-Fi 7 are well suited to delivering high-resolution video streams and XR services that can help people conduct meetings and interact with one another effectively without being physically present in the same location. These applications are typically indoor, where Wi-Fi is the technology of choice. In contrast, connecting an indoor device to an outdoor station uses an excessive amount of energy[20], resulting in more frequent recharge, increased battery wear, and hence electronic waste.

[11] See ABI Research: Indoor Positioning and RTLS: Technology Infrastructure, Applications, and Revenue, https://www.abiresearch.com/market-research/product/market-data/MD-RTLS/ [accessed: 9 August 2024]

[12] "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 4: Enhancements for Positioning," in IEEE Std 802.11az-2022 (Amendment to IEEE Std 802.11-2020 as amended by IEEE Std 802.11ax-2021, IEEE Std 802.11ay-2021, IEEE Std 802.11ba-2021, and IEEE Std 802.11-2020/Cor 1-2022) , vol., no., pp.1-248, 3 March 2023, doi: 10.1109/IEEESTD.2023.10058117.

[13] See IEEE P802.11bk, https://www.ieee802.org/11/Reports/tgbk_update.htm [accessed: 9 August 2024].

[14] See European Parliament briefing: A future-proof network for the EU: Full fibre and 5G, April 2024, https://www.europarl.europa.eu/RegData/etudes/BRIE/2024/762298/EPRS_BRI(2024)762298_EN.pdf [accessed 9 August 2024]

[15] WIK-Consult and Ramboll, Final Study Report for EU BEREC "External Sustainability Study on Environmental impact of electronic communications," BoR (22) 34, 15 March 2022.

[16] The digital environmental footprint in France: ADEME and Arcep submit their first report to the Government, 19 January 2022. Available online [accessed: 9 August 2024].

[17] Radio Spectrum Policy Group RSPG21-0041-final, RSPG Opinion on the role of radio spectrum policy to help combat climate change. Available online [accessed: 9 August 2024]

[18] Broadcast TWT has the advantage of allowing larger throughput while lowering latency since both devices are not only be aware of when transmissions will be made, but also enable energy efficiency since the devices can be idle or quiet when transmissions do not need to be made.

[19] If an MLD is capable of simultaneously sending traffic on links operating at 2.4 GHz, 5 GHz and 6 GHz bands, but the current load on the network is such that only one or two of these links are necessary to provide a robust service level, the other one or two links can be quieted and/or can be in power save mode dynamically. The links can be un-quieted once the load on the network increases, with the result that the radios consume only the amount of energy they need for a given traffic load.

[20] To provide indoor coverage from outdoor base stations, IMT has to compensate for the 23 dB building entry loss (see ITU-R P2109, 30/70 Thermal/Traditional, 50%). As a result, 200 times more power is required to cover indoors than outdoors.

Authorizing the entire 6 GHz band for license exempt operation makes it possible to allocate more channels for Wi-Fi operation, which reduces interference, improves performance, and further reduces overall power consumption.

II.2) Provide information about the sustainability of the above explained demand, especially the social economic assessment

Wi-Fi is a fundamental building block of both the digital economy and the digital services that are benefiting European citizens and fueling economic growth in Europe.

Wi-Fi contributes to gross domestic product (GDP) growth in Europe positively by providing low-cost broadband access and helping to bridge the digital divide by maximally utilizing the available backhaul connectivity. The economic value provided by Wi-Fi to the European Union reached USD $458 billion in 2021, and is expected to increase to USD $637 billion by 2025[21].

Significant global deployment of Wi-Fi devices, which are based on IEEE 802.11 standards, is evident from the data, that, by the end of 2024[22], 21.1 billion Wi-Fi devices will be in use and 576.2 million Wi-Fi CERTIFIED 6E devices will enter the market. The current widespread availability of Wi-Fi devices that can access and use the entire 6 GHz band means that most enterprises and industries in Europe will see immediate and sustained economic benefit from license-exempt access to the upper 6 GHz band.

Fibre broadband offering with speeds of up to 25 Gbps to residential customers is increasing in EMEA. Full capitalization of this huge investments is only possible by allowing European citizens to make use of the available speeds through multi-gigabit Wi-Fi services that can be supported only through expansion in the 6 GHz band.

III.1) Provide information about the possible role of the upper 6 GHz for MFCN or WAS/RLAN

Wi-Fi access to the upper 6 GHz band is critical to meeting the goals of the European Union's Gigabit Infrastructure Act[23] and the Digital Decade Policy Programme 2023[24].

According to Plum[25], the current spectrum for Wi-Fi access in Europe is not sufficient to support these goals. For example, the current allocation of five 160 MHz channels in the 5 GHz and lower 6 GHz bands can support gigabit coverage to only approximately 50-60% of residential building area. To ensure complete gigabit coverage, a minimum of ten channels is necessary thus necessitating operation of Wi-Fi technologies in the upper 6 GHz band.

[21] See Wi-Fi Alliance: Global economic value of Wi-Fi® 2021-2025, https://www.wi-fi.org/system/files/Global_Economic_Value_of_Wi-Fi_2021-2025_202109.pdf [accessed: 9 August 2024].

[22] See IDC: Worldwide Wi-Fi Technology Forecast, 2023-2027, https://www.idc.com/getdoc.jsp?containerId=US50019923 [accessed: 9 August 2024].

[23] See European Commission: Gigabit Infrastructure Act. ("Achieving the targets set out in Decision (EU) 2022/2481 requires that, by 2030, all end users at fixed locations be covered by a gigabit network up to the network termination point and all populated areas be covered by next-generation wireless high-speed networks with performance at least equivalent to that of 5G, in accordance with the principle of technological neutrality.")

[24] See paragraph 1.(2)(a) of Article 4 (Digital Targets), Decision (EU) 2022/2481 of the European Parliament and of the Council of 14 December 2022 establishing the Digital Decade Policy Programme 2030 (Text with EEA relevance), 19 December 2022. ("all end users at a fixed location are covered by a gigabit network up to the network termination point, and all populated areas are covered by next-generation wireless high-speed networks with performance at least equivalent to that of 5G, in accordance with the principle of technological neutrality").

[25] See Plum Consulting: Wi-Fi Spectrum requirements, 25 March 2024, https://plumconsulting.co.uk/wi-fi-spectrum-requirements/#:~:text=To%20ensure%20whole%2Dbuilding%20coverage,of%20Wi%2DFi%20in%20Europe [accessed: 9 August 2024]

III.2) Provide information about use cases, expected deployments (e.g. number of BS for MFCN) and timeframe

Authorizing the entire 6 GHz band for Wi-Fi is critical in fully enabling latency sensitive high throughput applications like real-time XR for health, education and gaming, robotics, and industrial automation and sensory. In particular, this is critical in enabling relevant applications in dense residential environments in addition to scaling of applications in enterprise and industrial deployments when multiple of these application sessions have to be supported simultaneously and in close proximity. With access to 320 MHz channels, Wi-Fi devices can build upon IEEE Std. 802.11az-2023 to offer sub-1 meter positioning accuracy, which results in new innovative use cases such as micro-targeting for retail and warehouse asset tracking.

The availability of a large number of channels at various channel widths (from 20 MHz to 320 MHz) is facilitating more modular and flexible deployments that allow scaled operation of services in the above mentioned target industries. Some examples[26] include multi-layer operation, service segmentation and prioritization, context-aware wireless networks, and hyper-aware access point deployments. Highly secure communication with WPA3 security[27], which is being now mandated for Wi-Fi devices operating in the 6 GHz band, further enhances these services and addresses new uses cases as well.

IV) Provide information about standardization and technology impact

In January 2024, Wi-Fi Alliance introduced[28] Wi-Fi CERTIFIED 7™ based on IEEE P802.11be technology. With the introduction of 320 MHz channel bandwidth, Wi-Fi 7 doubles throughputs relative to Wi-Fi 6E and significantly improves latency for XR through enablement of MLO over multiple bands, namely 2.4 GHz, 5 GHz, and 6 GHz bands. Wi-Fi 7 also provides higher efficiency, relative to Wi-Fi 6E, through offering of 4096 QAM. In addition, spectrum puncturing improves flexibility in utilizing spectrally efficient wide channel bandwidth, e.g., 160 MHz and 320 MHz, while protecting incumbent operation in the band.

With Wi-Fi 7 products already in the market, Wi-Fi deployments are going through another generation upgrade in the entire 6 GHz band globally[29]. It is believed that the majority of Wi-Fi 6E and Wi-Fi 7 devices already support the entire 1200 MHz bandwidth in the hardware, cost the same price, and use the same energy regardless of whether they operate on either 480 MHz or 1200 MHz in the 6 GHz band. By authorizing the upper 6 GHz band for licensed-exempt usage in Europe, Wi-Fi devices can have access to the entire 1200 MHz of spectrum and deliver more than 2.5 times capacity with higher spectrum efficiency than with 480 MHz allocation.

In November 2023, the IEEE 802.11 Working Group approved the creation of a new project, IEEE P802.11bn[30], to work on a major amendment, entitled "Enhancements for Ultra High Reliability" for next generation wireless LAN that applies to carrier frequency operation between 1 GHz and

[26] Selected examples of frequency-band-agnostic new services and architectures include smart automation facilities (https://community.hpe.com/t5/networking/hyper-aware-facilities-will-drive-the-future-of-smart-automation/ba-p/7219007) and hyper-aware smart buildings (https://www.arubanetworks.com/assets/wp/WP_Smart-Buildings.pdf) [accessed: 9 August 2024]

[27] See Wi-Fi Alliance: Discovery Wi-Fi Security, https://www.wi-fi.org/discover-wi-fi/security [accessed: 9 August 2024] ("WPA3 is a mandatory certification for Wi-Fi CERTIFIED™ devices.")

[28] See Wi-Fi Alliance: Wi-Fi Alliance® introduces Wi-Fi CERTIFIED 7™, https://www.wi-fi.org/news-events/newsroom/wi-fi-alliance-introduces-wi-fi-certified-7 [accessed: 9 August 2024].

[29] See Wi-Fi Alliance: Wi-Fi 7 market momentum: Wi-Fi 7 is here – is your network ready?, https://www.wi-fi.org/beacon/chris-hinsz/wi-fi-7-market-momentum-wi-fi-7-is-here-is-your-network-ready [accessed: 9 August 2024].

[30] See IEEE P802.11bn, https://www.ieee802.org/11/Reports/tgbn_update.htm [accessed: 9 August 2024].

7.250 GHz. Of note is that backward compatibility and coexistence with legacy IEEE 802.11 devices in the 2.4 GHz, 5 GHz and 6 GHz license-exempt bands will be ensured.

IEEE P802.11bn, which is also known as Wi-Fi 8, targets at increasing medium access control (MAC) throughput by 25%, improving latency by 25%, and reducing the MAC Protocol Data Unit (MPDU) loss by 25% relative to IEEE P802.11be. This project also aims to provide a mechanism to reduce power consumption for access points (APs) (including mobile APs) and improved peer-to-peer (P2P) operation compared to IEEE P802.11be operation.

Section B: Ultra wide band (UWB)

I.1) What are your current and future spectrum needs (before and beyond 2030) in the upper 6 GHz band?

IEEE 802 LMSC appreciates RSPG's recognition of UWB technology as a valuable incumbent service in the upper 6 GHz band. The upper 6 GHz band is included in the European UWB regulations' preferred spectrum for UWB.

UWB devices, as specified in IEEE 802.15 standards, are currently being widely used worldwide in the 6 GHz to 8.5 GHz range for various applications, including communication, measurement, location, imaging, surveillance, and medical systems[31], providing significant value and utility. These applications often operate in conjunction with other short-range device technologies, enhancing their operation and efficiently sharing spectrum.

The next generation of UWB technology, being developed under IEEE P802.15.4ab[32], will continue to require access to the upper 6 GHz band. This project builds on IEEE Std 802.15.4z-2020[33], which utilizes both the 6 GHz and 7 GHz frequency bands. Future developments supported by this project include:

- Improved link budget and reduced air-time
- Enhanced sensing capabilities for presence detection and environment mapping
- Improved accuracy, precision, and reliability for high-integrity ranging
- The use of interference mitigation techniques to support greater device density and higher traffic use cases
- Improved coexistence with other services
- Reduced complexity and power consumption
- Enhanced support for ultra-low power, low latency streaming
- Support for emerging applications such as high-definition audio

The use of UWB is experiencing rapid growth in both economic value and positive social impact. As UWB technology is still in the early, steep area of its growth curve, we anticipate continued expansion of spectrum needs in the upper 6 GHz band before and beyond 2030.

IEEE 802 LMSC emphasizes that UWB technology efficiently uses spectrum in a non-disruptive manner, playing a key role in addressing the increasing scarcity of mid-band spectrum. Its inherent "low impact" nature promotes effective sharing of spectrum for multiple uses and users simultaneously, which is crucial for maximizing the value of available spectrum. So long as new incompatible uses are not introduced into the bands, UWB does not need exclusive access to spectrum.

[31] See FiRa Consortium: Unleashing the Potential of UWB: Regulatory considerations, August 2022, https://www.firaconsortium.org/sites/default/files/2022-08/Unleashing-the-Potential-of-UWB-Regulatory-Considerations.pdf [accessed: 9 August 2024]. ("The introduction of IEEE 802.15 UWB-enabled devices in smartphones and laptops puts forecasts at more than 1 billion devices shipped annually worldwide by 2025.")

[32] See IEEE P802.15.4ab, https://www.ieee802.org/15/pub/TG4ab.html [accessed: 9 August 2024].

[33] "IEEE Standard for Low-Rate Wireless Networks--Amendment 1: Enhanced Ultra Wideband (UWB) Physical Layers (PHYs) and Associated Ranging Techniques," in IEEE Std 802.15.4z-2020 (Amendment to IEEE Std 802.15.4-2020), vol., no., pp.1-174, 25 Aug. 2020, doi: 10.1109/IEEESTD.2020.9179124.

I.2) What impact on your service do you expect from the introduction of MFCN and/or WAS/RLAN in the upper 6 GHz band?

The introduction of high-powered MFCN in the upper 6 GHz band is expected to have significant negative impacts on UWB services. UWB devices operate at extremely low power levels, making them highly susceptible to interference from higher-power systems.

UWB presents an extremely small interference footprint due to the extremely low transmit power used and non-continuous signal characteristics.

Impulse radio signals are comprised of pulse durations in the order of a nanosecond, typically transmitted in short bursts with gaps between pulses. UWB power limits are many orders of magnitude lower than more traditional wireless systems. This view illustrates the potential for a high-power service like MFCN to render the band unusable for other uses.

It has been demonstrated that UWB can coexist with Wi-Fi devices, based on IEEE 802.11 standards, effectively when transmit power is reasonable and sufficient separation in space is provided[34,35]. While the impact of Wi-Fi is significantly greater on UWB than the other way around, these references show that with reasonable mitigations sharing is possible. For example, reducing the Wi-Fi power to levels that are sufficient to maintain high throughput at link distances typical of many deployments significantly improved coexistence. Ongoing work in IEEE 802 is developing new techniques to improve coexistence performance both ways.

Wi-Fi devices, based on IEEE 802.11 standards, are widely available indoors, and on all mobile handsets. The use of Wi-Fi calling is an effective means to extend mobile coverage indoors. This is far more efficient use of spectrum than increasing mobile base station (or handset) power to overcome the outdoor-to-indoor losses. Wi-Fi power levels indoors can be much more compatible with UWB and other uses than increasing base station power to penetrate the building.

I.3) What measures could improve compatibility from your perspective?

To improve compatibility between UWB services and potential new services in the upper 6 GHz band, IEEE 802 LMSC suggest the following measures:

1. *Encourage "using only what you need" through regulatory incentives:* This can promote innovation that enables new users to share with existing users and improve the overall efficiency of spectrum use.
2. *Consider Power Limitations:* The use of moderately low power is a proven coexistence technique. Introduce new allocations and services with transmit power limits that are compatible with existing license-exempt uses such as UWB.
3. *Consider Time Domain Gaps:* For high-powered transmissions, especially in wide-area systems like MFCN, implement duty cycle restrictions to provide silent periods during which UWB can slot its transmissions. This can mitigate the blinding effect of high-powered signals on UWB receivers.

[34] See: F. Nabki, *et al.*, "SSBD enabled UWB radio coexistence with Wi-Fi 6e demo," IEEE 802.15 submission, 15 November 2022, https://mentor.ieee.org/802.15/dcn/22/15-22-0642-02-04ab-ssbd-enabled-uwb-radio-coexistence-with-wi-fi-6e-demo.pptx [accessed: 9 August 2024].

[35] See UWB alliance: Ultra-Wideband (UWB) Aggregation and Co-existence of Wi-Fi 6E Operating in the Presence of UWB, 16 May, 2023, https://uwballiance.org/wp-content/uploads/2023/05/UWBA-Interference-Testing-Report-April-2023-corrected-final.pdf [accessed: 9 August 2024].

By implementing these measures, it may be possible to introduce new services in the upper 6 GHz band while maintaining the valuable functionality and growth potential of UWB technology.