GSMA response to Ofcom consultation on “Hybrid sharing: enabling both licensed mobile and Wi-Fi users to access the upper 6 GHz band”

September 2023

About the GSMA

The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Our vision is to unlock the full power of connectivity so that people, industry, and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

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Introduction

The GSMA welcomes the opportunity to provide our views on Ofcom's proposals for hybrid sharing and its potential to enable both licensed mobile and Wi-Fi to use spectrum in the upper 6 GHz band on a shared basis. We will discuss the potential for sharing this band between licensed mobile and Wi-Fi later in this document, but before then we briefly describe the need for additional mid-band spectrum for licensed mobile, and how upper 6 GHz spectrum would be used in 5G networks. A summary of key points and conclusions is provided at the end of this document.

The need for additional mid-band spectrum for 5G

As customers continue to experience the benefits of 5G networks, additional mid-band spectrum will be critical to meet future demand for mobile services. There are very limited options available in Europe, with the upper 6 GHz spectrum being the most viable and suitable mid-band frequency range which can be used for future 5G expansion. It is therefore crucial that the bands 6425-7025 MHz and 7025-7125 MHz are identified for IMT at WRC-23.

Significant amounts of mid-band spectrum will be required for mobile networks to be able to provide the capacity and performance that will be required on a city-wide basis to meet customer demand for 5G services in future. A study for GSMA[1] has estimated that an average of around 2 GHz of mid-band spectrum will be required to meet the ITU data speed requirements by 2030, leaving a substantial shortfall compared to what is currently available. Detailed traffic forecasts and projections from mobile network operators confirm that 5G network capacity will be exhausted before the end of this decade. Without this additional spectrum, it will not be possible to economically meet customer demand and realise the full potential of 5G[2].

The UK and rest of Europe is expected to benefit both significantly and quickly from mid-band 5G. A study for GSMA on the socio-economic benefits of mid-band spectrum[3] forecasts that the socio-economic value generated by mid-band 5G could contribute an additional US$67 billion to European GDP in 2025 with a further uplift of US$121 billion (equivalent to approximately 0.4% of European GDP) in 2030. Beyond the potential economic benefits, the study also concluded that if no additional mid-band spectrum is assigned to mobile services, the GDP boost would be reduced by up to 40%. The UK Wireless Infrastructure Strategy[4] highlights the importance of 5G for transforming the UK economy and public services and the challenge of providing access to spectrum for this.

If spectrum is limited to current levels as demand for services grows, increased network congestion and deployment costs will stifle 5G. Network quality and speed will suffer, limiting 5G adoption and its economic impact. The use of upper 6 GHz spectrum for licensed mobile/5G is critical to keep pace with the new connectivity leaders in East Asia, the Middle East and elsewhere, particularly in terms of 5G adoption and generation of economic value from mobile.

Mobile coverage using 6 GHz spectrum will be similar to the 5G coverage already delivered today with mid-band spectrum in the 3.5 GHz band, enabling increased wide-area capacity using existing macro-sites in urban areas for enhanced mobile broadband, ultra-reliable low-latency services (e.g. AR/VR), massive IoT, as well as fixed wireless access in small towns and villages. Obtaining the additional mid-band 5G spectrum that will be required to enable these services and applications will not be feasible without 6 GHz capacity. If 6GHz spectrum is not made available, this would significantly increase the cost of public mobile network deployments, with significant impacts on

[1] Vision 2030 Insights for Mid-band Spectrum Needs, GSMA, July 2021
[2] See also 6 GHz in the 5G Era: Global Insights on 5925-7125 MHz, GSMA, July 2022
[3] The Socio-Economic Benefits of Mid-Band 5G Services, GSMA, February 2022
[4] https://www.gov.uk/government/publications/uk-wireless-infrastructure-strategy

energy consumption, carbon emissions and the environment[5]. Operators would need to densify their networks across many locations, to an extent that will not be technically or economically feasible, and would result in a degradation in network quality.

Upper 6 GHz spectrum and mobile networks

The primary use of upper 6 GHz spectrum for mobile networks will be to provide capacity and performance for 5G on a city-wide basis, using existing base station sites that already use spectrum in the 3.4-3.8 GHz band to provide 5G services across urban areas. Mid-band spectrum provides a unique combination of capacity and coverage for wide-area services, and widespread use of macro-cellular base stations using similar power levels to 3.5 GHz radios is needed in order to take advantage of this. Use of medium power 5G base stations would heavily impact the 6 GHz coverage reach and additional capacity provided by adding the band to mobile networks. Medium power usage of mid-band spectrum would reduce the coverage to approaching that of mmWave full power macro base stations, hindering mid-band's advantages and potentially killing the mobile business case in the upper 6 GHz band.

The mobile industry has invested billions developing technologies such as active beamforming antennas that allow mid-band spectrum to provide high performance, high capacity public mobile services across outdoor and indoor areas; this technology is already being used today for 5G networks operating at 3.5 GHz. Restricting the capabilities of equipment deployed for 6 GHz would negate the value of the band and represent a backward step for mobile networks.

Upper 6 GHz spectrum will be able to achieve a similar level of coverage to the 3.4-3.8 GHz band if allowed to use similar power levels. Hence, network operators will be able to expand their 5G networks in a practical, cost-effective and environmentally friendly way by adding additional radio transmitters using upper 6 GHz spectrum to existing 5G macro sites that use spectrum in the 3.4-3.8 GHz band.

To verify this, Deutsche Telekom conducted a trial to evaluate whether macro IMT deployments in the upper 6 GHz range are able to provide coverage comparable to deployments in the 3.5 GHz band[6]. The results of this trial confirmed that this assumption is correct, and that the upper 6 GHz band is feasible for macro cellular network deployment and can provide similar coverage to the 3.4-3.8 GHz band. The trial also demonstrated that 6 GHz outdoor sites can provide indoor coverage with significant data rates. New trial results from Deutsche Telekom[7] further demonstrate the potential of the upper 6 GHz band for enhancing mobile networks in urban areas and its ability to transport large amounts of data quickly.

It has been suggested that mobile networks could support the additional capacity that will be required in years to come by massively densifying networks and building many more sites in urban areas. Although network densification has a role to play, and is already being undertaken by mobile operators where possible, additional mid-band spectrum will be needed in order to satisfy future capacity demands in a manner that is technically, practically and economically feasible.

Network density in the densest areas is already very high, with both macro-cells and small cells already deployed, and distances of less than 200 meters between macro-cell sites in some places, reaching limits of what is practically and technically possible. There are a range of practical issues

[5] Analysys Mason, "Impact of additional mid-band spectrum on the carbon footprint of 5G mobile networks: the case of the upper 6GHz band", June 2023

[6] CEPT/ECC document PT1(23)104, "Outdoor to indoor 6 GHz coverage - trial results", Deutsche Telekom, April 2023

[7] https://www.telekom.com/en/media/media-information/archive/world-record-12-gigabits-per-second-in-mobile-communications-1048610

that affect the feasibility of network densification (both in existing mid-band spectrum and small cells in mmWave spectrum), including difficulty of finding and securing suitable site locations, planning and environmental issues, availability and provisioning of backhaul and power supply, and maintaining and upgrading these sites over time, meaning that network densification is not a practical alternative to additional spectrum in order to increase network capacity. Higher densification of a mobile network with more sites will also lead to increased network costs, which will lead to higher prices for consumers and other users of mobile services, and reduced attractiveness of network investment, and environmental impact, including increased energy consumption and carbon emissions. mmWave spectrum is fundamentally constrained by coverage and while it may have a role to play in providing very localised high capacity services, it cannot substitute the need for mid-band spectrum to provide wide-area coverage and capacity in urban areas.

Potential sharing between licensed mobile and Wi-Fi

The GSMA recognises the need to use spectrum efficiently, including in particular the valuable mid-band spectrum in the upper 6 GHz band, which provides a highly advantageous combination of capacity and coverage for mobile networks. We also appreciate Ofcom's desire to investigate novel techniques for sharing between different services which might potentially help to enable more efficient use of spectrum. We believe, however, that there are a number of very significant and difficult challenges associated with sharing of the upper 6 GHz band between licensed mobile and Wi-Fi.

Although such sharing may be a reasonable objective, we believe that some potential solutions to sharing between mobile networks and Wi-Fi/RLANs will result in sub-optimal outcomes. We believe that use of the lower 6 GHz band for Wi-Fi/RLANs and the upper 6 GHz band for macro-cellular mobile networks represents the best overall usage of the 6 GHz frequency range in Europe. The lower part of the 6 GHz band (around 500 MHz) has recently been allocated for use by unlicensed WAS/RLANs in Europe, almost doubling the spectrum available for this purpose. Against this background, careful consideration and a holistic view are necessary with regard to the upper 6 GHz band, especially considering that once a spectrum band has been made available for unlicensed use it will be almost impossible to reverse that decision.

We would like to highlight that, in addition to mobile networks, GSMA members also provide fixed broadband services and extensively use Wi-Fi to distribute the fixed connection within homes and offices. GSMA members consider that a balance between mobile networks and Wi-Fi/RLANs is needed to address the overall needs of consumers and digital economies and to deliver the greatest overall socio-economic benefits, and that this can best be achieved in Europe by using the upper 6 GHz spectrum for licensed mobile networks with the lower 6 GHz band for unlicensed Wi-Fi.

Co-channel operation of mobile networks and Wi-Fi at the same place and time would result in extensive harmful interference and severe degradation in the performance of both types of radio systems. Without additional measures, the interference to both licensed mobile and Wi-Fi operating in the same spectrum is likely to be unacceptable, and would occur at locations and times that are hard to predict, and would result in inefficient use of the spectrum.

One fundamental problem for sharing between licensed mobile and Wi-Fi is that public mobile / 5G networks and Wi-Fi / RLAN technologies use very different and incompatible medium access control (MAC) radio protocols in order to access spectrum, each designed to optimally deliver their distinct performance requirements, based on licensed and licence-exempt authorisations respectively:

- Mobile technologies (5G NR, 4G LTE) use schedule-based MAC protocols that are designed

to operate in licensed spectrum and in the absence of other co-channel networks, and can therefore deliver a managed QoS.

- RLAN technologies (Wi-Fi, LTE-U, NR-U) use stochastic MAC protocols that are designed to operate under general authorisation (licence-exempt spectrum) on a non-protected non-interference basis and in the presence of an indefinite number of co-channel RLANs, and can therefore not deliver a managed predictable QoS and suffer from non-graceful degradation in performance when subjected to congestion.

These fundamental differences between protocols used in mobile networks and Wi-Fi will make it very difficult to achieve effective sharing between the two types of systems, in the same frequency band and adjoining/overlapping geographic areas, without significantly compromising the performance of one or both of the systems.

Advanced coexistence mechanisms and mitigation techniques will be necessary if there is going to be any possibility to enable effective use of both licensed mobile and Wi-Fi in the same frequency band. Additional interference management mechanisms and mitigation techniques are likely to be necessary to manage the sharing of resources between the two services. We appreciate Ofcom's desire to try to develop an innovative approach to sharing between the two services, however we believe this is an extremely challenging objective, and we are concerned about the practicality and complexities that this may involve, and the effectiveness of any solution.

The idea of separating use of the upper 6 GHz band between Wi-Fi indoors and licensed mobile outdoors may sound attractive in theory, however the concept is very idealistic and we have severe doubts whether it would work on a general basis in practice. While some buildings are built with materials that have very high building penetration losses. there will be many locations where there will be much less isolation between indoors and outdoors (e.g. buildings where there are openings such as doors and windows and/or where the building penetration loss is lower) and many other cases where mobile signal levels within buildings will be high (e.g. in buildings close to a base station site and multi-storey buildings with more line-of-sight or near line-of-sight paths to a base station antenna), and in such cases interference between mobile and Wi-Fi will occur. The signal/penetration loss between indoors and outdoors will vary greatly between different buildings and locations within them. It should be noted that a significant percentage of mobile network traffic (70-80%) is generated indoors. A trial conducted by Deutsche Telekom at their campus in Germany[8] demonstrated that 6 GHz outdoor cells can provide indoor coverage with significant data rates.

Enhanced sensing mechanisms might potentially have a role to play in reducing interference to Wi-Fi operating indoors in the same areas as mobile operating outdoors, however we believe this will be difficult to achieve effectively in practice. There will be cases when the mobile signal indoors is stronger than the Wi-Fi signal, and in such cases the Wi-Fi will need to avoid using the mobile frequencies when mobile is transmitting, otherwise neither of the services will be able to work effectively. A recent input to CEPT from Vodafone and Ericsson[9] provides a study which highlights the significant challenges associated with sharing the 6 GHz band between IMT outdoors and Wi-Fi indoors.

Use of databases might potentially be a more practical technique for (geographic) sharing between mobile and Wi-Fi in the same frequency band (see below). Such sharing solutions have been discussed for many years, however successful implementations have been limited. There are a number of challenges that would need to be overcome, e.g. to accurately predict interference (both in-band and adjacent) so as to avoid interference from one service to the other without leaving a

[8] CEPT/ECC document PT1(23)104, "Outdoor to indoor 6 GHz coverage - trial results", Deutsche Telekom, April 2023

[9] CEPT/ECC document PT1(23)216, "6 GHz sharing", Vodafone, Ericsson, September 2023

substantial 'buffer zone' between the areas that are used by the two services.

We believe that such a sharing framework would only work if licensed mobile use was prioritised over Wi-Fi, and that any framework for sharing the upper 6 GHz band between mobile networks and Wi-Fi should assign priority to licensed mobile use. In case of concurrent attempts by mobile and Wi-Fi to access any shared spectrum resource at the same location and time, priority should be given to the licensed mobile use, in accordance with the performance requirements of the two types of systems/technologies.

Identifying and prioritising the upper 6 GHz band for licensed mobile use would also enable geographical sharing of the band where licence holders could be authorised to operate in specific geographic areas, e.g. cities, with licence-exempt Wi-Fi operation permitted in other areas. However, as with other co-existence scenarios, this would only be possible if Wi-Fi access points and devices are managed by a central database which must authorise their operation in the geographic areas where not used for mobile services. This is essential as there is otherwise no mechanism to control where consumer Wi-Fi devices operate.

Another important aspect that should be considered is the ability to change use of the band after a decision has been made. In the case of Wi-Fi, we believe that it will in practice be very difficult to reverse any decision to use the upper 6 GHz band for Wi-Fi, once consumer devices using the band have been introduced, due to Wi-Fi's fragmented ownership. In the case of licensed mobile, however, the use of the band by mobile devices is fully controlled by a mobile network of known base station transmitters, and hence much easier to manage. Restrictions such as where a particular type of service can be used (e.g. restricting Wi-Fi to indoor use only) can be difficult to ensure in practice, particularly for consumer devices (and particularly in case of device-to-device use).

Summary and conclusions

- **Additional mid-band spectrum will be required for mobile networks** to be able to provide the capacity and performance that will be critically required on a city-wide basis and in other strategically important network areas to meet customer demand for 5G services in future. **Upper 6 GHz is the most viable spectrum for this**.
- **City-wide coverage and capacity will require the use of 6 GHz spectrum in macro-cells, using similar power levels and existing sites** used for initial 5G deployments in the 3.4-3.8 GHz band. The upper 6 GHz coverage from these sites will be similar to the 3.5 GHz band, and will provide service to indoor users as well as outdoors.
- Although we appreciate Ofcom's desire to investigate novel techniques for sharing between different services, **we believe there are a number of difficult and significant challenges associated with sharing of the upper 6 GHz band between licensed mobile and Wi-Fi** that would result in a degradation of performance in both systems and in an inefficient use of the spectrum.
- One fundamental problem is that technologies for licensed mobile and Wi-Fi use very different and incompatible protocols to access spectrum, each designed to optimally deliver their distinct performance requirements.
- Although use of the upper 6 GHz band for Wi-Fi indoors and licensed mobile outdoors might sound attractive in theory, we believe it would be very difficult for this to work effectively in practice. For example, there will be many locations with low isolation between indoor and outdoor areas, and we believe that avoiding interference between mobile and Wi-Fi will be extremely difficult, even with advanced coexistence mechanisms.
- Reducing power levels used for 5G in the 6 GHz band will hinder mid-band's ability to provide

good coverage and result in inefficient use of the band and kill the mobile business case.

- Any framework for sharing between mobile networks and Wi-Fi in the upper 6 GHz band **should be based on 5G macro power levels and assign priority to licensed mobile use.**
- It will be very difficult to reverse any decision to use the upper 6 GHz band for Wi-Fi once consumer devices have been introduced in the band.