IEEE 802 LMSC is a leading consensus-based standards developing organization, 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 both standards for wired Ethernet networks and standards for Time Sensitive Networks ("TSNs"), and technologies produced by implementers of our standards are critical for all networked applications today.

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IEEE 802 LMSC welcomes Ofcom's initiative to explore the possibility of hybrid sharing and appreciates the opportunity to provide feedback to the initiative in this consultation.

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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.

Your response

Question	Your response
Question 1: Hybrid sharing could mean that the upper 6 GHz band will be used for mobile outdoors and Wi-Fi indoors. What are your views on the priorities for each of these two services, assuming that suitable coexistence mechanisms are developed?	*Is this response confidential? – N* IEEE 802 LMSC welcomes Ofcom's initiative to explore the possibility of hybrid sharing. Having said that and as it is stated in our responses to previous consultations ("Enabling spectrum sharing in the upper 6 GHz band" in April 2022[2] and "UK preparations for the World Radiocommunication Conference 2023 (WRC-23)" in October 2022[3]), we believe that the best choice for upper 6 GHz band for UK is to be authorized for license-exempt to support the increasing the demands from existing Wi-Fi applications and new innovative use-cases supported by Wi-Fi in UK. While the demand for Wi-Fi connectivity, which is based on the IEEE 802.11 standard, continues to grow, and the number of emerging applications continue to expand, IEEE 802 LMSC respectfully asks the Ofcom to reconsider the proposed hybrid sharing proposal. Of note, the IEEE Std 802.11ax-2021[4] standard supports operation in the upper 6 GHz band (6425 MHz to 7125 MHz), and products based on this standard are seeing significant adoption where regulatory rules permit deployment.[5] The significance of unlocking the upper 6 GHz band for Wi-Fi radio access networks cannot be overstated, as access to larger, contiguous bandwidths in the entire 6 GHz band (5925 MHz to 7125 MHz) reduces the potential for harmful

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[2] IEEE 802 LMSC submission, April 2022. Available online [accessed: 21 September 2023]

[3] IEEE 802 LMSC submission, October 2022. Available online [accessed: 21 September 2023]

[4] "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), pp.1-767, 19 May 2021, doi: 10.1109/IEEESTD.2021.9442429.

[5] Wi-Fi Alliance: Wi-Fi 6E momentum underscores need for entire 6 GHz band, November 2022. Available online [accessed: 21 September 2023].

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interference[6] and allows for IEEE 802.11 technologies to more effectively support emerging delay-sensitive residential, enterprise, and industrial applications. A new generation of IEEE 802.11 technologies, currently under development in the IEEE P802.11be amendment, will continue to enhance coexistence strategies and provide even more effective spectrum sharing and sustainable utilization in these bands.

Considering 320 MHz channel bandwidth size as one of the key features in the IEEE P802.11be amendment, IEEE 802 LMSC would like to use this opportunity and highlight the importance of availability of multiple 320 MHz channels to support scaling of IEEE 802.11be based deployments in environments with multiple simultaneous sessions of high throughput low latency applications such as AR/VR in education or health industries.[7,8] This highlights importance of the opening of 6425 MHz to 7125 MHz for not only the low power indoor (LPI) mode of operation, but also both the standard power (SP) and the very low power (VLP) modes of operation.

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[6] CEPT: Section 6.2.6, ECC Report 302 - Sharing and compatibility studies related to Wireless Access Systems including Radio Local Area Networks (WAS/RLAN) in the frequency band 5925-6425 MHz, May 2019. Available online [accessed: 21 September 2023].

[7] D. Akhmetov, R. Arefi, H. Yaghoobi, C. Cordeiro and D. Cavalcanti, "6 GHz Spectrum Needs for Wi-Fi 7," in IEEE Communications Standards Magazine, vol. 6, no. 1, pp. 5-7, March 2022, doi: 10.1109/MCOMSTD.2022.9762843.

[8] M. Mehrnoush, C. Hu and C. Aldana, "AR/VR Spectrum Requirement for Wi-Fi 6E and Beyond," in IEEE Access, vol. 10, pp. 133016-133026, 2022, doi: 10.1109/ACCESS.2022.3231229.

Question 2(a): Hybrid sharing could mean that the upper 6 GHz ban will be used for mobile in some locations, and Wi-Fi in others. We would like feedback on the priorities for each of these two services, assuming that suitable coexistence mechanisms are developed. From the point of view of mobile, is the upper 6 GHz band most useful to provide outdoor coverage, or indoor coverage? Is it most useful in urban areas, or in those base stations that are currently carrying more traffic, or some other split?	*Is this response confidential? – N* *The notion of location based prioritization may not be the most effective method for sharing since the most plausible scenario where cellular usage would be prioritized in a geographic area will be in dense urban environments, where the likely need for additional spectrum for indoor RLAN use will be most critical as well.*
Question 2(b): Similarly, what are the priorities from the point of view of Wi-Fi deployments?	*Is this response confidential? – N* Since individuals may spend most of their time indoor[9], the majority of Wi-Fi activities and traffics are also indoor. The Wi-Fi operation in the indoor environment is supported by using the LPI mode of operation and, in some regions, with the SP mode of operation. Having said that, we should not underestimate the importance of the VLP mode of operation for both indoor as well as outdoor usages. In contrast, as we understand, mobile cellular deployments are typically targeting outdoor mobile use cases and deployments. Consideration of any hybrid sharing should protect Wi-Fi's indoor and VLP deployment scenarios.
Question 3: What are your views on a modified AFC or SAS-type approach to enable hybrid sharing? What additional work do you think would be required?	*Is this response confidential? – N* Regarding the AFC system and its sharing compliance mechanism, the design is based on a basic assumption that incumbent receivers are sporadic and their antennas are installed outdoor with fixed, very directional transmit/receive radiation patterns.[10] In the consultation, Ofcom provided two examples where priority/protection areas for mobile and Wi-Fi were considered. Considering the case that an AFC-like database is to protect licensed

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[9] United States Environmental Protection Agency: Report on the environment. Available online [accessed: 21 September 2023].

[10] Intel: Spectrum Sharing Using Automated Frequency Coordination. Available online [accessed: 21 September 2023]

	mobile, mobile cellular network coverage is designed to support users that are mobile in nature and the receivers are mobile, their antennas are present both outdoor and indoor with mostly non-directional radiation patterns. As in the case of implementation of Wi-Fi database to protect/prioritize Wi-Fi, Wi-Fi receivers are typically fixed or portable and their antennas are present both outdoor and indoor with mostly non-directional radiation patterns. In either case, there are significant differences with respect to protecting Fixed Services, which is the target of today's AFC systems. As a result, to deal with the differences, any consideration of an AFC-based approach on Wi-Fi or licensed mobile will involve a redesign of AFC system that is also involved with reconfiguring interference protection criteria. The redesign may require a trade-off between performance and complexity of the AFC system. In addition, with such an AFC based approach to protect license mobile, we believe that there will be a significant negative impact on Wi-Fi performance.
	Lastly, when considering the use of any AFC like database implementation to enable device-to-deice communication (covered in Question 5), IEEE 802 LMSC encourages the Ofcom to factor in a scenario that device-to-device communication may use any channels that may not necessarily be the ones used by the access points.
Question 4: How could existing access protocols and sensing mechanisms be leveraged (i.e., those in Wi-Fi or 5G NR-U) to enable hybrid sharing?	*Is this response confidential? – N* *No comment*
Question 5: What mechanisms could potentially enable device-to-device connectivity?	*Is this response confidential? – N* Device-to-Device communication (also known as peer-to-peer communication) is supported in significant portion of IEEE 802.11 based technologies. There are an increasing use of device-to-device communication in various innovative applications and use cases for both indoor and outdoor deployments, such as indoor immersive VR, UHD video streaming, file sharing, multicasting, mixed reality, high speed tethering, and in-vehicle entertainment/infotainment.

	Many of these use cases are operated at low power and can be easily impacted by interference from high power cellular operation in a shared environment.
Question 6: If hybrid sharing is eventually adopted, and requires licensed mobile to operate at medium power, in what way would mobile networks use the upper 6 GHz band?	*Is this response confidential? – N* *No comment*
Question 7: How would you suggest that the mechanisms presented here can be used, enhanced, or combined to enable hybrid sharing or are there any other mechanisms that would be suitable that we have not addressed?	*Is this response confidential? – N* *No comment*
Question 8(a): Assuming the future of the band includes indoor use for Wi-Fi and outdoors use for mobile: How could this be achieved without creating or suffering interference?	*Is this response confidential? – N* *No comment*
Question 8(b): Could there be a combination of technical adjustments such as power limits and other mechanisms (including databases or sensing mechanisms)?	*Is this response confidential? – N* *No comment*
Question 9(a): We are interested in input about the importance of the upper 6 GHz band for its incumbent users, and on the potential impact of hybrid sharing of the band. What evidence do you have on whether incumbents are likely to coexist with hybrid sharing of the band with mobile and Wi-Fi? Are there unique advantages of the upper 6 GHz band for these uses?	*Is this response confidential? – N* *No comment*
Question 9(b): What are your views on the initial analysis we have conducted around hybrid sharing and coexistence with incumbents?	*Is this response confidential? – N* *No comment*
Question 9(c): For any incumbent uses that you view as unlikely to be able to coexist, what alternatives are there? What are the barriers that might prevent those alternatives?	*Is this response confidential? –N* As there are similar incumbent scenarios in the lower and upper 6 GHz bands, IEEE 802 LMSC believes that sharing studies between Wi-Fi and fixed and satellite incumbent services should show similar positive sharing results for both the

	upper 6 GHz band and the lower 6 GHz band. Similar studies conducted in other countries and regions including the United States of America[11] demonstrated positive sharing results between Wi-Fi and incumbent services in the entire 6 GHz band. These positive sharing results were the basis for the adoption of the entire 6 GHz band for licence-exempt operation. Regarding the sharing of mobile system with incumbent services in an outdoor environment, any power level above 14 dBm, based on the ECC Report 302[12], requires additional studies and/or require special frequency coordination.
Question 10: Do you have any other thoughts that you would like to share about hybrid sharing in the upper 6 GHz band, or about hybrid sharing more generally and its potential for applications in other bands?	*Is this response confidential? – N* *No comment*
Question 11: Do you have any other comments to make on these proposals or on the future use of the upper 6 GHz band?	*Is this response confidential? – N* Considering the market demand and maturity of IEEE 802.11 based technologies as well as the related product capabilities in supporting the entire 6 GHz band,[13] IEEE 802 LMSC proposes that Ofcom proceed with opening up the upper 6 GHz band for license-exempt operation with both the LPI and VLP modes of operation, and continue exploring opportunities for mobile operation outdoor. IEEE 802 LMSC recommends Ofcom to initiate enabling of the SP mode of operation in both the indoor and outdoor environments under the supervision of an AFC system for the lower 6 GHz band. Experience gathered from such deployment and operation of the system will be very valuable to Ofcom for the upper 6 GHz band and other candidate bands.

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[11] United States Federal Communications Commission: Report and Order and Further Notice of Proposed Rulemaking (ET Docket No. 18-295; GN Docket No. 17-183), April 2020.

[12] CEPT: Section 6.2.6, ECC Report 302 - Sharing and compatibility studies related to Wireless Access Systems including Radio Local Area Networks (WAS/RLAN) in the frequency band 5925-6425 MHz, May 2019. Available online [accessed: 21 September 2023].

[13] Wi-Fi Alliance: Wi-Fi 6E momentum underscores need for entire 6 GHz band, November 2022. Available online, [accessed: 21 September 2023].

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