Ofcom

Hybrid Sharing: enabling both licensed mobile and Wi-Fi users to access the upper 6 GHz band

Summary of responses and next steps

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1. Overview and next steps

Introduction

1.1 In July of this year, we published a consultation on enabling both licensed mobile and Wi-Fi to share access to the upper 6 GHz band. The consultation explored how a potential shared use of the band between new entrants (mobile and Wi-Fi) could potentially bring wider benefits for consumers and businesses by providing more capacity, supporting faster internet, and enabling innovative broadband services.

1.2 There is interest in the upper 6 GHz band to provide different wireless services: the majority of the 41 submissions to our July consultation emphasised the importance of this band for delivering commercial mobile and/or Wi-Fi connectivity.

1.3 Respondents ranged from mobile operators, chipset and equipment manufacturers, academia, and representative bodies. The band is already in use providing other types of communications – such as fixed services, satellite, radio astronomy observations and PMSE uses – stakeholders related to these industries also provided responses.

1.4 This document gives a summary of the responses as well as a brief description of our next steps in relation to this band. The summary is intended to provide a high-level indication of the range of responses we have received. In this document, we do not provide a view on the merits or otherwise of the substance of the responses. We recommend reading the full text of all the non-confidential responses to understand the different viewpoints and opinions from the various stakeholders.

1.5 We will continue to carefully consider every contribution as we progress our work.

Overview of the responses

1.6 Some of the key messages in the responses include[1]:

- There is consensus on the high value of the upper 6 GHz band to support wireless broadband applications for consumers and industry.
- Twenty respondents argued for Wi-Fi use of the band, either to the exclusion of mobile, or with very limited mobile use. This group included large tech companies including Apple, Amazon, Meta, HPE, Cisco and Broadcom; the BBC and Sky; stakeholders with a focus on Wi-Fi such as the Wi-Fi Alliance; and most incumbents in the band.
- Eight respondents argued for commercial mobile use of the band, to the exclusion of Wi-Fi, or with very limited Wi-Fi use. This group included the mobile operators (BT/EE, Three UK, Virgin Media o2 and Vodafone UK); and some mobile equipment manufacturers including Ericsson, Nokia, and Huawei; and a mobile industry body, GSMA.
- Seven respondents argued for hybrid sharing or agreed it should be explored. This group includes chipset manufacturer Qualcomm and Internet Service Provider

[1] We received four fully confidential responses. Three of these agreed for us to refer to the contents of the response without identifying the respondent and were therefore included the in the response counts above. We counted a joint submission from three academics as a single respondent for the purpose of this count.

TalkTalk. Samsung and TechUK agreed we should at least explore hybrid sharing. Samsung asked for feasibility to be fully understood before proceeding to implementation.

- Almost all the arguments against hybrid sharing fall into two categories: (i) hybrid is not needed because the need for mobile spectrum is much greater than the need for Wi-Fi spectrum, or vice-versa; and/or (ii) feasibility concerns. These were correlated - those who prefer single use also raised the most concerns about the practical challenges of hybrid. There were few arguments against hybrid sharing in principle.
- Most of the respondents who believed in demand for both Wi-Fi and mobile were more positive about the practical implementation of hybrid, and presented some useful ideas about how it could be implemented.
- Respondents in general agreed that hybrid mechanisms should be developed via industry collaboration and international harmonisation.
- Incumbents of the band tend to favour single use for indoor Wi-Fi over hybrid or mobile use as they perceive that indoor low power use as less likely to cause interference.

Next steps

1.7 We appreciate the responses to the July consultation, and we will consider all viewpoints when making decisions about the upper 6 GHz band.

1.8 In our consultation we provided a preliminary view that without any changes to the technologies or without any enabling mechanisms, it is unlikely that mobile and Wi-Fi could effectively coexist and share spectrum resources. Many of the responses concurred with this view. Therefore we will continue to work in international fora as well as engage with businesses and other regulators in the coming months, as we believe that collaboration across industries is essential to identify such solutions.

1.9 We will be hosting discussions and workshops this year, and during 2024, alongside contributing to the work on hybrid sharing mechanisms in Europe (e.g., in CEPT PT1).

1.10 We will also continue to engage with stakeholders and relevant parties as we progress with this work.

1.11 We anticipate publishing a further consultation in 2024, once WRC-23 is finished and the European studies around hybrid sharing have developed further.

2. Demand for access to the band

2.1 In this section we present the different views of respondents about future demand for the spectrum in the upper 6 GHz band.

Demand for mobile

2.2 Some stakeholders, including Ericsson, Nokia, and Mobile Network Operators (MNOs), argued that there is a need for high power mobile use of the upper 6 GHz band. Ericsson, Nokia, VMO2 and Three say MNOs will need to increase capacity on already congested sites, with access to this band being necessary to satisfy this demand.

2.3 Ericsson, Nokia, and MNOs also identified the band as a crucial resource to develop 5G services and provide cost effective network coverage both indoors and outdoors. Ericsson, Three and Vodafone stated that the upper 6 GHz band could achieve a similar performance to the 3.5 GHz band.

2.4 MNOs expect to utilise this band predominantly in urban areas, with deployment in rural areas occurring on a case-by-case basis, dependent on the level of deployment density. Nokia also highlighted the higher demand in urban and suburban areas, while raising a concern about the need for the same quality of experience across the UK including rural areas.

2.5 GSMA highlighted the importance of opening this band for mobile, stating that without this spectrum, the cost of public mobile network deployments would increase; as would their energy consumption and carbon emissions.

Demand for Wi-Fi

2.6 Other respondents, including Apple, Samsung and Sky, believe that Wi-Fi use will require access to the upper 6 GHz band. Many of these respondents pointed to high indoor usage and stated that Wi-Fi is better suited for indoor coverage, as the access points are located indoors. For example, HPE quoted a study showing that people spend 90% of their time indoors, and referred to Ofcom's own reports indicating that the large majority of data traffic in the UK is carried via the fixed networks.

2.7 Several respondents said that the full 1200 MHz in the whole 6 GHz band (lower and upper) would complement the increasing number of fibre to the home connections. HPE stated that 10 Gbps home broadband is already available in the UK, and the upper 6 GHz band will allow these speeds to be available wirelessly. Sky and UKWISPA believe access to this band would increase gigabit speed and make fibre more accessible to users.

2.8 Apple and IEEE 802 LAN/MAN Standards Committee (LMSC)[2] identified the importance of Very Low Power (VLP) operation both indoors and outdoors. While this was not always explicit in the responses, we understand that VLP use is generally discussed to enable use of direct connections between portable devices ("device to device"). Broadcom also

[2] For simplicity, we refer to 'IEEE' in the remainder of this document.

emphasised the importance of “device-to-device” communications, which it highlighted as particularly efficient, as the data does not have to travel via a Wi-Fi router.

2.9 The increasing demand for high quality personalised media experiences underpins arguments made by HPE and Meta for the prioritisation of Wi-Fi. HPE and Meta discussed the capability of this band to support AR/VR and holographic communication, which they believe are going to primarily be used indoors. Similarly, the BBC discussed the demand for Wi-Fi in relation to personalised media consumption and the reliance on streaming services.

2.10 Various stakeholders, including HPE, Meta and WBA, identified a higher demand for Wi-Fi in high density areas, such as flats and university buildings. HPE and WBA argued that Wi-Fi needs at least seven non-overlapping channels to provide optimum user experience in high density areas and thirteen non-overlapping channels in very-high density areas. However, Vodafone contested the need for this number of channels.

2.11 Amazon, HPE and Meta argued that there are no alternative bands for expanding Wi-Fi spectrum access. This is supported by Shure and Wi-Fi Alliance, who highlight the potential for this band to encourage innovation not possible in lower bands (2.4 GHz and 5 GHz).

Demand for both

2.12 Some respondents, including Shure and Cisco, expect that there will be demand from both mobile and Wi-Fi services. Qualcomm and Samsung, as well as Saunders, Webb, and Temple (in their joint response) also acknowledged the demand for both mobile and Wi-Fi. They highlighted the importance for both mobile and Wi-Fi to develop with the increasing technological demands of our society.

2.13 TechUK discussed how hybrid sharing of the band could promote medium-term innovation and promote connectivity of users to services. This was supported by TalkTalk, who stated that this band is suitable for spectrum sharing in this capacity.

3. Hybrid sharing

3.1 Our consultation explained that we are exploring options to enable hybrid sharing, and that we hoped to identify appropriate mechanisms to support this; encourage the development of technologies to this end; and continue pressing for international harmonisation. We invited feedback on the principle of hybrid sharing and on the practicality of its implementation.

The principle of hybrid sharing

3.2 Most respondents who disagreed with our plan to explore hybrid sharing did not raise objections to the principle itself – instead, they said either:

- "Single use" was the best approach because they believed the demand to be mostly for Wi-Fi, or mostly for mobile (as in the previous section); or
- Hybrid sharing in practice would not be feasible to implement, or come at too high a cost, with loss of benefits compared to single use (as summarised later in this section).

3.3 Other respondents were supportive of the principle of hybrid sharing, even if they had practical concerns. For example:

- Samsung said that spectrum is a finite resource, and demand is growing both for mobile and Wi-Fi. It considered it important to explore options such as hybrid sharing, with careful consideration of feasibility.
- Sky said that Ofcom's aims in allowing multiple use cases is ambitious and admirable, but it did not think hybrid sharing was feasible.
- Amazon, HPE and Meta stated a preference of Wi-Fi use, but agree that a general framework for hybrid sharing could benefit the mobile sector, and other sectors, by opening opportunities in several bands.

The practicality of implementing hybrid sharing

3.4 We received feedback on preferred modes of sharing; on implementation challenges and feasibility; and finally, suggestions on how to overcome some of these challenges.

Preferred modes of sharing

3.5 Those respondents who would prefer the band to be used solely for mobile were mostly aligned on a second preference – if hybrid sharing is to be done, it should be done geographically with urban centres and other areas of high demand prioritised for mobile, via use of databases. For example:

- Vodafone and Three said that if Ofcom wishes to explore sharing options, it should concentrate on geographical sharing with mobile being the primary licensed service. In this way, Ofcom can licence mobile in densely populated areas and strategically important areas and Wi-Fi usage can be permitted outside those areas.
- BT/EE preferred a partition by frequency, with most (or all) of the band for mobile.

3.6 Those respondents with a preference for Wi-Fi use had mixed views on hybrid implementation:

- Cisco and Apple mentioned 5G NR-U as the best way to allow mobile and Wi-Fi into the band. However, WISPA was critical of 5G NR-U.
- BBC preferred a database approach over sensing mechanisms.
- Shure and Broadcom suggested combining both (with a preference for databases in Shure's case)
- Meta suggested sensing could be combined with lower power mobile deployments, while asking for careful consideration of the cost implications for the Wi-Fi ecosystem.

3.7 Respondents who saw demand for both Wi-Fi and mobile also had a range of preferences:

- Qualcomm suggested an indoor/outdoor split, to be implemented via sensing techniques. TalkTalk stated that sensing is already used in DFS (used to allow Wi-Fi to share part of the 5 GHz band with radars), and favoured sensing as a solution.
- Some respondents suggested a database approach. They highlighted the scope for hybrid sharing to reuse and combine several existing database approaches including SAS and AFC. This potential for re-use of existing database approaches was also highlighted by Saunders, Webb, and Temple in their joint response.

Implementation challenges and feasibility

3.8 Many of the respondents raised implementation and feasibility challenges. These challenges were more strongly presented by stakeholders who saw strong demand for a single use only (either Wi-Fi or mobile). Examples include:

- Several respondents warned that additional requirements to implement a hybrid sharing mechanism would add cost and complexity to devices.
- Ericsson argued that even with mitigation measures such as sensing or databases, mobile and Wi-Fi would still interfere with each other, reducing the performance of both. It referred to a study it submitted to CEPT PT1. [3]
- Huawei said that efficient use of spectrum via databases relies on accurate information about geographic location of radio equipment, and this is not likely to be available for mobile handsets and Wi-Fi equipment. Similarly, IEEE said that existing databases solutions such as AFC were developed to protect fixed incumbents and will need to be redesigned to take into account the mobile nature of the mobile service.
- Apple said that Very Low Power (VLP) licence exempt use cases are important to the company. It stated that these uses will have an outdoor component which will make it challenging to cover under an outdoor/indoor split (where licence exempt use is indoors).
- Several respondents pointed to the 'hidden node'[4] issue in sensing implementations.

[3] https://www.cept.org/ecc/groups/ecc/ecc-pt1/client/meeting-documents/

[4] This is a challenge often encountered in different guises in wireless network design, originating when two devices cannot directly sense each other, but can still affect each other via a third device.

- Samsung expressed concerns about the operation of mobile near a building and the operation of Wi-Fi indoors near windows. It suggested this should be one of the areas for further study before any decisions are made on hybrid sharing.

3.9 On the other hand, some respondents thought that hybrid sharing would likely be feasible to implement, and presented practical suggestions on how to proceed, as detailed in the next sub-section.

Practical suggestions on how to implement hybrid

3.10 There was general agreement with our priority to seek international cooperation and harmonisation for any hybrid solution, from a wide range of stakeholders. In addition, respondents made the following suggestions:

- Qualcomm suggested a sensing-based approach, helped by harmonisation between Wi-Fi and mobile protocols. In particular, it suggested that mobile channelisation in the band could be aligned with the existing Wi-Fi channels; and mobile could also use existing Wi-Fi control frames. In this way, mobile and Wi-Fi would be able to sense each other and give way in areas where the other service has priority, in an indoor-outdoor split. In addition, use of large antenna arrays would allow mobile to create more directional beams, improving the reuse of spectrum.
- A confidential respondent pointed to some existing standards that can solve some of the technical challenges associated with hybrid sharing – this includes the "Coexistence Manager" developed by the OnGo Alliance[5] and an IEEE standard developed for network-based coexistence among dissimilar or independently operated networks.[6]
- Broadcom suggested using existing Wi-Fi sensing features, including "Listen Before Talk" to enable hybrid. It also mentioned more advanced Wi-Fi 7 features, that would allow Wi-Fi to move out of a channel that was being used by mobile: sub channel puncturing and Multi-Link Operations. With respect to databases, Broadcom suggested a proportionate approach to hybrid sharing – with sophisticated techniques implemented in Wi-Fi routers for major enterprise and public deployments, but not required in residential equipment, which would be less likely to cause interference into mobile.
- Some stakeholders suggested a phased approach to introducing hybrid. Apple, Meta, Amazon and HPE suggested we should licence exempt the band first, as the equipment is already available, and decide later whether and how to allow mobile use. Some mobile proponents suggested the opposite – we should focus first on releasing the band for mobile and decide later whether Wi-Fi can share the band.
- Saunders, Webb, Temple (in their joint response) suggested that reusing existing standardised databases mechanisms such as AFC and SAS could be efficient and will facilitate rapid deployment in the UK. They suggested enhancing these by using a previously proposed flexible framework[7]. This would allow criteria about who to

[5] https://ongoalliance.org/wp-content/uploads/2022/03/OnGo-TS-2001_v4.1.0_-Published-March-08-2022.pdf

[6] https://ieeexplore.ieee.org/document/8520953

[7] UK Spectrum Policy Forum, Explanatory Guide on the Functional Specification for Dynamic Spectrum Access in shared UK mobile spectrum bands

prioritise to evolve over time, taking into account up-to-date market information, deployment plans, and the need to provide certainty for both services.

- Some responses, mostly from Wi-Fi proponents such as Meta and Broadcom, suggest mobile could use lower power and/or antenna pointing limitations to improve coexistence with Wi-Fi. Mobile proponents in general were strongly opposed to lower power for mobile and argued that this would reduce the benefits from mobile use of the band.

4. Incumbents, including coexistence

4.1 We have received feedback from stakeholders that are currently operating services in the band. Respondents expressed concerns about the potential for interference when sharing with new services, particularly outdoors, including high power mobile or standard power Wi-Fi.

4.2 Stakeholders flagged concerns about interference to satellite uplinks, fixed links, PMSE uses and radio astronomy sites:

- With regards to possible interference to radio astronomy sites: Jodrell Bank Observatory flagged that due to the nature of the use of the band, it wouldn't be feasible to find alternative spectrum to carry out the 6.67 GHz methanol line, used for observations of interstellar gas. It stated, in the context of future hybrid sharing, a preference for priority to be placed on indoor Wi-Fi usage – as it is much less likely to interfere with the radioastronomy sites. It added that any proposed mobile use would have to be further studied to establish acceptable separation distances.
- Some stakeholders, including the BBC and IEEE, flagged that PMSE uses would require protection – or suitable alternative adjacent spectrum should be identified to account for the potential loss of two channels used for wireless cameras. Other respondents, including Shure, suggested that databases could be used to afford PMSE the appropriate protection.
- Some stakeholders, including Arqiva, said that it would be difficult for mobile services to share the band or coordinate with fixed link services, noting that separation distances in the order of 10s of kilometres would be required to protect fixed links from interference. Some respondents also flagged the challenges that could be associated with the migration of fixed links, including costs and operational risks. However, others including BT/EE, stated that there is potential for continued shared use of the band with fixed link services, particularly in the early stages of mobile deployment; and others such as Vodafone and Ericsson referred ongoing CEPT studies that suggest that coordination could be achieved on a site-by-site basis.
- Satellite sector stakeholders, including GSOA, ViaSat and Avanti, reiterated their concern regarding the protection of fixed satellite services in the band, highlighting the importance of this spectrum for their services. They stated that fixed satellite receivers in the band could only coexist with outdoor IMT deployment if technical constraints placed upon mobile deployments or deployments are limited to certain areas.

4.3 There were various suggestions made regarding how coexistence with incumbents could be achieved:

- Qualcomm noted that mobile services could utilise large antenna arrays, which could significantly reduce interference;
- the GSOA flagged that appropriate protection measures including EIRP limits could allow coexistence between the hybrid sharing scheme proposed and fixed satellite service uplinks; and

- several other stakeholders flagged the possibility of reducing the maximum power allowed for mobile networks, to enable both hybrid-sharing and a continuation of incumbent services.

A1 List of published responses

A1.1 The following responses were listed as non-confidential and are published on our website. There was one partially confidential response. The text marked as confidential has been redacted as appropriate, and the response published alongside non-confidential responses.

- Apple Inc.
- Arqiva
- Avanti
- BBC
- Broadcom
- BT/EE
- Cisco
- Dynamic Spectrum Alliance
- Ericsson
- European Utilities Telecom Council
- GSMA
- GSOA
- HPE
- IEEE 802 LAN/MAN Standards Committee
- Jodrell Bank Observatory
- Joint Radio Company
- MCA
- Meta
- Multi-company response, Amazon, HPE, Meta
- Nokia
- Qualcomm
- Samsung
- Saunders, S; Temple, S; Webb, W
- Scottish Futures Trust
- Shure Europe, GmbH
- Sky
- TalkTalk
- TechUK
- Three UK
- UKWISPA
- ViaSat
- Virgin Media O2
- Vodafone UK
- Wi-Fi Alliance
- Wireless Innovation Forum
- World Broadband alliance