# Vodafone Response to Ofcom call for inputs: Hybrid sharing: enabling both licensed mobile and Wi-Fi users to access the upper 6 GHz band

# 1. The feasibility of sharing

### Usage of the Upper 6GHz is needed for mobile

Vodafone welcomes the opportunity to respond to Ofcom's consultation regarding the prospect of the Upper 6GHz band being shared between mobile and Wi-Fi users. This represents an interesting topic, but one which should not detract from the need for an IMT identification for the band at WRC-23 to facilitate an ecosystem for mobile to develop (whether on an exclusive or shared basis). We respect Ofcom's efforts to squeeze a quart out of a pint-pot of spectrum, and consider that some form of sharing may well be feasible, but we believe that there are insurmountable issues in some of the proposals.

Prior to making our comments, as a reminder, we must highlight that whilst Vodafone is perhaps best known for our mobile operations, we also have significant fixed operations: over 1M UK consumers use Vodafone for their home broadband services, and globally we serve some 28M fixed broadband customers. As such, in the debate of whether the Upper 6GHz band is best utilised for mobile or Wi-Fi services, we truly do have a foot in each camp when we conclude that the requirements of mobile must take priority.

We believe that it is now incontrovertible that mobile networks face a capacity crunch in the next 5-8 years. As highlighted by Ofcom's analysis, mobile data consumption continues to rise, at 27% between 2021 and 2022, with 5G users consuming even more data[1]. Our debate with Ofcom has been how best to address this. Whereas Ofcom has made the case for large-scale densification of networks utilising mm-wave spectrum[2], we do not believe that this is economically and, in many ways, practicably possible, without a significant and unacceptable change to the pricing of mobile services to consumers. It also has a significant impact on energy consumption and carbon emissions. Whereas Ofcom is wary that high-power usage of the Upper 6GHz for mobile would just delay the inevitable of needing to densify networks, we believe that further mid-band spectrum deployment would defer this by at least 5-10 years, during which time demand growth may flatten and/or technological improvements be made that would render such densification redundant (at least at the scale envisaged in Ofcom's thinking). All of this said, we acknowledge that the requirement for additional mid-band spectrum will not be nationwide, so this does open up the opportunity to at least consider whether some forms of sharing are feasible.

As we have discussed with Ofcom, our vendors inform us that they will produce mobile network equipment which, when operated at equivalent high transmit-power levels, will provide similar coverage to that of 3.xGHz kit. Our detailed analysis and initial testing have confirmed this as a realistic target, as has independent testing by other network operators across the globe using early versions of 6GHz capable

[1] "Connected Nations Dec 2022" Section 3 - https://www.ofcom.org.uk/__data/assets/pdf_file/0034/249289/connected-nations-uk-report.pdf . We note that fixed data consumption (Section 2) only increased by 6%, but would be cautious of extrapolating a single year's trend.
[2] "Ofcom's future approach to mobile markets and spectrum – Conclusions Paper", paras 1.5-1.6 https://www.ofcom.org.uk/__data/assets/pdf_file/0036/248769/conclusions-mobile-spectrum-demand-and-markets.pdf

network equipment. The UAE regulator TDRA recently announced successful completion of its "advanced Phase 2" 6GHz trials[3] and Deutsche Telekom has also reported world record speeds in its trials using the band[4]. These trials clearly demonstrate the performance and capacity benefits enabled by wider channel bandwidths deployed on existing macro cell sites using the upper 6GHz band.

As more countries globally consider using the upper for IMT we expect to see further trial announcements over the coming months. ✂

### Geographic sharing

We believe that mobile 6GHz equipment would ultimately be deployed across the order of ✂. As these locations will tend to be in city and urban environments – with exceptions – this does represent an opportunity to explore sharing on a geographic basis.

Unlike mm-wave, however, where the proposed award splits the country into high/low density areas and takes a disparate administrative approach to licensing, in the case of Upper 6GHz the sharing party would be unlicensed usage, meaning that there would need to be a technical approach to managing where U6 Wi-Fi equipment was deployed. Realistically, this would imply that Wi-Fi equipment wishing to use the band queried a geo-location database (initially and regularly) to determine whether they were permitted to do so at their specific location. We leave this to the manufacturers of Wi-Fi equipment as to the feasibility of doing this, but we do have some concerns around whether the locations involved would practicably be of any use to prospective Wi-Fi users, and around the investment stability of Wi-Fi deployment (given that mobile deployment in the area would necessitate the Wi-Fi equipment no longer using the band, hence potential wasted expense on the part of the Wi-Fi deployer).

### Indoor/outdoor sharing

We have greater issues with the prospect of sharing spectrum at a given geographic location on an indoor/outdoor basis.

Firstly, we do not accept the proposition that mobile users mainly revert to using Wi-Fi when indoors, relying on mobile service only when outdoors. Indeed, contrary to this assumption, our analysis (confirmed across the industry) indicates around 70-75% of mobile network traffic is from customers in indoor locations, highlighting, that even in the presence of local Wi-Fi networks mobile customers expect the reliability, performance and security of public mobile networks "anytime anywhere" across outdoor and in particular indoor areas. We note the "spot case" analysis that Ofcom has undertaken at Riverside House for the 3.4GHz band, but if anything the material presented in Figure 2 of the consultation suggests the opposite of what the commentary describes: there is, on the whole, good coverage depicted at the front/glazed part of the

[3] https://tdra.gov.ae/en/media/press-release/2023/tdra-announces-successful-completion-of-phase-ii-of-advanced-5g-trials
[4] World record: Telekom demonstrates 12 gigabits per second in mobile communications | Deutsche Telekom

building, with the signal strength only diminishing deep indoors in the conference room areas and around the building lift shafts. Our understanding is this also represents the coverage in near ground level conditions and could be substantially different on other floor levels or even areas around ground level floors where devices may be more directionally facing mobile base stations. In any case, Riverside House has recently been refurbished and is likely to be an example of a thermally-efficient office building, which is far from representative of the generality of the UK building stock, which is far more leaky (both from a perspective of propagation of mobile Upper 6GHz into the building and, as we will return to, leakage of 6GHz Wi-Fi out of the building).

As Ofcom are aware mobile coverage levels can vary based on a number of factors particularly for new technologies and bands such as 3.4GHz, e.g. number of deployed sites/sectors, configurations, equipment/device capabilities, and these can evolve over time. For instance our analysis indicates the main limitation in terms of 3.4 GHz coverage is the uplink, which can be mitigated by 'Stand-alone' aggregation (enabled with new 5G Core networks) with a suitable lower band, which will extend the corresponding downlink 3.4 GHz coverage by many dBs.

Notwithstanding this, a position that users overwhelmingly switch to Wi-Fi when inside buildings is reliant on an assumption that they are able to freely utilise such networks:

1. For domestic properties, we accept that many consumers revert to using Wi-Fi via their home broadband connections when at home – indeed, we make facilities such as VoWiFi available to facilitate uninterrupted mobile service in such circumstances. However, whilst it may not be a dramatic social *faux pas* to demand the Wi-Fi access code when visiting friends and relatives, it would seem extreme to have a spectrum policy that relies upon mobile users having to do this in order to maintain continuity of service. In any case, we have seen little evidence that any demand for usage of Upper 6GHz for Wi-Fi stems from domestic properties – for example densification via usage of Wi-Fi mesh networks is relatively nascent, and we have a long way to go before there is any significant congestion of existing Wi-Fi bands in this environment.
2. For offices, we would suggest that it is far from the norm for enterprises to allow their staff and visitors to utilise their personal mobile devices on the corporate Wi-Fi (and even if they did, many employees would baulk at their personal mobile usage going via company infrastructure and being subject to any policies/oversight that their IT department might impose). If enterprises were to allow relatively unrestricted access – especially to third parties - we would also question whether this would put them in the position of providing a Public Electronic Communications Network/Service hence liable to meeting the security requirements introduced by the Telecoms Security Act. It is therefore unsurprising that employee personal mobile devices commonly rely on the public mobile network when at work (which for many people, is indoors). This may become even more the case as 5G Standalone services provide capabilities that are not available via Wi-Fi.
3. For more public environments such as shopping centres and sports venues, many mobile users are reluctant to go through the rigmarole of signing on/up to a Wi-Fi service. From a user-perspective,

fallback to public Wi-Fi is best when it is enabled by the mobile network operator, i.e. a federated authentication allows all customers of a mobile network to "roam" (in the loosest sense) onto a given provider's Wi-Fi service. However, if Ofcom wished to rely on this as a spectrum policy and deprive mobile networks of adequate access to spectrum indoors to meet demand, then ✂. Even then, per the enterprise case, reliance on Wi-Fi could compromise the operation of more advanced 5G services.

We therefore believe that the foundation of sharing Upper 6GHz based on indoor=Wi-Fi / outdoor=mobile is fundamentally flawed. If the Upper 6GHz is made available for mobile, then our mobile customers will seek to use it indoors, as is the case today where 70-75% of mobile network traffic is from customers within indoor locations.

Technically we have conducted a detailed analysis of the potential interference scenarios resulting from sharing the upper 6GHz band between Mobile and Wi-Fi in the same area. This study included a detailed coverage analysis of 6GHz deployed in one of our networks in a large European city (typically where 6GHz will be deployed). The results of this study, conducted jointly with Ericsson, were submitted and presented to ECC PT1 #76 meeting (Berlin, 6-8th September 2023) for the discussion on work item PT1_50 (Feasibility and sharing studies of MFCN and RLAN in the upper 6GHz band). The key conclusions from this study are as follows:

- 6GHz indoor coverage is material and therefore effective in offering both indoor and outdoor mobile services.
- Mobile signal levels are not strong enough to trigger Wi-Fi Energy Detection therefore Wi-Fi APs and devices will operate in these areas resulting in **significant mutual interference between MFCN/IMT and Wi-Fi networks.**
- Any restrictions in Mobile transmit power level to create more isolation between systems **will substantially degrade *both* outdoor and indoor mobile service performance and capacity**

Even if it was appropriate to have an indoor/outdoor demarcation (we do not believe it is), then management of the boundary presents particular technical difficulties.

- From what we have seen of the suggested technical parameters for coexistence studies at CEPT, in order to ensure that mobile signals do not propagate into buildings and compromise Wi-Fi operation, the proposal is that mobile transmissions are limited to medium power, which would restrict the outdoor coverage achieved. This restriction would render a macro-deployment strategy ineffective, severely compromising the value of the Upper 6GHz band for mobile customer usage, to the point where the business case would be as questionable as mm-wave.
- At the boundaries of the building, mitigation measures would be required to ensure that Wi-Fi usage did not interfere with mobile operation. The consultation suggests sensing technologies, i.e. that Wi-Fi Access Points would recognise the presence of a mobile network and reduce power. However, this would not be possible with existing mobile technologies, and would require amendments to

transmit some form of preamble which is recognisable by Wi-Fi: we leave the mobile equipment manufacturers to comment on the feasibility of this, but *prima facie* this would require amendment of long-standing 3GPP standards. From a Wi-Fi perspective, clearly there would need to be technology development to achieve such sensing, but we would further highlight that sensing by the Access Point is of little value – it is only Wi-Fi terminals that are at the network edge that could recognise that they were in the presence of a weak mobile network signal, hence communicate this information to the Access Point for it to reduce power. We do not believe that existing Wi-Fi standards support this.

- The situation of Wi-Fi leakage outside buildings is even more stark. Per the first bullet, we believe the proposal would see mobile network transmissions kept at a deliberately reduced level so as to reduce propagation into buildings, which means the outdoor signal strength at the cell edge would be low. This means that even weak propagation outside from indoor Wi-Fi could compromise outdoor mobile network operation unless the Wi-Fi Access Point reduced power to avoid this. But the terminals outside the building that could see that a Wi-Fi signal was getting through the building fabric would not typically be those that are authenticated onto the Wi-Fi network – in the example of Riverside House, it would be passers-by who could see that Ofcom's Wi-Fi was interfering with mobile reception outside, rather than Ofcom's own staff inside. This implies that the sensing mechanism to instruct the Access Point to reduce power would need to be wider than authenticated terminals. We leave Wi-Fi manufacturers to comment on whether this represents a security risk.

Ofcom's consultation document has been useful in detailing the many significant and complex interference scenarios that can occur with hybrid sharing. It has also highlighted the type of restrictions and conditions which would need to be imposed on the operation of either or both technologies such as limited mobile base station powers which significantly reduces the value of the spectrum for mobile services. While databases and new special sensing mechanisms can potentially be implemented to mitigate some of these interference scenarios, these mechanisms, particularly in the case of sensing, will require extensive research, development and additional investment across both the mobile and Wi-Fi supplier ecosystem. This investment would be passed down as an additional cost to mobile network operators and other service providers further increasing the cost pressures they face.

With content for future 3GPP and Wi-Fi specification releases already agreed and in motion, the timescales around delivery of any features would also be highly uncertain and unlikely to be available when the band is required for 5G mobile network capacity.

While we appreciate Ofcom's efforts to explore ways to maximise the efficient use of spectrum (as a scare resource) the conclusion from our analysis, and we believe unanimously across the Mobile industry is , is hybrid sharing of the upper 6Ghz band through indoor Wi-Fi and outdoor mobile is fundamentally impractical and ultimately results in the 'worst of both worlds' as opposed to the desired best of both.

### Practicable sharing

We believe that if Ofcom wishes to explore sharing options, then it should concentrate on geographic sharing, with mobile being the primary licensed service. In this way the licensing and authorisation process can specify mobile usage in certain geographic areas (e.g. cities and other strategically important public areas) and Wi-Fi usage permitted outside these areas. This would require Wi-Fi Access Points to support Automatic Frequency Coordination (AFC) and Ofcom to manage and administer a database as indicated Para 4.38/Table 1 to ensure Wi-Fi access point usage only in areas where the band is not licensed for use for mobile networks

It also worth noting the licensing and authorisation regime could also be used to protect any Fixed Links operating in the band by specifying exclusion zones around any Fixed links which are deemed susceptible to interference from mobile base stations in the frequencies they operate.

# 2. Answers to Questions

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?

Question 2: Hybrid sharing could mean that the upper 6 GHz band 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.

a) 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?

b) Similarly, what are the priorities from the point of view of Wi-Fi deployments?

As set out in Section One to this response, whilst accepting that in certain circumstances many users utilise Wi-Fi on their mobile device (notably when at home), it is an erroneous over-simplification to suggest that mobile is used mainly outdoors, Wi-Fi indoors, given that 70-75% of mobile network traffic today is to/from devices in indoor locations. We do not believe that the suggested Wi-Fi/mobile indoors/outdoors split is the case for consumer devices in a business environment, and it is certainly not the case for commercial premises – if it was true then there would be no demand for DISA coverage solutions, and there would have been no demand for liberalisation of mobile repeaters. However, whilst some buildings can attenuate mobile signals more than others e.g. new thermally efficient buildings, buildings will always naturally vary in terms of materials and structures, resulting in a very large variation in penetration losses (c.f. ITU and 3GPP models). In addition, the signal level penetrating into a building will also depend on the distance and general clutter (e.g.

other buildings) from the transmitter to the building which can vary vertically depending on number of floors. Spectrum policy should reflect the reality of the UK's building stock rather than aspirations for how thermally efficient it may become in the future.

For mobile, it is critically important that additional mid-band capacity is made available in the medium term (around 5 years), that this should be usable on both an outdoor and indoor basis, and that any permitted transmit power levels should be compatible with high power mobile usage. We acknowledge that mobile usage would predominantly (but not necessarily exclusively) be in city and urban areas, to a first approximation this being the current aggregate 3.xGHz usage across the mobile networks.

For Wi-Fi, we are unconvinced of the need for additional capacity in domestic premises. We are only beginning to see densification of home networks using mesh technology and are not aware of any significant capacity concerns, now that the Lower 6GHz band has been made available. In enterprise and commercial premises, we would regard additional capacity beyond the Lower 6GHz as a "nice to have" rather than essential (in contrast to the case for mobile).

One particular area we believe could see a high demand for Wi-Fi spectrum is industries (e.g. production plants, factories), which in moving to Industry 4.0 will require high bandwidth, low latency wireless connectivity for process automation, automated guided vehicles, AR/VR based maintenance, digital twins etc. The connectivity requirements for these environments can easily be stretched to show any desired demand however we believe existing Wi-Fi spectrum can accommodate these requirements through the following:

- Properly designed Wi-Fi networks in industrial premises which through optimised placement of high-quality Access Points and sectorised antennas can maximise the coverage and performance and limit interference
- Availability of existing 5GHz spectrum and lower 6GHz spectrum allowing use of up to 5x160MHz channels
- Use of latest Wi-Fi technologies, in particular Wi-Fi 7, which offers significant performance enhancing features enabling spectrally efficient, low latency services versus significant limitations in previous generations of the technology

Proponents of more Wi-Fi spectrum indicate systems with a channel re-use of over three and up to seven 160 MHz channels are needed due to Wi-Fi performance limitations, however, we have found no solid evidence that this is the case, particularly with Wi-Fi 7 performance enhancements. It is also interesting to note these channel re-use factors correspond to an exact need for all, but no more than, the upper 6GHz band. Naturally any system or technology requiring channel re-use with high channel bandwidths results in inefficient use of spectrum and begs the question how sustainable it is going forward; the multiplicative effects of channel re-use and even higher channel bandwidths would imply another 1.2GHz (or significant amount) of spectrum is required when deploying 320 MHz channels. Some consideration must also be given if alternative technologies and spectrum such as mmWave are better suited to support these services.

mmWave technology has been specifically designed to support high bandwidth, low latency services in localised areas, and is already being used for these purposes in industries, stadiums in other regions of the world (US, Asia)

We are aware of other certain niche applications that could benefit from additional Wi-Fi channels, notably the oft-cited football stadium case. However, again, it is questionable whether usage of Wi-Fi to effectively create a cellular deployment with high bandwidth channel re-use is an efficient usage of spectrum. The mobile industry abandoned channel re-use decades ago when moving from narrowband 2G channels to wideband 3G channels, as it did not represent an efficient use of valuable spectrum and could not be sustained longer term. We also question the overall system design for the stadium which seems to involve simply flooding it with hundreds of uncoordinated Wi-Fi Access Points and then using inefficient channel re-use to mitigate interference. By contrast Vodafone recently deployed a solution for RB Leipzig's football stadium in Germany with just 4 properly positioned sectors using 400MHz of spectrum, delivering throughputs of up 2Gbps to users[5]. This was a project with a major sports broadcaster to deliver AR content i.e. real services with real service requirements.

Notwithstanding our technical concerns, even if spectrum was allocated to mobile at a given location such as a stadium, this does not preclude a commercial agreement to release it for a Wi-Fi deployment on a Local Access Licence basis.

We have seen other proposals for the band that amount to a Personal Area Network[6], for example usage of licence-exempt spectrum to connect PCs/terminals to VR/XR headsets. Given a required transmission distance of sub-1M, we would consider this to be a gross waste of prime mid-band spectrum. However, we have also analysed these requirements in detail and do not see the need for additional Wi-Fi spectrum to support them. Using Qualcomm's Fast Connect technology, 2 x 80MHz channels providing two simultaneous 1.5 Gbps Wi-Fi links would be more than enough to support tethering for VR/XR device and applications. There are at least 9 x 80MHz channels (or 5 x 160MHz channels) available across both the 5GHz and Lower 6GHz band, therefore the need for additional Wi-Fi spectrum seems very doubtful. It is also important to consider that application processor offloading to PCs/Laptops/Smartphones is only initially required due to form factor and power constraints on 1st generation XR devices, but this will diminish over time with 'stand-alone' devices supporting integrated application processing and additional suitable short-range communications technologies operating in other bands such as Bluetooth and UWB, as well as 5G for mobile network connectivity

[5] https://www.digitaltveurope.com/2021/11/11/vodafone-and-sky-deutschland-test-5g-multiview-app-in-stadium/
[6] Sometimes termed Personal Area Connectivity

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?

On the assumption that any Wi-Fi usage would be licence-exempt (hence administrative mechanisms could not be used to enforce that the usage is only at specific locations), we agree that in order to support geographic sharing some form of database lookup would be required on the part of Wi-Fi Access Points. We have outlined in Section One how AFC can enable geographic sharing by allowing Wi-Fi usage in regions where licensed mobile usage is not permitted and conversely prevent Wi-Fi usage in regions where mobile usage is permitted. For this to work every Access Point must use AFC to authorise operation before use and as a safeguard also re-authorise operation on a regular basis. Access Points unable to provide location (e.g. unable to geolocate using GPS in certain indoor areas) would not be permitted to operate.

Any more granular approach such as permitting Wi-Fi usage in specific areas where mobile usage has been licensed but 6GHz has not yet been deployed and operational, or more precisely locations where significant 6GHz signals transmitted by mobile base stations are not deemed to exist, would be challenging without risking any impact on the services offered by both technologies. The reason, as clearly indicated in Para 4.35 of the consultation, is databases cannot understand local radio environments which do not only vary significantly over relatively short distances both horizontally and vertically (as highlighted by Ofcom's measurements at its offices) but also over time as existing sites are redesigned (e.g. antennas re-orientated). As new mobile masts are deployed, and existing ones moved in order to accommodate e.g. building changes, this authorisation lookup would need to be ongoing and frequent rather than a one-off exercise carried out when the Access Point was deployed. A modified AFC approach might be feasible – we leave it to the Wi-Fi equipment vendor community to comment on what steps would be required to achieve AFC-based control as described, but note that likely the approach would need to be agreed on at least a European basis to benefit from any scale economies. Action would also be needed to ensure that equipment designed for e.g. the USA market (without the required modifications) did not enter the UK market.

In the reverse case, we note that mobile networks are licensed, and controlled by very few mobile operators (depending upon location and whether MORAN is deployed, a maximum of four and sometimes fewer operators). We believe that redesigning mobile networks to automatically suppress usage of the Upper 6GHz for mobile if it was required on a temporary basis by Wi-Fi would unlikely be proportionate, when manual intervention by network management centres could achieve the same goal. Indeed, we would prefer the engagement of our network management centre to mitigate the impact on our network. We note, however, that the scenario set out in Example 2 of the consultation neatly illustrates the flaw with the proposal – the timing of when it is suggested that mobile usage of the Upper 6GHz is disabled (match days) is precisely when our networks will be at their busiest in areas surrounding the stadium especially by those attending the event. Restricting mobile services, which would likely require restricting services of several base stations close the stadium would impact services over wide areas and taking such action could force them into congestion.

| 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? |
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As set out in Section One, we do not agree with the underlying premise that Wi-Fi be used indoor and mobile outdoor.

Section One also highlights Vodafone's detailed analysis of indoor mobile coverage levels possible from 6GHz equipment deployed on its existing macrocell sites in a large city. The analysis shows a large proportion of indoor areas would experience mobile signal levels below current Wi-Fi detection threshold levels, meaning Wi-Fi Access Points deployed in these areas would consider the channel free to transmit and result in significant interference to mobile devices, and in some cases to mobile base stations. This inherent problem is considered insoluble as mobile receivers are designed to operate well below the Wi-Fi detection threshold. We also draw your attention to our commentary in Section One, in particular that a Wi-Fi Access Point is unlikely to be able to detect a weak mobile signal, and instead would be reliant on feedback from terminals at the edge of its coverage footprint. For the case of leakage of the Wi-Fi signal outdoors, the information of this occurring would need to be provided from terminals which are not authorised to use the Wi-Fi network.

| Question 5: What mechanisms could potentially enable device-to-device connectivity? |
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As explained in detail in Section One, we do not believe that the device-to-device connectivity described in para 4.49 requires additional Wi-Fi spectrum and in any way represents efficient usage of mid-band spectrum, so we are disappointed that Ofcom is seeking to accommodate it. The proposal that device-device communication only be permitted where there is an "enabling signal" from an indoor Wi-Fi system seeks to prevent outdoor usage, but is critically flawed:

a) it is predicated on the assumption we disagree with, that there is an indoor/outdoor Wi-Fi/mobile demarcation,

b) Ofcom has no way of enforcing that Wi-Fi Access Points are actually indoor, and

c) every mobile device typically has the inbuilt capability to act as a Wi-Fi Access Point, regardless of location – which would defeat the proposal.

Ofcom might alternatively ban the usage of Upper 6GHz for device-device usage, but such a restriction would be easily overcome by one device acing as Access Point and the other as terminal.

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?

As indicated in Section One, mobile operators across the world have already successfully completed advanced trials confirming the enhanced performance and capacity benefits using the wider channels (200-400MHz) possible in the upper 6GHz band. A medium-power restriction would severely limit the use and efficiency of the Upper 6GHz band critically required to sustain and evolve public mobile services in this decade and beyond. It would mean the benefit of macro network deployment to customers would be limited (in essence the Upper 6GHz would be used for terminals extremely close to the mast, leaving other bands to service demand at the cell edge, and most likely lead to continued congestion on these other bands).

Instead, given such restrictions, usage of the Upper 6GHz band would likely be constrained to limited small cell deployments which can only provide coverage in specific locations and are economically and practically challenging to deploy (hence their limited use in mobile networks today). The majority of the comments that mobile networks have previously made to Ofcom about the economics of densifying networks by deploying small cells utilising mm-wave will also apply to the Upper 6GHz used in this mode. There would be some utility, but severely restricted when compared to high power usage.

Question 7: How would you suggest that the mechanisms presented here can be used, enhanced, or combined to enable hybrid sharing or are there any other mechanisms that would be suitable that we have not addressed?

We note that if the Upper 6GHz were to be exclusively assigned for mobile, this would actually represent a sharing of the 6GHz band given the Lower 6GHz has already been assigned for licence-exempt usage. Sharing of the Upper 6GHz amounts to mobile being allowed a share of the 6GHz band, then being asked to further share it with those who have already been given the Lower 6GHz. We do not believe this to be equitable.

If Ofcom is convinced that the upper 6GHz should be shared, then we believe that the focus should be on sharing on a geographic basis (as elaborated elsewhere in this document), rather than seeking to coexist mobile and Wi-Fi at a given location based on whether the user is indoors or outdoors. Indoor/outdoor sharing is based on a false assumption on usage, and would demand technological changes long after the standards have been agreed. We are not convinced of the merits.

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| Question 8: Assuming the future of the band includes indoor use for Wi-Fi and outdoors use for mobile:<br>a) how could this be achieved without creating or suffering interference?<br>b) could there be a combination of technical adjustments such as power limits and other mechanisms (including databases or sensing mechanisms)? |

We draw your attention to our comments in Question 1. We do not believe that this approach can be supported without causing interference.

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| Question 9: 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.<br>a) 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?<br>b) What are your views on the initial analysis we have conducted around hybrid sharing and coexistence with incumbents?<br>c) For any incumbent uses that you view as unlikely to be able to coexist, what alternatives are there? What are the barriers that might prevent those alternatives? |

We believe that there is a need to distinguish between incumbent usage by satellite and fixed-link users.

For satellite, we fully acknowledge and respect incumbent satellite services operating in the band and the need to adequately protect these services. Based on Ofcom's analysis, it seems likely that coexistence with mobile would be possible in all but the most extreme situations, however, we are disappointed Ofcom has decided to assume an extreme/unrealistic deployment scenario and subsequently submitted a proposal for a very restrictive emissions mask for inclusion as a technical condition in the European Common Position on 6GHz at WRC-23 (to be discussed at CEPT Common Preparatory Group meeting, CPG12-9, 18-22 September).

We consider Ofcom's decision to assume a density of base stations based on UK MNOs deployments of the 2100 MHz band, and to extrapolate this across the whole of Region1 (Europe, Africa & Middle East), as unrealistic, excessive and overly protective. In the UK at least, 2100 MHz band deployment was driven by the need to provide nationwide 3G coverage with specific coverage obligations attached to 3G licences. Vodafone and all operators have consistently stressed 6GHz will be used where it is most effective, primarily as a capacity layer for 5G networks primarily in cities and other strategically important locations, with other bands providing more efficient and cost-effective coverage across other areas.

We also contest Ofcom's actual assumed value for the average number of base stations with 2100 MHz band deployed by UK MNOs today (16,000 sites per Operator) - ✂. Operators are not permitted to exchange sensitive network information, but this average is far in excess of our 2100 MHz band deployments today and therefore strongly implies as an average is incorrect. Again, when extrapolating over the whole of Region 1 (Europe, Africa and Middle East) and perhaps wider this would represent a serious error. We urge Ofcom to check before proceeding with any proposals to international regulatory meetings.

We are disappointed Ofcom have decided not to consider a more suitable proposal from UK MNOs to use its D1 model (based on 2600MHz deployments) as a realistic deployment model with a 'safety margin' to account for possible growth in IMT deployments.

We believe Ofcom's D2/2100MHz deployment assumptions also contradict the very essence of this consultation on sharing which is based on the fundamental premise 6GHz will not be deployed everywhere and hence may introduce some possibilities for sharing, in particular geographic sharing which we have proposed as an option.

Finally, we also note Ofcom's general approach and position on satellite co-existence is inconsistent and incompatible with Ofcom's 2021 Spectrum Management strategy which sets out Ofcom would look to "apply greater realism in analysis of coexistence between spectrum users, at both a national and international level" and that "this is key to making sure that we don't over-protect services and thereby limit the scope for spectrum sharing." Ofcom also adds: "We will therefore adopt a pragmatic approach, prioritising the coexistence analysis that offers the most opportunities for increased spectrum use". It also mentioned that its work would include "adopting realistic approaches to coexistence, based on protections that are actually necessary in real-life situations rather than theoretical 'worst-case' scenarios".

For fixed-links, again we fully acknowledge and respect incumbent services operating in the band. We also welcome Ofcom's initial analysis on the location and operating range/direction of the links however there are many more parameters to consider in this analysis including:

- channels and bandwidths used by the links, including the utilisation of these channels
- equipment capabilities (e.g. single band operation or multi-band operation)
- evolution of the services operating in the band (expected growth/decline)
- potential migration plans for these links/services to other spectrum bands and/or other technologies e.g., fixed links or higher capacity spectrum bands or satellite services

We also refer Ofcom to the 'toolbox' approach for managing and coordinating co-existence specified in ECC report 303.

Therefore, we believe fixed link and Mobile network coexistence can be handled through coordination and/or geographic separation. Licensing spectrum for Mobile networks actually enables co-existence as regulators can specify through licence conditions where and when Mobile network operators can deploy base stations, and through knowledge of base station and Fixed link locations can identify potential sources

of interference and take any mitigating action. This is not possible for licence-exempt devices which although operate at lower power levels cannot be controlled and guaranteed to not interfere with fixed services especially if deployed in vertically elevated positions in multi-storey buildings.

Moreover, as we set out in Section One, mobile usage would unlikely be nationwide, so, for example, links in rural areas may well be able to coexist (in any case, we note that the most prevalent users of these links are BT and MBNL, meaning that they are either supporting mobile networks, or are licensed to entities with mobile network operation interests). Nonetheless, we accept that there will be some links where coexistence with mobile deployment may be challenging. However, nobody has a perpetual right to utilise spectrum, and under Ofcom's standard Administered Incentive Pricing (AIP) model, if mobile usage was to be excluded by the presence of fixed links, then we would expect the fees associated with those fixed links to reflect the value loss to the excluded mobile networks. In reality, we would expect that the vast majority of fixed link usage should be possible to migrate to other spectrum bands.

It is suggested by Ofcom use of lower power/medium power levels for Mobile base stations could lower separation distance requirements, however, our estimation based on ITU propagation modelling assumptions (ITU-R P.452/2001) shows this reduction will not be significant. ✂. On the other hand, use of medium power 5G base stations across the whole network will heavily impact 6GHz coverage and performance for mobile networks. A better, more granular approach, again facilitated by spectrum licencing, could be to specify lower power levels only for base stations deployed within certain areas of Fixed links (rather than across the whole network which is unnecessary),

Finally, as outlined in the above response on satellite co-existence we again remind Ofcom of the principles it sets out in its 2021 Spectrum Management Strategy.

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?

Question 11: Do you have any other comments to make on these proposals or on the future use of the upper 6 GHz band?

See Section One. We respect Ofcom's exploration of the potential sharing of the Upper 6GHz band, but this must not detract from the immediate task-at-hand, which is to secure an IMT identification for the band at WRC-23. We believe that there is some scope for sharing on a geographic basis, but believe that the ideas around indoor/outdoor sharing will serve to severely constrain the value of spectrum for both mobile and Wi-Fi – in an attempt to squeeze a quart from a pint-pot, the result is likely a schooner.

Vodafone UK
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