Non-confidential version

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

BT's response to Ofcom consultation document issued on 6 July 2023

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BT Group

Contents

Executive summary

1. BT welcomes Ofcom's consultation to explore the options for a hybrid sharing approach that would enable the introduction of both Wi-Fi and licensed mobile in the upper 6 GHz band. It is important that a clear future spectrum roadmap exists so that network operators can plan for future investments in network equipment and spectrum. BT's overall position is that Ofcom should focus use of U6GHz on the highest value use case which is mobile:
    a. High power mobile presents the greatest value for this spectrum, especially given other options alone (mmWave, small cells, new technologies) will not be sufficient. Insufficient mobile spectrum risks poorer experiences for consumers, and longer term risks undermining the goals of Government's Wireless Infrastructure Strategy.
    b. Hybrid sharing is technically difficult and potentially costly. Eventually, it could mean neither Wi-Fi nor mobile works well enough for consumers in this band, as evidenced by studies being discussed in the CEPT ECC PT1 forum.
    c. Any move to hybrid shared use would need to be internationally supported. This is not currently the case, but is under study. The UK cannot go it alone on spectrum policy.
    d. Fixed link sharing would be possible geographically. Satellite sharing can also work, though we think Ofcom has used too conservative assumptions in its sharing studies.
2. There is a pressing need to identify additional mid-range spectrum to deliver the required mobile network capacity growth to meet future demand. Improvements in technology, introduction of small cells and availability of mmWave spectrum will play an important role but will be insufficient on their own: additional mid-band spectrum is important to deliver additional capacity in a technically and economically viable way and U6 GHz is an obvious solution.
3. Mobile would represent the highest value use of the U6 GHz band and prioritising it for this would secure optimal and efficient use of this valuable spectrum. Our modelling suggests that a share of U6 GHz could reduce the investment needed to meet future mobile network capacity growth by {✂ redacted } (excluding spectrum licence cost). Without U6 GHz, capacity growth will be constrained by affordability as well as practical/technical limitations and the quality of UK mobile networks would be poorer in future, to the detriment of UK businesses and consumers.
4. Wi-Fi has already recently benefited from an additional 500 MHz of spectrum in the lower 6 GHz band. It is now beginning to be used in newer Wi-Fi products and is an important band for that use in future. Further spectrum in U6 GHz would provide more capacity for special scenarios where additional spectrum capacity may be beneficial and would allow additional 160/320 MHz channels. However, restricting the U6 GHz spectrum to low power licence-exempt use would likely represent less economically efficient use of the spectrum than higher power cellular use.
5. We are open to the possibility of shared use with lower power licence-exempt technologies, such as Wi-Fi, if such use does not conflict with higher power mobile use. But we are sceptical as to whether the technical complexity and associated impact on the commercial viability of such schemes would be workable: shared use does not necessarily mean that more efficient use of the spectrum would be achieved.

6. Hybrid shared use of the U6 GHz band risks interference, or technical complexity to avoid this which is likely to be costly. If both systems need to implement some measures it is possible that neither would be commercially viable. The requirement to implement and consult databases and develop and implement standards in equipment to include special features to enable sharing would need to be done on an international basis. A particular concern is how any such system would prevent interference between mobile devices working indoors to an outdoor base station and Wi-Fi systems indoors. Dedicated spectrum without constraints may be more efficient.
7. Sharing with fixed links is essentially a national issue. Large parts of the band in many areas of the UK would support mobile use without constraints to avoid interference with fixed links because there are no fixed links deployed. In other areas that are relatively remote, mobile use of the band may not be required for many years or could operate with a certain geographical separation determined by detailed frequency coordination. In urban areas, if mobile is a higher value use, Ofcom should consider requiring the existing users to migrate to other bands or technologies within a reasonable time frame.
8. Sharing with satellite services has been demonstrated to be feasible. It is important that any associated technical constraints are not based on overly conservative assumptions or place unnecessary constraints on future mobile use. We would encourage Ofcom to support the emerging European consensus to accept an identification of the U6 GHz band for International Mobile Telecommunications (IMT) within the ITU Radio Regulations and to minimise the technical constraints on mobile use so that the spectrum can be used to generate maximum value.

1 Introduction

BT[1] welcomes this opportunity to provide its views on Ofcom's consultation to explore the options for a hybrid sharing approach that would enable the introduction of both Wi-Fi and licensed mobile in the upper 6 GHz band[2].

In **section 2** we discuss the requirements to use the U6 GHz band for mobile and illustrate the benefits this could deliver to consumers and why the spectrum is valuable for mobile use.

In **section 3** we provide our views on the feasibility of hybrid shared use of the U6 GHz band between conventional mobile and Wi-Fi (or similar low power) use.

In **section 4** we discuss and provide evidence to support Ofcom's assessment of the feasibility of coexistence between mobile and existing users of the band, notably fixed links where BT has extensive use.

Finally, in **section 5**, we discuss the recommended way forward.

We have addressed Ofcom's specific consultation questions at relevant points in this response and provide a cross reference to the relevant section numbers in Annex 1.

2 Mobile spectrum requirements

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 will be 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 will be 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?

Question 6: If hybrid sharing is eventually adopted, and requires mobile to operate at medium power, in what way would mobile networks use the upper 6 GHz band?

Mobile traffic growth requires more mid-band spectrum by 2030

Ofcom rightly highlights the continued growth in both mobile and fixed broadband traffic. We agree with Ofcom's observations regarding rate of growth of mobile traffic. We agree that fixed link traffic growth is currently less than mobile traffic growth.

The U6 GHz band is likely to be primarily used as an additional capacity layer in areas of the country where traffic demand is highest and other existing spectrum has already been deployed. It would

[1] BT, including our mobile subsidiary EE Ltd.

[2] https://www.ofcom.org.uk/__data/assets/pdf_file/0031/263776/condoc-upper-6-GHz-review-June23.pdf

support projected data traffic growth and likely support 5G technology initially. In time, like other licensed mobile bands, it could also be suitable for future 6G technology and would need to be awarded on a technology and service neutral basis, as per Ofcom's normal approach.

In **Annex 2** we provide the results of simulations that predict the number of small cells that will be needed to meet capacity demand over the next decade, both in the absence of additional mid-band spectrum and in the scenario where the U6 GHz band is made available for mobile and BT secures access to a proportion of it.

The analysis we have undertaken shows:

- Small cells build with existing spectrum, even if affordable, and practically achievable given physical limitations and planning/access to sites, would not meet all future traffic demand due to technical limitations.
- Availability of additional mid-band spectrum, deployed on existing macrocell sites, would significantly reduce the number of small cells required to meet future growth in traffic demand, reducing future network costs towards more realistic levels and reducing the gap between traffic demand and the capacity that can realistically be delivered.
- The value of the U6 GHz spectrum, if useable for macro cellular networks at full power, is very substantial. Our modelling indicates {✂ redacted

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Whilst U6 GHz could be used for reduced power small cells, the greatest benefit comes from full power use on macro cell sites. It is therefore important that Ofcom does not introduce unnecessary technical constraints that would undermine this in domestic or international regulations.

More Wi-Fi spectrum would have less benefit and so is lower priority for BT

As Ofcom identifies, additional Wi-Fi spectrum would have benefits, for example supporting more 160 MHz / 320 MHz channels that could be important in some scenarios. We acknowledge this, but consider that the greatest benefits would come from making the spectrum available at much higher power for wide area mobile networks. The projected growth in capacity that is required to support ever increasing traffic cannot be satisfied entirely on practical, technical and economic grounds by alternative means, such as use of mmWave and deployment of small cells. To limit the U6 GHz spectrum to low power, when there is so much other low power spectrum already available, would not represent efficient use of this scarce resource.

3 Feasibility of hybrid sharing

3.1 Potential technical solutions

Ofcom says that over 60% mobile traffic is indoors. Even though the U6 GHz band may not reach indoors extensively as sub-1GHz bands, the fact that a high proportion of mobile network is associated with indoor users illustrates why hybrid sharing between Wi-Fi and mobile would be challenging and require some technical measures to avoid interference.

Recent studies in the CEPT ECC Project Team 1 (PT1), including a study submitted by Ofcom, which were discussed at the September 2023 meeting of that group[3], all clearly demonstrate that Wi-Fi and mobile networks operating co-channel in the same geographic areas, even with Wi-Fi deployed indoor and mobile base stations outdoors, would lead to significant interference problems for both applications.

In particular the studies highlight that Wi-Fi would not avoid frequencies used for mobile that are at a level below the current energy detection (ED) thresholds of Wi-Fi and would suffer significant degradation from mobile signals that would be above the noise floor of Wi-Fi systems. Wi-Fi is also predicted to extensively interfere with the mobile downlink and uplink signals.

These studies are based on median propagation and building penetration losses, and so will inherently under estimate interference risks in many cases.

Thus, mitigation techniques and regulatory measures would be needed for co-channel sharing and the question then arises as to what these may be, whether they are feasible in terms of complexity and costs and whether they would actually lead to more optimal and efficient use of the spectrum compared to if the two systems operate using separate frequencies.

3.1.1 Hybrid sharing mechanisms

Question 3: What are your views on reusing a modified AFC or SAS-type approach to enable hybrid sharing? What additional work do you think would be required?

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?

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?

Managed databases

In the case of mobile, if static assignments are provided at a specified maximum power level, a database is not needed as such since the MNO's spectrum licence could specify where base station deployment is allowed and end user mobile devices would only operate when connected to a base station.

In the case of licence-exempt Wi-Fi, a database could manage where access points may operate in the U6 GHz band. But, unlike with mobile networks where there are just 4 licensees to deal with on behalf of c. 80m end users, there are potentially tens of millions of Wi-Fi users and an automated database system would surely be required to manage them. This would be complex and costly and would likely require international standardisation. Consequently, it is questionable as to the extent to which it would be used, noting that in most circumstances other Wi-Fi bands would provide sufficient spectrum resources for the services that are to be provided. As Ofcom also has pointed out, geo positioning of indoor devices would be hard to accomplish, meaning that the places where access to the U6 GHz band by Wi-Fi is most likely to be of interest will be technically challenging. Furthermore,

[3] See documents ECC PT1(23) 196r1 (LS Telecom / Meta); ECC PT1(23) 197 (UK); ECC PT1(23) 200 (Broadcom); ECC PT1(23) 204 (Qualcomm); ECC PT1(23) 205 (Huawei); and ECC PT1(23) 216r1 (Vodafone/Ericsson) available at https://www.cept.org/ecc/groups/ecc/ecc-pt1/client/meeting-documents?flid=31595

database controlled access would not be suitable where Wi-Fi devices connect directly to each other rather than via an access point that communicates with a database system.

In Ofcom's example 1 (Mobile in London, Wi-Fi outside London) the need to geolocate Wi-Fi devices indoors is acknowledged but no explanation is given as to how that could be accomplished (GPS reception indoors is problematic). This seems to be a fundamental issue that would need to be solved for the hybrid sharing proposal to work from a technical standpoint.

In Ofcom's example 2 (time shared prioritisation of mobile or Wi-Fi in a stadium), we note that a database is not strictly necessary to manage which system can operate at which time period, but could be used to do so. This example is interesting as it is unclear whether the choice of who can install coverage in the stadium (Wi-Fi or mobile) might in practice be up to the stadium owner rather than Ofcom. It is also unclear how Ofcom would decide if Wi-Fi is considered a more efficient use of the spectrum than mobile in this example scenario, or why more Wi-Fi spectrum is needed if the system in the example stadium already works.

In Table 1 of the consultation document Ofcom illustrates how existing database solutions of AFC and SAS could be applied and adapted for hybrid sharing. In relation to this table we comment as follows:

- For an AFC database system to be used to support a geographical split similar to the example 1 referenced in the table, an important item of potential additional work is missing: how would indoor Wi-Fi systems identify device location so they could be reported to the AFC system?
- If an SAS database system were used to prioritise Wi-Fi deployments in particular areas, it might be necessary not just for Wi-Fi systems that require protection to be notified to the database (which in itself may be difficult to automate due to lack of GPS coverage when indoors), but for new Wi-Fi systems to check the database to see if mobile is already deployed.
- With an SAS database system new Wi-Fi couldn't be protected in all cases unless established mobile base stations have to vacate the band, which seems an unreasonable approach as it would mean mobile operators would be unlikely to commit large investments to deploy the base stations if tenure of assigned frequencies is uncertain.

Spectrum sensing

In TDD mobile systems the mobile and base station will be on the same frequency. The fact that there is building penetration loss between an outdoor mobile base station and an indoor Wi-Fi system is not particularly relevant when assessing risk of interference between mobile and Wi-Fi if the mobile is located in the building. In Example, 3 Ofcom assumes that an indoor mobile would be using lower frequencies than the U6 GHz band. While we agree it is possible that this could be the case, it is not necessarily so.

Changing or developing sensing protocols in mobile or Wi-Fi is theoretically possible but it is questionable how long this would take, how effective the protocols would be and what additional costs and complexity this would involve. Our concern is that this would take years to accomplish and might be so costly that the spectrum is less efficiently used than if it were assigned to one system or the other, or even initially partitioned while sharing protocols are established, if Ofcom believes the balance of value between the two alternative services requires this.

In Table 3 of the consultation document the sensing protocols that could support hybrid sharing are discussed. In relation to that table, we would note that:

- The **Listen Before Talk protocol**: where the IMT base station is distant (say >1km) from the Wi-Fi system it might be difficult to detect Wi-Fi and yet the mobile terminals could be in close proximity to Wi-Fi, leading to interference and negative consequences for user experience.
- Use of **DFS or ACS mechanisms**: a concern with a more dynamic ACS feature in the Wi-Fi would be that if Wi-Fi had to move off a frequency when mobile use is detected it could lead to poor customer experience, for example if a video stream to a set-top TV box is disrupted in the middle of a TV programme.

Combining sensing with databases

In theory we agree that this would likely be the more robust technical solution to hybrid sharing, but at the same time the downsides of complexity and costs are even greater in the scenario of combining both techniques. The risks that it will not be a commercially viable solution are therefore even greater than if just one technique were required..

3.1.2 Device to device considerations

Question 5: What mechanisms could potentially enable device-to-device connections?

We question whether device to device applications require additional licence-exempt spectrum and, if they do, whether accommodating these in the same spectrum as licenced mobile is a good idea. Our view is that the added cost and complexity of standardising and implementing suitable mechanisms to avoid mobile use in the same band would outweigh the benefits, given there is already a large amount of licence-exempt spectrum available in a range of bands that could be suitable for short-range device to device communications.

3.1.3 Alternative approaches

As Ofcom explains, an alternative to hybrid sharing would be to partition the U6 GHz band between Wi-Fi (licence-exempt technologies) and licenced mobile networks. Considering the amounts of existing spectrum available to Wi-Fi and the benefits of providing more spectrum for these applications, the priority should be for additional mobile spectrum and as such the partition should be at or close to the bottom of the U6 GHz band in this scenario.

In our view partitioning the band with all or most of the spectrum dedicated to mobile would lead to a more optimal and efficient use of the spectrum than pursuing hybrid sharing.

Whilst "fair sharing" of the spectrum is mentioned by Ofcom as an objective, this needs to be considered in the broader context of the existing amounts of spectrum already dedicated to Wi-Fi and to mobile, and taking into account that mobile spectrum assignments are already highly shared – by tens of millions of end users of each MNO – and sharing the same frequencies between MNOs, or between MNOs and Wi-Fi, may not actually generate much additional benefit: rather it would likely generate unnecessary costs, complexity and, ultimately, potentially less efficient use.

Licence-exempt Wi-Fi operates today on a non-interference non-protection basis[4] in other bands. If Wi-Fi were introduced on a shared basis alongside licensed mobile use in U6 GHz and was able to

[4] See, for example, para 2.6 of https://www.ofcom.org.uk/__data/assets/pdf_file/0021/68601/wta-exemptions-15.pdf

mitigate risk of interference to mobile use this could be a way forward, with the higher value mobile use having priority in the band.

3.2 Commercial considerations

Even if the theoretical technical measures could be established to control interference and enable hybrid sharing in the way Ofcom suggests, the commercial implications need to be considered.

For example, it is unlikely that an operator will commit substantial investment in a U6 GHz macro base station if, as per the sensing option of Listen before Talk proposal in Table 3 of the consultation, a single Wi-Fi deployment that appears in the coverage of the base station delivering wide area cellular coverage would require it to be turned off and rendered unusable.

3.3 Efficient and optimal use

The experience of the TV White spaces serves as a good example of how a theoretical scheme to improve spectrum efficiency by hybrid sharing may in practice not deliver the intended benefits. There are some parallels with the scheme that Ofcom is now considering for the U6 GHz band and these bring in to question whether the hybrid sharing will generate the benefits that Ofcom is seeking. The TV White Spaces initiative did not deliver as had been hoped, for multiple of reasons, but in our view the primary reasons were: the devices where far more expensive than standard 4G devices because the volume of devices produced was relatively very small; and the permitted transmit power levels were so low to prevent interference to TV that the system coverage was poor and therefore unattractive or commercially viable. Added to that, the need to develop or use database systems to manage the shared use and uncertainty over the availability of channels introduced additional complexity, risks and costs.

A further example of where shared use of spectrum is of questionable efficiency is the 3.8 – 4.2 GHz band. Here the number of licensees and assignments is very modest and deployments extend to cover a small fraction of the UK geography after several years. In contrast a similar amount of spectrum in 3.4-3.8 GHz has been rolled out in just a few years to cover the majority of the population with 5G service to the benefit of tens of millions of customers.

Our concern is that the hybrid shared use of the U6 GHz band may not secure the most optimal and efficient use of this spectrum as Ofcom intends. Instead it could result in much less efficient use of the band as the costs and complexity of implementing technical solutions to the band may deter its use by both Wi-Fi and mobile and would delay its availability.

It is better to keep licence-exempt use and licenced use in separate frequency bands in this case, partitioned according to what will generate optimal value from the use of the spectrum. Whilst in theory more efficient use could arise from sharing, in practice the demand for Wi-Fi and mobile is likely to be mostly in the same areas at the same times. So, in practice, there is not much efficiency to be gained by mixing licence-exempt and licensed technologies and users in the same frequency band.

4 Co-existence with existing users

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.

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?

b) What are your views on the initial analysis we have conducted around hybrid sharing and coexistence with incumbents?

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?

4.1 Fixed links

At first glance the large number of existing fixed links might lead to a view that coordinated shared use of the band between fixed and mobile use may not be feasible. However, a more detailed analysis of the fixed link assignments gives a better insight in to the potential for shared use of the band in each frequency segment and geographic area and is necessary to draw clearer conclusions.

We have analysed the existing fixed links deployments in the U6 GHz band, as recorded in the Wireless Telegraphy Register (WTR) that Ofcom maintains and publishes, to get a more detailed understanding of the existing use and whether some kind of continued shared use would be possible with appropriate frequency coordination.

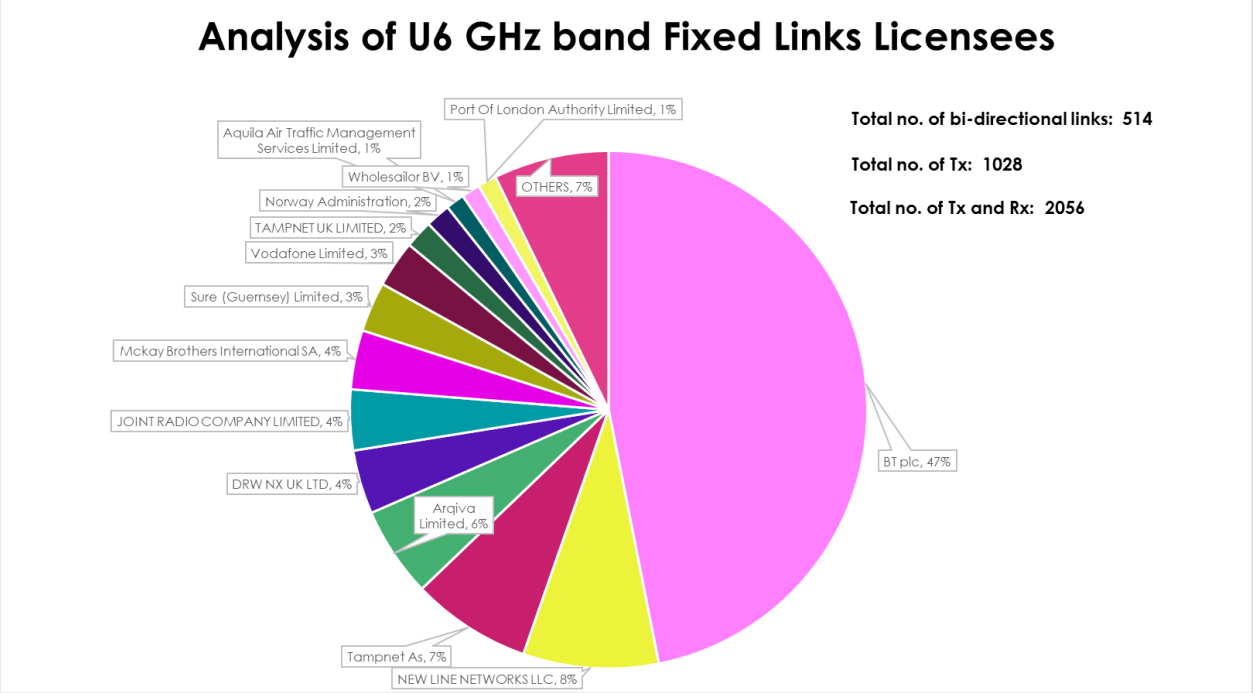
In the case of cellular mobile systems, the principle of 'listen before talk' is applied, whereby mobile devices only transmit when instructed to do so by a mobile base station that has been authorised to use the band (and if necessary only at specific locations according to a licence). This makes coordinated use by public mobile networks in relation to fixed links quite straightforward. In contrast, for Wi-Fi systems, if licence-exempt, it would be hard to limit where the systems are used and would require potentially complex and costly database solutions which might make the band less attractive than other equivalent spectrum (i.e. L6 GHz).

Analysis of U6 GHz fixed link licensees

There are currently 2056 entries in the WTR for Tx or Rx frequencies corresponding to 1028 transmit frequencies and 514 bi-directional fixed link assignments. The BT links are generally multi-channel links over the same path, so in fact the total number of unique fixed link paths will be far less than this number.

There are currently a total of 31 licensees with frequency assignments in the U6 GHz band, of which almost half of these assignments are to BT, as illustrated in Figure 1.

Figure 1



Analysys of U6 GHz fixed links frequency occupancy

As shown in Figure 2 and Figure 3, the existing fixed links occupy frequencies throughout the U6 GHz band.

In any national 100 MHz frequency block there are roughly 200 fixed links somewhere in the UK with a transmitter that could cause interference and an associated receiver that would need to be protected from interference in the relevant areas around each of those links.

The U6 GHz links use channel bandwidths of 20MHz (74 Tx/Rx's); 30 MHz (574 Tx/Rx's); 40 MHz (1384 Tx/Rx's); and 60 MHz (24 Tx/Rx's). Therefore, in a given 100 MHz block, as can be seen in Figure 2, if a fixed link conflicts with mobile use in a given location it would typically affect at least half of a 100 MHz block.

Figure 2

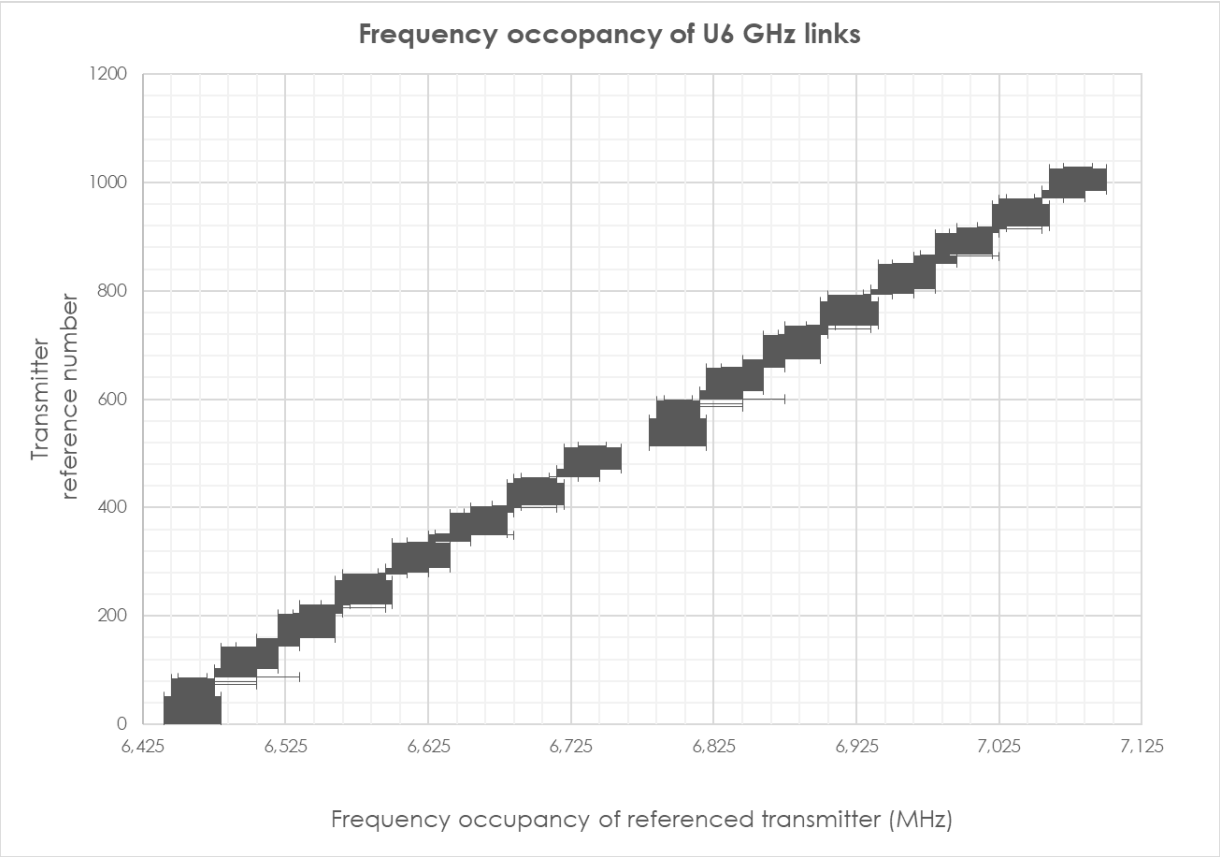
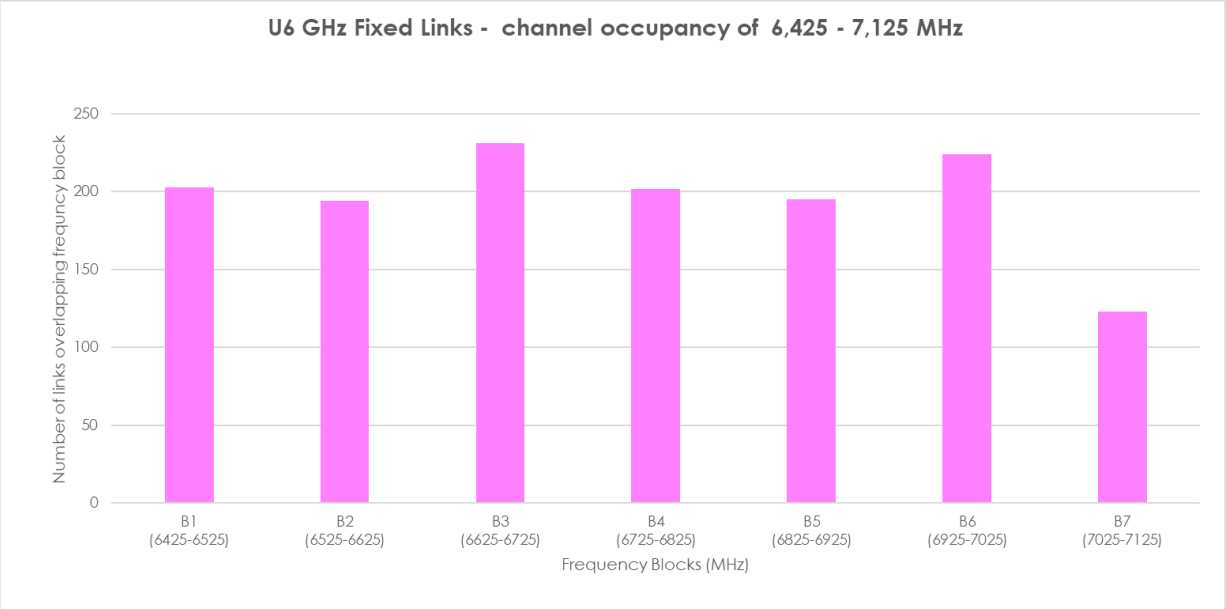


Figure 3

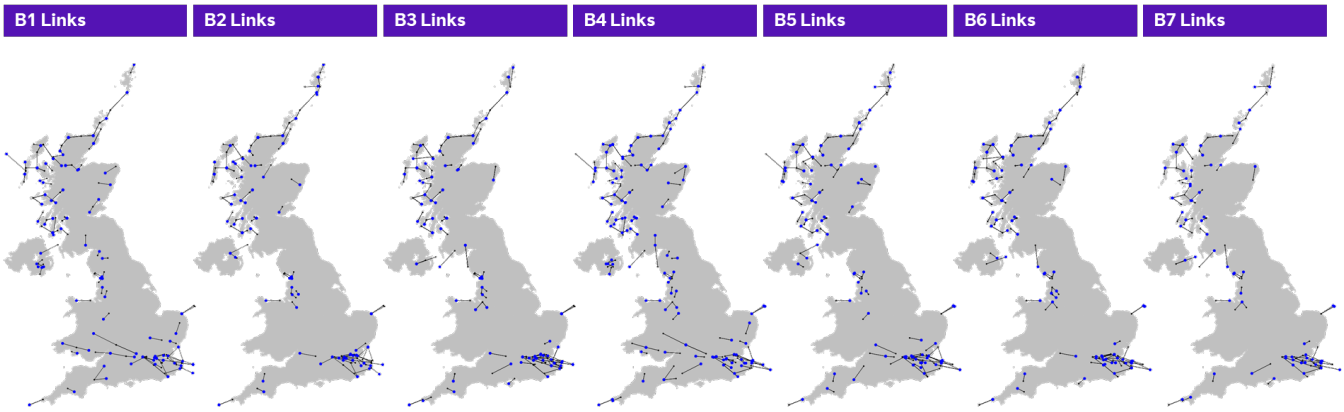


Analysis of U6 GHz fixed link locations

The maps in Figure 4 below show where in each 100 MHz segment (B1 – B7) of the 6,425 – 7,125 MHz band the links are located. The maps are reproduced individually in greater detail in Annex 3.

Figure 4

Geographic location of the U6 GHz fixed links in each 100 MHz segment of the band



Feasibility of coordinating mobile networks with existing fixed links

We have not modelled the size of the coordination zones around the fixed links but would expect these to be narrow corridors along the path of the links and extending well beyond the end of the links, largely dictated by the antenna radiation pattern of the fixed links[5]. Our preliminary view, in the absence of detailed modelling, is that in any given 100 MHz block of spectrum there will be a number of fixed link transmitters that could cause interference with corresponding fixed link receivers that must be protected from interference. Given the numbers of links, their locations and likely extent of the associated coordination areas, continued shared use of the spectrum with fixed links could be feasible, at least in the early years of rollout of mobile services and potentially in the longer term in many places.

Where fixed links are in or near urban areas, where there is likely to be greatest demand to use the spectrum for mobile, there may be a need to consider relocating the U6 GHz band fixed links to other bands, or migrate these to fibre connections. This is justified where use by mobile would represent more optimal and efficient use of the spectrum and Ofcom might consider whether there is a case to compensate licensees that are required to move with a grant to promote overall spectrum efficiency.

Overall, our conclusions are essentially in line with Ofcom's analysis provided in the consultation document, but seek to bring out the additional point that the existing links will, in many cases, only affect particular frequency slots within the band, which may reduce the coordination issue somewhat. The BT links in the U6 GHz band are generally multi-channel hops and may therefore present a greater coordination challenge, but these are generally in Scotland and near coastal areas rather than in urban areas.

[5] ECC Report 64, although rather dated and for another frequency band, provides an illustration of the basic concept. https://docdb.cept.org/download/2125 . The more recent ITU studies, that Ofcom has referenced (https://www.itu.int/md/R19-WP5D-230612-TD-0878/en) also support he view that coordination between fixed links and mobile could be manageable.

4.2 Fixed satellite services

The existing use of the band by transmitting UK Earth stations is very limited in terms of number of sites and extent of the frequency band that is used. Coordination around the relevant site(s) to prevent interference to mobile use should be straightforward.

Studies in the ITU and CEPT have considered possible aggregate interference to receivers on satellites and various conclusions have been reached, depending on assumptions used, as to whether shared use is feasible. Various constraints to mobile base station deployments that would ensure interference is avoided are under discussion.

We are following the international studies and discussions about how satellites may be protected from uplink interference, including the development of an "expected EIRP mask" that could be applied to mobile base stations to control interference and enable shared use of the U6 GHz band between mobile networks and fixed-satellite services. As Ofcom illustrates in the consultation document, the low elevation angle emissions that would affect satellites far from the UK seems to present the greatest challenge. The conclusion of the studies is very sensitive to the input assumptions used and the assumptions that Ofcom has chosen to use are more conservative than some other administrations have used and in turn lead to greater proposed constraints on future mobile networks.

Our concern is that with the conservative approach being taken, the proposed constraints may not be practical to implement in mobile base stations or will significantly constrain power levels that can be used. In practice base stations may use a range of power levels and it would not be appropriate when setting power limits to assume that all would operate at full power or would not be subject to significant blocking at low elevation angles. We encourage Ofcom to consider aligning with administrations that advocate less onerous constraints on mobile base station "expected EIRP" limits and to not seek to submit overly conservative proposals to WRC-23 or push for protections in the Radio Regulations that go beyond what is actually necessary to protect satellites given the likely extent of use of U6 GHz in most countries (i.e. in high traffic areas, not on every base station in Europe).

4.3 Radio Astronomy

We note the belated request to protect radio astronomy use. Typically this is achieved by establishing a suitable coordination zone around the relevant sites. We would be interested to understand more about the existing UK use and what protection from interference might be requested.

5 Our suggested and preferred way forward

Question 8: Assuming the future of the band includes indoor use for Wi-Fi and outdoors use for mobile:

a) how could this be achieved without creating or suffering interference?

b) could there be a combination of technical adjustments such as power limits and other mechanisms (including databases or sensing mechanisms)?

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

We suggest the following approach moving forwards on the U6 GHz band:

- Work with the rest of Europe to complete the work initiated to investigate the feasibility of a shared approach to use of the U6 GHz band by mobile and Wi-Fi.
- Join the emerging European consensus position on the U6 GHz band at the ITU WRC-23 conference and support an International Mobile Telecommunications (IMT) identification at the WRC-23. As part of this it is important to refrain from supporting technical measures that are more limiting than necessary that would in practice render the band not useable for high power mobile use.
- Prioritise the U6 GHz band for mobile and award this on a national basis by auction in time for use in a 2025-2030 timeframe.
- If shared use with Wi-Fi is ultimately found to be feasible with interference mitigation measures implemented by Wi-Fi, consistent with the usual basis for Wi-Fi of a non-protection and non-interference basis, allow introduction of Wi-Fi in the future in some or all of the U6 GHz band.

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?

We have not identified any other bands where we would recommend that Ofcom could usefully explore hybrid sharing at this time.

Annex 1 - Consultation question responses

Consultation Question	Relevant section of BT's Response
1	Section 2
2	Section 2
3	Section 3.1.1
4	Section 3.1.1
5	Section 3.1.2
6	Section 2
7	Section 3.1.1
8	Section 5
9	Section 4
10	Section 5
11	Section 5

Annex 2 – Illustration of the benefits of making U6 GHz available for mobile

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Annex 3 – Analysis of U6 GHz fixed links locations by band segment

Figure A2. 1: Fixed links in 6,425 – 6,525 MHz sub-band

Figure A2. 2: Fixed links in 6,525 – 6,625 MHz sub-band

Figure A2. 3: Fixed links in 6,625 – 6,725 MHz sub-band

Figure A2. 4: Fixed links in 6,725 – 6,825 MHz sub-band

Figure A2. 5: Fixed links in 6,825 – 6,925 MHz sub-band

Figure A2. 6: Fixed links in 6,925 – 7,025 MHz sub-band

Figure A2. 7: Fixed links in 7,025 – 7,125 MHz sub-band

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