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* In our view, Wi-Fi indoors should clearly have priority over mobile outdoors, for a number of reasons which we detail below: 1. Most wireless traffic growth will happen indoors. Studies of human living and working patterns show that people are spending more than 90% of the day indoors[i], and approximately 90% of professional activities are conducted indoors, as well[ii]. Consequently, future very high-bit rate applications such as high-definition video consumption, AR/VR, holographic communications, etc. will predominantly be used indoors. In the UK, like in most other European countries, fixed networks carry more than 90% of data traffic[iii]. More than 90% of that fixed network traffic is transferred over Wi-Fi[iv]. According to Ericsson, 70-80% of mobile use is indoors**Error! Bookmark not defined.**, and according to Huawei, 80% of mobile traffic goes over Wi-Fi[v]. With more than 18 billion Wi-Fi devices deployed globally, Wi-Fi is now ubiquitous. Virtually every household with a broadband connection, be it fixed or via FWA, uses Wi-Fi to provide wireless broadband connectivity indoors. All laptop PCs and tablet computers, almost all smartphones and desktop PCs, most TV sets from mid-range models upwards, and thousands of other device types feature Wi-Fi connectivity. Wi-Fi constitutes the critical link between the Internet and the user. 2. The future gigabit society will need gigabit Wi-Fi This link is of particular importance when it comes to extending the gigabit speeds that fibre will make available to users. For the UK,

	the target is to make gigabit-broadband available nationwide, i.e., to at least 99%" of premises by 2030[vi]. Already now, 10 Gigabits/s home broadband is available from internet service providers in the UK. With Wi-Fi 6E and Wi-Fi 7, the technology exists to make gigabit wireless broadband connectivity available to indoor users, provided an adequate amount of spectrum, i.e., the full 6 GHz band, will be available for Wi-Fi. A large and varied ecosystem has already been established; to date, more than 2000 Wi-Fi 6E devices have been certified and consumer-grade Wi-Fi 7 routers with integrated 10 Gbps optical interface are entering the market[vii]. 3. Enterprises depend on Wi-Fi The large number of non-overlapping channels and the diversity of channel widths from 20 MHz to 320 MHz that can be realized in the full 6 GHz band are of particular importance for enterprise networks. Typical enterprise deployments require a minimum of 7 non-overlapping channels to provide optimum user experience, in very high-density deployments a minimum of 13 non-overlapping channels is needed. In countries that have authorized Wi-Fi to use the full 6 GHz band, HPE 6 GHz Wi-Fi APs are operating in a large number of high-density deployments in universities, large public venues, and other locations. High-profile examples include the University of Michigan and the Chase Center in San Francisco which would not have been able to achieve their performance objectives with only 500 MHz of available spectrum. 4. No compelling arguments have been presented that would justify the demand for additional IMT spectrum. HPE is of the opinion that the upper 6 GHz band will not be needed to provide additional capacity for IMT 5G, for the following reasons: a) A total of 20 GHz of spectrum, of which approximately 1.9 GHz are in the low- and mid-bands has been identified for IMT use in ITU Region

	1 (EMEA). In many countries, only some of the identified bands have been assigned to IMT. Many of the assigned bands are under-utilized, especially in the mmWave bands[viii]. b) Despite a relatively good coverage in Europe of 73%, 5G take up stands at a mere 7%, as reported by ETNO[ix]. c) Mobile traffic growth rates have been dropping drastically, indicating that saturation is setting in. d) There is a lack of compelling use cases for outdoor IMT 5G. Currently, the primary use case for outdoor IMT is fixed wireless access (FWA). Network operators promote FWA as a solution for covering areas that have no or poor fixed broadband infrastructure (e.g., for DSL replacement). However, FWA is better served through mmWave technology[Error! Bookmark not defined.] which can provide considerably higher speeds than 6 GHz IMT. e) If at all, mobile capacity shortages occur in very small areas and only during very short periods. These small areas could be covered by either mmWave mobile technology in combination with existing IMT mid-band networks, as recommended by the GSMA[x], through densification and upgrading of existing 4G infrastructure to 5G, or by outdoor Wi-Fi hotspots. There is high growth potential for 5G for 'verticals' in local/private networks for which the 3.8-4.2 GHz band is likely to be made available throughout Europe.
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.	*Is this response confidential? N* For the first part of this question (priorities) please see our above response to Question 1. As a leading supplier of enterprise networks, HPE provides its customers with both Wi-Fi and IMT 5G connectivity solutions, depending on

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?	which solution suits our customer's needs best. We believe that the biggest potential for 5G growth is in the 'verticals' segment, in the form of local private networks operating with medium and low transmit power in the 3.8-4.2 GHz band. This band is much better suited for providing coverage and mobility than the upper 6 GHz band. These highly reusable 400 MHz of spectrum should provide more than sufficient capacity for realizing those enterprise use cases that cannot be fully addressed by Wi-Fi. 70-80% of mobile use is indoors[xi]. Depending on the environment, outdoor to indoor propagation losses can be considerably higher in the 6 GHz band than in lower frequency bands such as the 3.5 GHz band. From this perspective, the 6 GHz band would be more useful for outdoor coverage. Outdoor mobile traffic, however, constitutes only a tiny fraction of overall data traffic. In summary, an allocation of the upper 6 GHz band to IMT would result in a highly ineffective use of spectrum. A hybrid sharing solution should take into account the traffic distribution accordingly.
Question 2(b): Similarly, what are the priorities from the point of view of Wi-Fi deployments?	*Is this response confidential? – Y / N (delete as appropriate)* Wi-Fi is ubiquitous and used by consumers and enterprises alike, with the enterprise segment comprising public institutions such as schools, universities, libraries, and government facilities, hospitality, large public venues, logistics, industrial/manufacturing, and many more. If IMT and Wi-Fi were to share a band, it would have to be guaranteed that the performance of Wi-Fi would not suffer from the presence of IMT. This is particularly important in enterprise environments which rely on the high quality of service (e.g., high data rates, low latency, high availability) provided by Wi-Fi 6E and Wi-Fi 7. Dense enterprise deployments typically require a minimum of seven non-overlapping channels. Very high-density deployments, such as universities and large public venues need a minimum of thirteen non-overlapping channels. The upper 6 GHz band adds two 320 MHz

	channels, or four 160 MHz channels, eight 80 MHz channels, or seventeen 40 MHz channels. Experience has shown that moving to wider channels widths in high-density environments increases overall throughput and reduces network load. The requirements of high-profile deployments of HPE Wi-Fi 6E networks at the University of Michigan with more than 17.000 Wi-Fi 6E APs and the Chase Center in San Francisco could not have been fulfilled with only 500 MHz of spectrum. If 6 GHz IMT was allowed to operate without restrictions in an area, an enterprise wishing to deploy full-band 6 GHz Wi-Fi in the same area would not be able to do so because of the unpredictable effects of IMT interference on Wi-Fi QoS, unless stable and reliable operating conditions for Wi-Fi could be guaranteed. Critical cases for enterprise Wi-Fi (exemplary): 1. If an enterprise Wi-Fi network, for instance of a university or a hospital was designed to use the full 6 GHz band and a 6 GHz IMT BS were to be set up nearby, it would have to be ensured that no harmful interference from IMT to Wi-Fi would be generated, i.e., that the Wi-Fi network's QoS requirements would still be fulfilled. If a 6 GHz BS had been authorized to operate in a certain area, it would have to be ensured that an enterprise, for instance a manufacturing site, would still have the possibility to deploy a 6 GHz Wi-Fi network that uses the full 1200 MHz band and fulfils the network's QoS requirements.
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? – Y / N (delete as appropriate)* AFC is an excellent method for enabling outdoor use of standard power (SP) Wi-Fi systems in the 6 GHz band. Canada and the United States recently announced the authorization of an AFC operator and the commencement of AFC trials, resp. Other countries such as Brazil and Saudi Arabia stated their intention to deploy indoor and outdoor SP Wi-Fi in combination with AFC.

	As Wi-Fi networks are ubiquitous, it does not seem feasible to establish a database of Wi-Fi APs and devices that IMT networks could query to identify available frequencies. We understand that the use case for 6 GHz IMT considered by Ofcom would be to provide additional capacity in a small number of urban areas and only during certain times. Consequently, a database of 6 GHz IMT base stations would contain only very few entries, but all 6 GHz Wi-Fi APs would have to query that database to identify available channels. Implementation of this query function and the database itself would require significant and in our view disproportionate effort which would result in higher product costs for the users. A possible consequence of such an approach would be that, because of a lack of scale, licence-exempt devices would not use the upper 6 GHz band in the UK. These considerations apply to both consumer and enterprise Wi-Fi networks. Enterprise Wi-Fi networks are used by SMEs, large enterprises, public institutions, schools and universities, and other entities, with the number of deployed APs ranging from a few to tens of thousands.
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? – Y / N (delete as appropriate)* As presented by members of the IMT industry during the recent ECC PT1#76 meeting in Copenhagen, their objective is to deploy 6 GHz IMT nationwide, in urban and rural areas, outdoors and indoors. In our view, the need for IMT spectrum in the upper 6 GHz band to provide more capacity for outdoor users is non-existent, as explained in our response to Question 1 of this document. If MNOs needed extra capacity for serving indoor users, they could deploy 5G NR-U in the 6 GHz band. ETSI TC BRAN has spent years developing Harmonized Standard EN 303 687 which ensures both 5G NR-U and Wi-Fi can use the 6 GHz band. Wi-Fi has been designed to share spectrum with other systems. For this purpose, two channel access mechanisms were defined which are based on Energy Detection (ED) and

	Preamble Detection (PD). While a Wi-Fi device uses PD to detect the presence of other Wi-Fi networks, ED is intended to determine whether energy is present in a channel Wi-Fi may want to access. If this energy exceeds a certain threshold, Wi-Fi will not use that channel. Initial studies have shown that signals of IMT outdoor macro base stations will in many cases exceed the ED threshold of LPI Wi-Fi devices which will make Wi-Fi devices vacate the affected channel and result in significant loss of Wi-Fi performance. As it will not be possible to prevent 5G UEs from being used indoors, they would also interfere with indoor RLAN operation. LPI Wi-Fi, in contrast, is much less likely to interfere with outdoor IMT BS and UE because of its low transmit power which will be further reduced by wall attenuation. In the case of an IMT UE operating indoors, interference from Wi-Fi would be very limited because the Wi-Fi AP would detect the UE transmit signal and vacate the channel. There may be "hidden node" cases where the AP cannot detect the IMT UE signal which could result in mutual interference between IMT and Wi-Fi. In summary, the existing RLAN access protocols and sensing mechanisms are not sufficient for protecting RLAN. Relying just on these protocols would greatly disadvantage RLAN compared to IMT.
Question 5: What mechanisms could potentially enable device-to-device connectivity?	*Is this response confidential? – Y / N (delete as appropriate)* HPE is not in a position to respond to this question.
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? – Y / N (delete as appropriate)* HPE is not in a position to respond to this question.
Question 7: How would you suggest that the	*Is this response confidential? – Y / N (delete as*

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?	*appropriate)* To improve protection of indoor Wi-Fi, modifications to the 3GPP architecture, such as an enhanced channel access mechanism / polite protocol would have to be implemented. Example: A UE detecting the presence of 6 GHz Wi-Fi will inform the base station that the occupied 6 GHz channels must not be used. It can be expected that all smartphones supporting 6 GHz IMT would also support 6 GHz Wi-Fi. Hence, detecting 6 GHz Wi-fi signals should not require any significant modifications of the UE hardware. However, this capability alone may not be sufficient, because a 5G BS constantly transmits pilot signals at maximum power which are likely to interfere with Wi-Fi operation even if no connection with an IMT UE is established. Modifying the Wi-Fi ED threshold (EDT), as suggested by some parties, can be ruled out as an option, at least in the short- and medium term. The current EDTs specified in ETSI EN 303 687 v1.1.1 are carefully crafted compromises resulting from year-long negotiations in IEEE and ETSI. Modifying the EDTs will have negative effects not only on the coexistence of Wi-Fi with other systems but also on the coexistence between different Wi-Fi systems, particularly in dense deployments. In countries that have already opened the full 6 GHz band for Wi-Fi, there is a large number of 6 GHz Wi-Fi devices in operation. Modifying the EDT would take several years of studies and negotiations and eventually result in incompatibilities between the large installed base of 'legacy' 6 GHz Wi-Fi devices and new devices entering the market. Another issue to be solved is that of Wi-Fi channels extending into both the lower and the upper 6 GHz band for which two different EDTs would apply.
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? – Y / N (delete as appropriate)* One conceivable method would be to reduce the transmit power of outdoor IMT BS to a level that would not negatively affect Wi-Fi indoor operation. In addition, a suitable mechanism

	would have to be developed to prevent IMT UE indoor use in the presence of 6 GHz Wi-Fi. In the case of enterprise Wi-Fi deployments with specific QoS requirements, sufficiently large exclusion zones would have to be defined for IMT. At the same time, the freedom for enterprises to choose a broadband wireless networking technology that suits their needs must be preserved.
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? – Y / N (delete as appropriate)* As stated in our responses to questions 3, 7, and 8a we believe that a reduction of outdoor IMT BS transmit power could be one element of a solution, but it would have to be complemented by a mechanism to prevent indoor operation of IMT UE. A database containing the location and other parameters of outdoor IMT base stations could, in principle, enable LPI Wi-Fi to avoid channels used by IMT. Considering the implementation effort and associated increase in Wi-Fi product cost, and the proprietary nature of such a database, we believe that this would not be a feasible solution. Furthermore, a database solution would not be able to secure enterprises' freedom of choice of a wireless broadband networking technology that fulfils their QoS requirements. In our view, a modification of the Wi-Fi EDT is not a feasible solution, at least not in the short and medium term.
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? – Y / N (delete as appropriate)* Studies conducted in Europe (by ECC SE45 and several national administrations including Ofcom) and the US have shown that LPI and VLP Wi-Fi can share the 6 GHz band with incumbent services. Various studies conducted by ITU-R WP5D and ECC PT1 have shown that outdoor high-power IMT, i.e., the typical macro base station type deployment, is likely to cause interference to all incumbent services and that separation distances of several hundred

	kilometers between IMT BS and terrestrial incumbents may be required[xii],. In the case of hybrid sharing of the upper[xiii] 6 GHz band by IMT and Wi-Fi, LPI Wi-Fi would still be able to co-exist with incumbents. However, the additional amount of RF noise generated by outdoor high-power IMT macro BS and UEs is very likely to cause harmful interference to incumbents.
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? – Y / N (delete as appropriate)* HPE concurs with the conclusions of the Ofcom study that, without additional measures, interference to both Wi-Fi and IMT is likely, at least in some locations and at some times, and that additional interference management mechanisms and mitigation techniques would be necessary to manage the sharing of the upper 6 GHz band. The 'preamble puncturing' feature of Wi-Fi 7 is intended to notch out relatively narrow bands occupied by interferers or potential victims. It will not be effective in case of IMT interferers operating on channels of 100 MHz width, as envisaged by the IMT industry. HPE understands that these measurements were a first step in the assessment process, and we very much appreciate the effort Ofcom is taking to contribute much-needed hard evidence to the studies. In this context we would like to note that IMT out-of-band emissions (OOBE) and their effect on Wi-Fi operating in adjacent channels within the 6425-7125 MHz band should also be considered. As studies conducted by the European Commission's Joint Research Center (JRC) on the effects of LTE OOBE on PMSE[xiv] have shown, the waveform can have a considerable impact on victim performance. 3GPP Test Model (TM) 1.1 waveform may not be the most critical waveform in terms of OOBE, hence, we invite Ofcom to carefully consider this aspect. Commission Implementing Decision (EU) 2021/1067 of 17 June 2021on the harmonised use of radio spectrum in the 5 945-6 425MHz

	frequency band for the implementation of wireless access systems including radio local area networks (WAS/RLANs) states in Article 3: *When introducing new applications into the 5 945-6 425MHz frequency band or into adjacent frequency bands after the entry into force of this Decision, Member States shall not adopt technical and operational conditions applicable to any new application that unduly restrict the continued use of WAS/RLAN in the 5 945-6 425MHz frequency band in accordance with this Decision*. While this EC Decision may not be legally relevant for the United Kingdom, we are of the opinion that the provision of Article 3 is reasonable and essential for ensuring the future operation of Wi-Fi and should be applied by all jurisdictions.
Question 9C: 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? – Y / N (delete as appropriate)* Studies have shown that fixed links (FS), fixed satellite service (FSS), and radio astronomy services (RAS) will not be able to coexist with IMT. These services would have to be migrated to other bands. Because of governmental and other critical usage, some European countries may not be able or willing to migrate their fixed links. We understand that migration of fixed links to other bands may take several years to accomplish.
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? – Y / N (delete as appropriate)* Considering that introducing IMT in the upper 6 GHz band would require relocating incumbent services to other bands, that spectrum would probably be used more efficiently if Wi-Fi and incumbents were sharing the band than if Wi-Fi and IMT were sharing it. HPE supports the concept of hybrid sharing, and we believe that studies should be undertaken to determine how in the future IMT could be enabled to share spectrum with other services. However, we are of the opinion that hybrid sharing should be applied if a real need exists.

	To date, no compelling arguments, let alone evidence, have been presented by the IMT industry that would justify making spectrum in the upper 6 GHz band available for IMT. Hence, we would suggest Ofcom takes a 2-step approach to implement sharing in the upper 6 GHz band: Step 1: Authorize licence-exempt/Wi-Fi use of the 6425-7125 MHz band under the conditions defined for the 5925-6425 MHz band. Timeframe: End of 2024 Step 2: Develop methods for IMT to coexist with licence-exempt/Wi-Fi systems, to be applied in case a need for additional IMT spectrum should arise. Timeframe: 2030
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? – Y / N (delete as appropriate)* We understand that the use case for 6 GHz IMT is to provide additional capacity in a small proportion of urban areas and only during short periods of time. Considering the large amount of spectrum that has already been identified for IMT in Region 1 (1886 MHz in mid-band, and close to 20 GHz overall), the low assignment rate for these identified bands, and the low utilization rate of the bands assigned to 5G[xv], only few countries may wish to make the upper 6 GHz band available for IMT. Nevertheless, to use the 6 GHz band, a large proportion of IMT UEs, predominantly mobile phones, would have to support the 6 GHz band. It is highly questionable whether major mobile phone manufacturers outside of China, which is the only major country that has publicly stated its intention to make the upper 6 GHz band available for IMT, would produce 6 GHz phones for a presumably small market. It should also be considered that alternatives to the upper 6 GHz band exist for IMT to address the envisaged use cases. An analysis by the GSMA[Error! Bookmark not defined.] found that in dense urban environments, deploying mmWave in a 3.5GHz 5G network can lower total cost of ownership (TCO) by up to 35%. In suburban and

	rural fixed wireless access (FWA) deployments, 5G mmWave can provide a TCO reduction of up to 34%. When deployed indoors, a 5G mmWave network could generate cost savings of up to 54%. 5G phones supporting mmWave bands are available on the market today. We believe that when assessing the need for sharing spectrum, the nature of usage should also be considered. Wi-Fi, be it in home or enterprise networks, is largely used with productivity applications but, of course, also for entertainment purposes. In contrast, mobile broadband on smartphones is primarily used for Internet search/web browsing, phone calls, listening to music, using social media apps, and sharing/sending photos and videos[xvi]. In our view, it is highly questionable whether making additional large amounts of exclusive-use mid-band spectrum available for these uses would be justified. The 5925-7125 MHz band is a band for which a flourishing Wi-Fi ecosystem exists which comprises more than 2000 certified devices of which several hundred million units have already been shipped to customers in all three ITU regions. This high-potential band should be made available in full for licence-exempt use as soon as possible to provide the capacity necessary to fully exploit the performance of the fast-growing fibre network.

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[i] The National Human Activity Pattern Survey (NHAPS); Journal of Exposure Analysis and Environmental Epidemiology, 2001 May-June; 11(3): 231–252.

[ii] Occupations by Proximity and Indoor/Outdoor Work; American Journal of Preventive Medicine; 2021; 60(5); p. 621−628.
[iii] Source: Ofcom Communications Reports
[iv] Wi-Fi Alliance - Wi-Fi 6E Insights, Issue 6, July 2022
[v] https://support.huawei.com/enterprise/en/doc/EDOC1100102755
[vi] https://researchbriefings.files.parliament.uk/documents/CBP-8392/CBP-8392.pdf
[vii] Example: The AVM Fritz!Box 5690 family of Wi-Fi routers
[viii] Plum Consulting - Examining the current assignment and usage of mobile spectrum, July 2023
[ix] ETNO - Review of 5G Progress to date, Presentation at the CEPT 6G Workshop, 29 June 2023
[x] GSMA -: 5G mmWave Coverage Extension Solutions Whitepaper, December 2022
[xi] https://www.ericsson.com/en/reports-and-papers/mobility-report/articles/indoor-outdoor
[xii] https://www.cept.org/Documents/ecc-pt1/74888/ecc-pt1-23-026_craf-skao-ai-12-related-studies-imt-vs-ras
[xiii] https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R19-WP5D-C-1198
[xiv] https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=4520
[xv] Plum report
[xvi] https://www.qualcomm.com/news/onq/2023/04/top-10-smartphone-uses-new-consumer-report-reveals-why-were-at-the-point-of-no-return