Three's response to Ofcom's Hybrid sharing: enabling both licensed mobile and Wi-Fi users to access the upper 6GHz band

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Executive Summary.

Three UK welcomes the opportunity to respond to Ofcom's consultation on Hybrid sharing: enabling both licensed mobile and Wi-Fi to access the upper 6GHz band. The upper 6GHz band has become a focal point of industry, particularly in discussions leading up to the WRC-23. There is disagreement within the industry regarding how this band should be used, with some supporting its exclusive allocation to licensed mobile while others propose its use for license-exempt such as Wi-Fi.

However, Ofcom has proposed an alternative approach in which Wi-Fi and licensed mobile can coexist. We believe that the approach proposed by Ofcom is impractical and that the optimal use of the upper 6GHz band is for mobile only.

Three UK's view is that the upper 6GHz band will be critical to ensure that future 5G and 6G mobile networks will be able to provide services that consumers demand. We expect that the 6GHz band will be critical to provide future congestion relief given its propagation characteristics and available bandwidth.

In our response we:

- [✂].
- Explain that i) spectrum is not a constraint on Wi-Fi demand and that the hybrid sharing mechanisms proposed by Ofcom would not be practical; and ii) allocating the upper 6GHz band for licensed mobile would yield maximum benefit for consumers.

If Ofcom nevertheless decides to share the band between Wi-Fi and mobile use, we ask Ofcom to at least ensure that mobile use takes priority in high-density areas (as there is greater demand for mobile use in those areas).

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In the rest of the section we:

- [✂]; and
- Discuss how other potential solutions to increase capacity are not economically or practically feasible.

Upper 6GHz is needed to alleviate mobile congestion

Ofcom's medium-growth scenario assumes that mobile data traffic will continue to grow by 40% per year up to 2035, with potentially faster growth depending on the availability of demand and demand for new data-intensive use cases. This means mobile traffic could be 110 times greater in 2035 than in 2021, with capacity needs in UK mobile doubling every 25 months.[1]

Increased traffic volume is driven by a variety of sources: greater use of existing data-heavy applications, IoT devices, mobile broadband and Fixed Wireless Access subscriptions.

Consequently, ensuring sufficient spectrum availability is essential to realize UK's 5G vision and to deliver best in class networks. The availability of the upper 6GHz band for high power mobile is essential to achieving this vision.

In its consultation, Ofcom suggests that operators have scope to increase capacity on most of their sites by adding other bands already licensed to them, and that the addition of upper 6GHz spectrum would be useful in providing additional capacity only in a subset of sites.[2]

[✂][3].

An illustrative example is provided in Figure 1 below. [✂].

Figure 1: [✂]

[1] Ofcom's Future Approach to Mobile Markets and Spectrum Conclusions, Figure 4.1.
[2] Hybrid sharing: enabling both licensed mobile and Wi-Fi users to access the upper 6 GHz band (ofcom.org.uk), para 3.26
[3] [✂]

[✂]

Source: Three UK

Other potential solutions to increase capacity are not economically or practically feasible as the sole way to meet future capacity requirements. In its Consultation[4] and December 2022 Discussion Paper[5], Ofcom has said that there are several ways in which operators could have additional capacity over the next ten years including through the development of mmWave spectrum.

Ofcom's findings in its Discussion Paper that MNOs will not require further spectrum by 2030 to relieve network congestion assume that MNOs will deploy 'many thousands' of small cells with mmWave spectrum by 2030 and tens of thousands by 2035.

As previously mentioned in our response to Ofcom's Call for Input WRC-23 consultation[6], this is not realistic for two reasons. Firstly, widespread small cell deployments are uneconomic. [✂]

Secondly, small cells are not practical for widespread network deployments since they need to be positioned very precisely to efficiently reduce spectrum congestion. In many cases this will not be possible for various reasons (e.g. lack of street furniture, power, transmission or planning issues), requiring an alternative approach to reduce network congestion.

Mobile operators increase their network capacity through a combination of:

[4] Hybrid sharing: enabling both licensed mobile and Wi-Fi users to access the upper 6 GHz band (ofcom.org.uk), para 2.14
[5] Conclusions: Ofcom's future approach to mobile markets - Ofcom
[6] Three (ofcom.org.uk)

- Deploying more spectrum across different bands
- Building/upgrading mobile sites; and
- Improving spectral efficiency

Explosive growth in data traffic has meant that we must regularly increase our utilisation across all three of these categories and cannot rely on just one. While these techniques will be important elements in the provision of additional capacity in some locations, availability of the upper 6GHz band to existing mobile sites will be the only or most economically viable solutions in many cases.

The upper 6GHz band stands as the most probable source of additional mid-band spectrum, necessary to accommodate the continually growing traffic demands. Its allocation becomes imperative for ensuring the essential capacity needed to prevent a decline in service quality, especially in busy areas, as the available spectrum becomes fully utilized and other avenues for additional capacity becomes impractical or uneconomical.

2. Optimal use of upper 6GHz band is for mobile only

Executive summary

The upper 6GHz band has become a focal point of industry, particularly in discussions leading up to the WRC-23. There is disagreement within the industry regarding how this band should be used, with some supporting its exclusive allocation to licensed mobile while others propose its use for license-exempt such as Wi-Fi.

However, Ofcom has proposed an alternative approach in which Wi-Fi and licensed mobile can coexist. We believe that the approach proposed by Ofcom is impractical and that the optimal use of the upper 6GHz band is for mobile only.

In this section we discuss:

- Spectrum is not a constraint on Wi-Fi demand and that the hybrid sharing mechanisms proposed by Ofcom would not be practical;
- Allocating the upper 6GHz band for licensed mobile would yield maximum benefit for consumers

If Ofcom nevertheless decides to share the band between Wi-Fi and mobile use, we ask Ofcom to at least ensure that mobile use takes priority in high-density areas (as there is greater demand for mobile use in those areas).

Spectrum is not a constraint in Wi-Fi demand

In its consultation, Ofcom has outlined the growing prevalence of Wi-Fi in recent times. However, Ofcom has not presented any substantiated rationale for the necessity of additional spectrum for W-Fi. Notably, there is a lack of evidence suggesting any congestion issues faced by Wi-Fi networks.

The performance of Wi-Fi is ultimately constrained by the speed of the fixed broadband (FBB) connectivity supplied to the Wi-Fi access points. As a result, spectrum is not the bottleneck of user experience now and in the future for home broadband access.[7] Allocating additional spectrum for Wi-Fi usage will not contribute to an improved customer experience.

Other major fixed broadband providers like Vodafone, BT and Virgin Media, which are among the largest broadband providers in the UK, have supported IMT identification of the upper 6GHz band for WRC-23. This is because such allocation would yield more substantial social and economic benefits compared to assigning it for license-exempt use.

BT stated[8]:

[7] Microsoft Word - The 6GHz Opportunity for IMT - Coleago - 1 Aug 2020.docx
[8] BT plc (ofcom.org.uk)

"BT has a strong interest in ensuring that suitable Wi-Fi connectivity is possible for customers to use with fixed broadband as well as suitable capacity on its public mobile network, and also in the convergence of these two access mechanisms. Consequently we have strong interest in ensuring that adequate spectrum is available for both Wi-Fi and wide area mobile networks. In the case of U6GHz we have come to the view that although a case van be made for both use cases, there is clearly a greater benefit to UK consumers if the U6GHz band can be made available for wide area cellular mobile networks."

Vodafone stated[9]:

"We reiterate that Vodafone is not just a mobile operator, but is also one of the largest broadband providers in Europe and, by extension, a supplier of large volumes of home Wi-Fi router equipment. However, considering that the lower 6GHz band has recently been made available for licence-exempt use, and recognising that spectrum is a finite resource, as a stakeholder with interests in both camps we consider that the social and economic benefits of licensed mobile use of the upper 6GHz band are overwhelming."

VMO2 stated[10]:

"However, given there is no shortage of spectrum for such use, further identifying the upper 6GHz band for licence-exempt use would represent a clearly unbalanced approach and would be a mistake when taking into consideration the scarcity of, and requirement for, additional mid-band spectrum for mobile use."

Hybrid sharing as proposed by Ofcom will not be practical

The consultation proposes hybrid sharing mechanisms to facilitate coexistence between licensed mobile, Wi-Fi and existing users of the upper 6GHz band. Ofcom believes that hybrid sharing in the upper 6GHz band could deliver optimal use of the spectrum.

However, we do not believe that this approach is workable due to several significant challenges as we explain in detail below.

Upper 6GHz requires high power mobile use to provide similar capacity and coverage as the 3.4-3.8 GHz band

Advances in radio technology have enabled comparable coverage using the upper 6GHz band to that achieved with the 3.4-3.8 GHz band, for both outdoor-to-outdoor and a majority of outdoor-to-indoor communications.

This means that MNOs can enhance capacity of their existing 3.4-3.8 GHz sites with 6GHz radios, eliminating the need for extra infrastructure deployment. This

[9] Vodafone (ofcom.org.uk)
[10] Virgin Media O2 (ofcom.org.uk)

was further illustrated by Nokia[11], who conducted simulations and found that operators should be able to reuse their macro grids with 6 GHz.

Furthermore, the larger available bandwidth in the 6GHz band will allow significantly greater capacity compared with what can be made available with the 3.4-3.8 GHz band.[12]

However, to attain comparable coverage and greater capacity when compared to the 3.4-3.8 GHz band, it is important that the upper 6GHz band allows high power usage without any technical constraints. In its consultation, Ofcom has indicated that for Wi-Fi and mobile to coexist, certain technical constraints might be necessary, such as imposing stricter power limits on licensed mobile.[13]

This approach may not yield an optimal and practical solution. Restricting power limits on licensed mobile could substantially impede the coverage capacity that mobile operators can deliver. Such limitations might result in compromised network performance, especially in scenarios where coverage and high data throughput are vital.

Sharing spectrum between Wi-Fi and cellular systems is not practical

Spectrum sharing between Wi-Fi and cellular systems has been extensively examined by multiple research bodies, leading to the standardization of LTE-U/NR-U by 3GPP. However, due to many technical and economic challenges, NR-U and LTE-U have not been widely deployed in the UK. Proposed commercial solutions from RAN vendors have not demonstrated substantial economic or technical advantages for consumers.

Intel[14] has highlighted the challenge of unavoidable interference between Wi-Fi, LTE and 5G. The deployment of filtering technology may raise equipment costs (both for handsets and network infrastructure) and potentially prolong the deployment timeline for both 5G, ultimately reducing the overall benefits to consumers.

Adopting Ofcom's proposal, which is different from LTE-U/NR-U, could worsen the interference problem, primarily because of the limited testing and trials conducted thus far. Intel has emphasized that successful spectrum sharing requires new testing equipment to validate the coexistence of both technologies.

Without such testing capabilities, there is no assurance that deploying 6GHz in densely populated areas will avoid harmful interference. Moreover, Ofcom's proposal is not in the scope of any standardisation bodies (3GPP or Wi-Fi Alliance) that allow seamless coordination between both technologies.

[11] Society cannot cope with the growing demands on 5G without 6GHz | Nokia
[12] Licensed-6-GHz-opportunity.pdf (6ghzopportunity.com)
[13] Hybrid sharing: enabling both licensed mobile and Wi-Fi users to access the upper 6 GHz band (ofcom.org.uk), para 1.14
[14] Testing and validation challenges for enabling LTE/5G and Wi-Fi networks Coexistence | IEEE Conference Publication | IEEE Xplore

Upper 6GHz mobile performance would be degraded due to interference between Wi-Fi and cellular systems

The consultation shows that indoor Wi-Fi access points may not be able to detect low level signals from outdoor mobile base stations. In this case, the listen-before talk protocol may incorrectly assume the channel is clear and the access point may start transmitting, potentially causing interference to any nearby mobile handsets receiving data from base station.[15] This is particularly the case when there is some degree of path loss and building entry loss, and the Wi-Fi access point is unable to detect the signal.

Upper 6GHz is needed for Fixed Wireless Access service

Fixed wireless access (FWA) technology is growing in the UK. FWA offers broadband connections through mobile networks, creating a synergy where these services coexist and share network capacity with mobile users.

Although dependent on available spectrum and the quality and coverage of the underlying 5G network, 5G FWA can surpass the speeds of copper and fibre-to the-cabinet (FTTC) and match speeds of FTTH where the mobile network has sufficient capacity.

Mid-band spectrum is deemed ideal for Fixed Wireless Access (FWA) applications. While maintaining a comparable area to that of 4G, it boasts ample channel bandwidth and improved spectral efficiency. This results in the capacity to transmit more data and achieve higher connections speeds. Consequently, mid-band spectrum emerges as an excellent choice for FWA, delivering up to 10 times the capacity of 4G networks. FWA connections typically place a much larger capacity burden on mobile networks than a smartphone.

Given that FWA employs mobile networks to deliver indoor broadband services, accommodating both Wi-Fi and FWA services simultaneously might be challenging. Notably, the consultation has not delved into practical implications of hybrid sharing involving FWA services and Wi-Fi in the same spectrum.

Ofcom's hybrid sharing proposal could hinder commercial roll-out of the upper 6GHz band

The consultation states that international harmonisation is an important factor in enabling hybrid sharing of the band. The standardisation work for the band via 3GPP is already complete. Mobile equipment industry can, therefore, already develop products for this spectrum.

The development of mobile ecosystems for a particular band only starts once there is demand from mobile operators. For example, equipment manufacturers typically require MNOs to commit to a minimum order before they develop units which support new bands.

[15] Hybrid sharing: enabling both licensed mobile and Wi-Fi users to access the upper 6 GHz band (ofcom.org.uk), para A7.18

However, Ofcom's proposal to implement a hybrid sharing approach in the upper 6GHz band would necessitate equipment manufacturers to develop specialized kits for the UK market. This, in turn, would increase the cost of deployment and could hinder commercial roll-out of the upper 6GHz band.

Ofcom's hybrid sharing proposal could drive up device cost

Discussions about the future of 6GHz band are taking place around the world. Some countries have proposed license-exempt in the band (United States), others have decided to move towards licensed use (China), while others may decide to split the band for license-exempt (lower 6 GHz) and licensed use (upper 6 GHz).[16] As a result, device manufacturers would have to develop products for either licensed mobile regions, licensed-exempt regions, or regions where the band is divided between license-exempt and licensed mobile.

Hybrid sharing mechanisms proposed by Ofcom would not fall into any of the above categories, necessitating the development of a specific device ecosystem (and device hardware/software skews) for the UK market by device manufacturers to support simultaneous lower and upper 6GHz co-existence.

This may result in an increase to the complexity of hardware design requiring specific UK centric device skews, and thus potentially limit availability of fully supporting devices, driving up device costs for fully 6GHz hybrid capable devices.

Allocating upper 6GHz to mobile will result in maximum consumer benefit

Ofcom's overall objective when considering the future use of the upper 6GHz band is to maximise the benefits to people and businesses. We believe that the best way to achieve this is allocating the upper 6GHz band for high power mobile use as this will result in maximum consumer benefit. Other uses could be supported by the lower part of the band.

This view is supported by a cost-benefit analysis undertaken by the GSMA.[17] They assess the use of the 5925-6425 MHz and 6425-7125 MHz bands for licensed or license-exempt use in a cost benefit analysis. This study concludes that allocating the upper 6GHz band for licensed mobile use – when the lower 6GHz band is allocated for license-exempt use – would drive the greatest socio-economic benefits with extremely high-speed fixed broadband availability.

The consultation also states that Ofcom's hybrid sharing proposal could drive innovation through access to wide Wi-Fi channels for use cases such as AR/VR and device-to-device communications. However, with the current development in 5G technology, 5G is able to provide wider coverage and more stable latency than Wi-Fi. Nokia in its whitepaper[18] has found that 5G uses spectrum three

[16] Analysys Mason document
[17] The socioeconomic benefits of the 6 GHz band (gsmaintelligence.com)
[18] Nokia: Nokia 5G and Wi-Fi6 radio: options for operational technology

times more efficiently than unlicensed Wi-Fi6E due to technical features and the inherent design of 5G.

If Ofcom seem intent on sharing the band, we ask Ofcom to put mobile as priority in high-density areas.

In its consultation, Ofcom has not established a specific definition for the priorities concerning mobile and Wi-Fi services. Instead, Ofcom has offered several examples, such as:

- Example 1: Mobile would be prioritised outdoors and Wi-Fi would be prioritised indoors.
- Example 2: Prioritising mobile and Wi-Fi by time.
- Example 3: Prioritising mobile in busy areas and Wi-Fi elsewhere.

We discuss below why the only practical approach would be example 3 which is prioritising mobile in high-density areas and Wi-Fi elsewhere.

Example 1: Mobile would be prioritised outdoors and Wi-Fi would prioritised indoors

As noted by Ofcom, there is a high level of mobile traffic in areas of high footfall, mostly around dense urban environments. MNOs have strategically deployed sites in these areas to fulfil the demand and increase capacity. Coexisting Wi-Fi networks (Wi-Fi indoors) in these densely populated areas would not be feasible, as doing so would compromise the performance of both mobile networks and Wi-Fi connections due to interference issues.

As stated by Ofcom in its consultation that even with outdoor macro-cells further away from Wi-Fi access points, there is still some possibility in some circumstances for the access points to cause interference to a mobile base station. Furthermore, even when Wi-Fi access points use spectrum sensing, there remains the potential for Wi-Fi to be unable to detect mobile signals. This primarily attributed to factors like building entry loss and path loss, which could cause interference to a mobile base station.

Example 2: Prioritising mobile and Wi-Fi by time.

The consultation has provided an example of time-based spectrum sharing where different users access the same channel in the area but at different times. Ofcom has provided an example of football stadiums, where the upper 6GHz band could be prioritised for Wi-Fi during match times and licensed mobile would be prioritised before and after the match and on other days.

Ofcom's proposed approach involves Wi-Fi and mobile using separate databases for coordination. Wi-Fi access points would rely on Automated Frequency Coordination (AFC), while mobile base stations would use a Spectrum Access System (SAS) database interface.

Implementing and managing two distinct databases introduces practical difficulties and complexities. Especially when MNOs deploy thousands of sites, each with unique usage patterns and busy hours, raises practical concerns.

Example 3: Prioritising mobile in busy areas and Wi-Fi elsewhere

In our view, prioritising mobile in high-density areas and Wi-Fi elsewhere would be the most feasible option. As discussed above, coexistence between Wi-Fi and mobile in high-density areas poses significant challenges. Given the high demand for mobile services in these areas, prioritising mobile would be optimal as it would deliver maximum benefits to consumers.