

Fixed Wireless Spectrum Strategy

Consultation on proposed next steps to enable future uses of fixed wireless links

CONSULTATION:

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About this document

We recently¹ gathered information on how the uses of fixed wireless links could change over the next 5-10 years. This document summarises our key findings and consults on specific areas which focus on enabling ultra-high capacity wireless backhaul requirements for the future.

Fixed wireless links are used to provide wireless connectivity for a range of uses such as mobile backhaul, utility services, broadcasting and financial networks using a range of spectrum bands.

In light of stakeholder responses, we are now consulting on specific areas that would enable evolved uses of fixed wireless links. With capacity requirements set to increase significantly, particularly as new technologies and networks evolve towards 5G, greater focus is now being placed on the higher millimetre wave bands to deliver this capacity. In order to start this discussion, this document explores new potential spectrum above 92 GHz.

The document consults on changing the authorisation regime in the 64 – 66 GHz band to licence exempt and seeks views on a revised technical condition across the 57-66 GHz, commonly known as V band, in order to enable new fixed wireless access use cases. We are also seeking views on the adjacent 66 - 71 GHz band given that it could be part of the same ecosystem as V band.

This consultation closes on 1 February 2018.

¹ <https://www.ofcom.org.uk/consultations-and-statements/category-1/call-for-inputs-fixed-wireless-spectrum-strategy>

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1. Summary

Introduction

- 1.1 A fixed wireless link, also referred to as a microwave link, is the wireless transmission of information between two or more fixed locations using electromagnetic waves.
- 1.2 Fixed wireless links complement other transmission media such as connections provided by fixed networks e.g. fibre. Fixed wireless links are used where fibre is not available or cost effective for a variety of applications including:
 - backhaul provision for mobile network base stations;
 - distributing TV signals from studios to broadcast transmitter sites;
 - connecting nodes within private or corporate communication networks;
 - enabling the safe and secure supply of water, electricity and gas in the UK;
 - emergency services communications backhaul; and
 - provision of fixed wireless broadband for last mile connectivity commonly known as fixed wireless access.
- 1.3 In the UK, the radio spectrum used to deploy fixed wireless links consists of specific bands currently ranging from 1.3 GHz to 86 GHz. The choice of frequency band is dependent on various factors including range, resilience to rain and availability of spectrum. The bands are also, in most cases, harmonised across Europe and shared with other services.
- 1.4 With the increasing requirement to carry even more data, along with a number of significant market, technological and spectrum developments, we are continuing our focussed look at the fixed wireless service sector. We want to better understand the impact these changes mean for the fixed wireless sector over the next 5-10 years and how the regulatory and licensing framework can best support it to ensure that citizens and consumers will continue to benefit from fixed wireless services in the future.
- 1.5 To develop our view of the future and to help us determine the scope and scale of the policy issues that might be addressed, we published a Call for Input² (CFI) in July 2016. We invited stakeholders to present information and evidenced views to help us understand current use and likely future demand. The CFI also focussed on technology changes and their impact on spectrum used by fixed wireless links. The CFI was followed by a stakeholder engagement process for those stakeholders wishing to have one to one discussions with us. This has provided us with a more detailed insight into the diverse range of uses of fixed wireless links and how these are expected to evolve over time.

² <https://www.ofcom.org.uk/consultations-and-statements/category-1/call-for-inputs-fixed-wireless-spectrum-strategy>

- 1.6 Additionally, in the international arena several spectrum bands used by fixed wireless links are being considered for mobile access including for 5G³ which is likely to affect the future nature of availability of spectrum for fixed wireless links.
- 1.7 This document reflects the findings of our information gathering and sets out our views on the areas we plan to focus on going forward. We are consulting on this programme of work and on specific technical regulatory and policy changes in the 57 - 66 GHz band where we consider additional flexibility can be provided to allow for a wider range of applications and use cases.

Our view on how the fixed wireless sector continues to evolve

- 1.8 Our CFI findings indicate that over recent years the use of fixed wireless links has been influenced by the following key changes:
- **Greater data and coverage requirements:** data capacity is significantly increasing, predominantly in areas that depend on fixed wireless connectivity. Services such as mobile broadband rely heavily on fixed wireless links to provide backhaul connectivity. In the move towards 5G, this review has considered stakeholder information on how they expect demand will change as both capacity requirements and geographic reach increase. The need to increase population reach driven by Government initiatives has also meant that even more emphasis is being placed on how data will be delivered to rural communities.
 - **New technology developments and uses:** the equipment used by this sector is evolving to meet the changing demands. Various new technology options are being developed and considered to enable efficient high capacity data transmission to accommodate the emerging requirements now and in the future. In recent years, there have also been new applications for fixed wireless connections such as utilising the low latency properties of wireless (compared to fibre) to connect financial trading centres to support financial applications.
 - **Evolving network architecture:** The above two influences have brought about the continuing need to evolve networks to support the delivery of high capacity data. More recently, this evolution has seen further advancement in the way the networks are changing. For the interconnectivity and backhauling for mobile broadband, particularly small cells in the dense urban areas, delivery of more capacity is a key consideration for the networks that are being developed. In addition to this expected increase in wireless capacity, the use of fibre is becoming more prominent increasingly shifting the use of fixed wireless links towards the edge of the network. For other uses of fixed wireless links, resilience, reliability and low latency remain key factors in the choice of how the network architectures evolve and the technologies that are used.

³ 5G is the next generation of mobile technologies and is being designed to provide greater capacity for wireless networks, offer greater reliability, and deliver extremely fast data speeds, enabling innovative new services across different industry sectors. Under WRC-19 Agenda Item 1.13 – 8 out of the 13 fixed service bands are being considered for alternative use (as part of the work on IMT2020)

The impact of this means that the spectrum supporting these changing needs has to be fit for purpose.

Our vision for the coming decade

- 1.9 Spectrum is a vital component to enable wireless communication and one of Ofcom's main duties is to ensure that radio spectrum is used in the most effective way. To enable this, the objective for this review is to understand how the needs of the fixed wireless services sector are changing to meet future connectivity needs. A key aspect of this is to understand the needs of the disparate uses of fixed wireless links and how these will evolve over the next 5-10 years.
- 1.10 Our high level goal is to ensure that spectrum is not a barrier to making communications work for everyone. To achieve this, we will work towards ensuring timely availability of the right mix of spectrum for the fixed wireless sector and with the right authorisation approach to meet future requirements.

Our views on the main findings

Moving towards 5G

- 1.11 We consider the main driver for future demand for fixed wireless links will be mobile / 5G backhaul requirements. We expect this demand, particularly from the denser networks anticipated for 5G, will drive much higher capacity requirements using shorter fixed wireless links closer to the edge of the network.

Connectivity using fibre

- 1.12 We consider that connectivity using fibre will remain the first choice where cost effective and available. However, stakeholders indicated that fixed wireless links will continue to be relied on where the cost of laying fibre is prohibitive, quick deployment is required or to provide a redundant route to fibre which is particularly important for some sectors like the utilities.

More capacity to provide better broadband using fixed wireless links

- 1.13 We note some SME interest in responding to government initiatives to provide better broadband connectivity. Some SMEs indicated this as a key part of their strategy. To enable this, fixed network operators tend to use fixed wireless links in all fixed wireless link bands and indicate that they expect that this requirement will continue over the next 5-10 years as fixed wireless links still offer connectivity to the rural areas and are often more cost effective and faster to deploy than fibre.

Monitoring the possible impact due to a more distributed model for electricity generation

- 1.14 Moving from a centralised to a distributed electricity generation model is likely to encompass a variety of ways in which electricity is generated including a drive towards renewable energy sources. Energy distribution along with all the necessary communications and network management, monitoring and control functions all require high reliability communications infrastructures. A change to a more distributed model could result in additional requirements for fixed wireless links which we will monitor.

New uses of fixed wireless links

- 1.15 We've identified trends in new uses of fixed wireless links for the financial sector which has contributed to one of the largest increases in links since our 2012 review. This is a trend that we will continue to monitor.

Our preliminary conclusions

Bands below 20 GHz

- 1.16 From our findings, we consider that bands below 20 GHz will continue to be required by users requiring longer links in both rural and suburban areas, as well as for applications where an increase in capacity would be required on longer routes. This has also been indicated for wireless backhaul provision of rural broadband (such as connecting between aggregation nodes to local access points) in the cases where fibre is not available or cost effective.
- 1.17 Ofcom has set out plans⁴ to make the 3.6 – 3.8 GHz band currently used by fixed wireless links⁵ available for mobile. Ofcom is currently considering representations from fixed link licensees on its proposals to revoke existing fixed link licenses authorising transmission using frequencies in this band, and will notify affected licensees of its decisions on these proposals by the end of this year. This frequency range (channels 1-7 on the 30 MHz channel plan) is closed to new applications for fixed link licences.
- 1.18 European harmonisation of a mobile band plan for the 1.4 GHz band (1492 – 1518 MHz) is currently underway in CEPT⁶. In addition, there are plans for the band to be harmonised for mobile use (SDL)⁷ on a EU wide basis under EU harmonisation measures⁸.

⁴ https://www.ofcom.org.uk/_data/assets/pdf_file/0017/103355/3-6-3-8ghz-statement.pdf

⁵ At the time of writing of this consultation there are 26 fixed links in the 3.6 – 3.8 GHz band.

⁶ CEPT (the European Conference of Postal and Telecommunications Administrations) is a regional European body of 48 countries that carries out technical studies to promote harmonisation of spectrum use and enable economies of scale in spectrum technology.

⁷ Mobile Fixed Communication Network Supplemental Downlink (MFCN SDL, generally referred to as SDL in this document)

⁸ https://circabc.europa.eu/sd/a/0518563d-6cbc-4f51-aa48-02ce20413a96/RSCOM17-41%20Draft%20Amending%20Decision%201.5_GHz.pdf

Taking these developments into account, we are seeking further information and views regarding the suitability of the 1350 - 1375 MHz band for low capacity TDD fixed wireless link applications. We also wish to further explore small channels based on CEPT channel plans at 6 GHz as potential replacement option for low capacity links in the 1.4 GHz band noting that spectrum at 6 GHz is also currently being considered for radio local area network (RLAN) within Europe⁹.

Bands between 20 and 45 GHz

- 1.19 The primary use in these bands is for mobile backhaul. With greater fibre penetration in urban areas, we anticipate new backhaul links in urban areas would focus on bands above 60 GHz including different network topologies such as point to multipoint/mesh architecture operating closer to the edge of the network. The spectrum at this frequency range offers shorter connections but higher capacity backhaul to fibre point of presence. From our discussions with stakeholders, there are indications that there would also be an increase in capacity requirements for backhaul to mobile macro cells in suburban areas where fibre is not cost effective.
- 1.20 Licensees with block assigned¹⁰ spectrum expect to make more use of their “blocks” than requesting additional spectrum managed by Ofcom. Indications from MNOs therefore point to a reduction in the number of fixed wireless links in Ofcom managed spectrum between 20 GHz and 45 GHz due to this increased use of block assigned spectrum.
- 1.21 Within Europe, the Radio Spectrum Policy Group (RSPG)¹¹ has identified the 26 GHz band¹² as the European pioneer millimetre wave band for 5G and Ofcom has recently published a Call for Input¹³ on 5G spectrum access at 26 GHz.
- 1.22 Our preliminary view is that making the 26 GHz band available for mobile is unlikely to have an adverse impact on the overall ability to provide connectivity by fixed wireless links given the greater use of self-managed spectrum and shift in focus to higher bands for higher capacity shorter hop systems.

Bands above 45 GHz

- 1.23 From our discussions with stakeholders we expect greater take-up of the 60/65 GHz band (V band) for street level small cell and fixed wireless access for last mile connectivity.

⁹ https://circabc.europa.eu/sd/a/d63ea67f-8171-4619-a53d-8feb57387c27/RSCOM17-40_RLAN%206%20GHz.pdf

¹⁰ Block assigned bands referred to in this review were made available through auction on a technology neutral basis and licensees have chosen to utilise these blocks for fixed wireless links.

¹¹ RSPG which is a high-level advisory group that assists the European Commission in the development of radio spectrum policy.

¹² The 26 GHz band in this context refers to the 24.25 – 27.5 GHz band.

¹³ https://www.ofcom.org.uk/data/assets/pdf_file/0014/104702/5G-spectrum-access-at-26-GHz.pdf

- 1.24 We expect continued growth in demand in the 70/80 GHz band (E band) for very high capacity backhaul (multigigabit) for urban macro cell connectivity and wireless broadband.
- 1.25 In order to cater for the higher capacity requirements of the future, there is a need to consider the possibility of additional spectrum in the 92 – 114.25 GHz band (“W”) and 130 – 174.8 GHz (“D”) bands to complement the use of 60 GHz and 70/80 GHz bands.

Proposals on which we are consulting

Specific proposals

- 1.26 Based on our findings, we are making specific proposals as part of this consultation on the regulatory framework for the 57 – 66 GHz band (V band).
- 1.27 We consider the need to review the technical framework in V band as a high priority work item. There is equipment innovation in this range and indications of likely demand for alternative fixed wireless topologies such as point to multipoint and mesh architecture. To enable the new uses cases, we consider that it will require a change to the technical framework.

Areas in which we are seeking further information

- 1.28 We also consider the areas that require further work, or where we need to seek further information as part of this review are as follows:
- i) **Further information about low capacity spectrum at 1350 - 1375 MHz and smaller channels at 6 GHz.** There are current plans for the band to be harmonised on a EU wide basis under EU harmonisation measures. Noting this development, we are seeking further information and views regarding the suitability of the 1350 - 1375 MHz band for low capacity TDD fixed wireless link applications. We also wish to further explore small channels based on CEPT channel plans at 6 GHz to enable such low capacity applications in the future, noting that spectrum at 6 GHz is also currently being considered for RLAN within Europe.
 - ii) **Consideration of alternative authorisation approaches for 52 GHz and 55 GHz.** We note the significant interest in utilising spectrum around 60 GHz. We further note that the nearby spectrum currently available at 52 GHz and 55 GHz, both with harmonised channel arrangements and made available for HDFS¹⁴ applications worldwide, remains unused in the UK. We therefore seek views on whether alternative authorisation approaches would facilitate interest and use of these bands.
 - iii) **Consideration of spectrum at W band and D band for future fixed wireless links.** There has been a consistent message from stakeholders around the need for very

¹⁴ RR 5.547 High density applications in the fixed service

high capacity channels to meet future requirements for mobile backhaul connectivity, particularly at the edges of the network. Both W and D bands spectrum are also being studied in Europe and by various specialist groups as key spectrum to enable such applications. We are therefore seeking further information on the likely use cases and timescales for these bands to allow us to further consider if and when this spectrum should be made available.

- iv) **New capacity enhancing techniques** - here we seek information on new approaches to enhancing capacity such as multiband operation. We would also like to seek views from stakeholders to understand the likelihood of implementing such new techniques.

2. Introduction

About fixed wireless links

- 2.1 A fixed wireless link, also referred to as a microwave link, is the wireless transmission of information between two or more fixed locations using electromagnetic waves. Fixed wireless links complement other transmission media such as connections provided by fixed networks e.g. fibre and are used for a variety of backhaul and access applications, including:
- backhaul provision for mobile network base stations;
 - distributing TV signals from studios to broadcast transmitter sites;
 - connecting nodes within private or corporate communication networks;
 - monitoring and control networks to enable the safe and secure supply of water, electricity and gas in the UK;
 - emergency services backhaul; and
 - the provision of fixed wireless broadband last mile connectivity, commonly known as fixed wireless access.

Spectrum used for fixed wireless links and how it is managed

- 2.2 A range of specific frequency bands from 1.3 GHz to 86 GHz are used for providing connectivity using fixed wireless links (as shown in Tables 1 and 2 below). Most of this spectrum is usually used in duplexed form, using two specific paired bands. This spectrum consists of Ofcom managed¹⁵ bands, block assigned bands and bands made available on a licence exempt basis.

Table 1: Frequency bands managed by Ofcom

Frequency band	Frequency range ¹⁶	Current management approach
1.4 GHz	1350 - 1375 MHz 1492 – 1517 MHz	Ofcom managed – technically assigned on a link by link basis
4 GHz¹⁷	3815 - 3875 MHz 4135 - 4195 MHz	Ofcom managed – technically assigned on a link by link basis
5.8 GHz	5725 – 5850 MHz	Ofcom managed – light licensed

¹⁵ These are bands that are either technically coordinated by Ofcom on a link by link basis or self-coordinated by the licensee.

¹⁶ Note that the ranges given may include edge guard bands and centre gaps. Specific band edges are defined in Ofcom document [OfW48](#).

¹⁷ It should be noted that the 3.6-3.8 GHz band is currently being considered [separately](#). The 3.6-3.8 GHz frequency range (channels 1-7) is closed to new applications for fixed wireless link licences.

Frequency band	Frequency range ¹⁶	Current management approach
Lower 6 GHz	5925 - 6425 MHz	Ofcom managed – technically assigned on a link by link basis
Upper 6 GHz	6425 - 7125 MHz	Ofcom managed – technically assigned on a link by link basis
7.5 GHz	7425 - 7900 MHz	Ofcom managed – technically assigned on a link by link basis
13 GHz	12.75 -13.25 GHz	Ofcom managed – technically assigned on a link by link basis
15 GHz	14.5 - 15.35 GHz	Ofcom managed – technically assigned on a link by link basis
18 GHz	17.7 - 19.7 GHz	Ofcom managed – technically assigned on a link by link basis
23 GHz	22 - 23.6 GHz	Ofcom managed – technically assigned on a link by link basis
26 GHz¹⁸	24.5 - 26.5 GHz	Ofcom managed – technically assigned on a link by link basis
31 GHz	31.0 - 31.3 GHz 31.5 - 31.8 GHz	Ofcom managed - technically assigned on a link by link basis
38 GHz	37 - 39.5 GHz	Ofcom managed – technically assigned on a link by link basis
52 GHz	51.4 - 52.6 GHz	Ofcom managed – technically assigned on a link by link basis
55 GHz	55.78 – 57 GHz	Ofcom managed – technically assigned on a link by link basis
60 GHz (“V” band)	57 - 64 GHz	Licence exempt
65 GHz (“V” band)	64 - 66 GHz	Ofcom managed – self coordinated on a link by link basis
70/80 GHz (“E” band)	71- 76 GHz 81 – 86 GHz	71.125-73.125 GHz and 81.125-83.125 GHz: Ofcom managed – technically assigned on a link by link basis. 73.375-75.875 GHz and 83.375-875 GHz: Ofcom managed – self coordinated on a link by link basis

¹⁸ The 26 GHz band is being considered in https://www.ofcom.org.uk/data/assets/pdf_file/0014/104702/5G-spectrum-access-at-26-GHz.pdf.

Table 2: Block assigned frequency bands

Frequency band	Frequency range
4 GHz	3605 - 3689 MHz 3925 -4009 MHz
10 GHz	10.125 - 10.225 GHz 10.475 - 10.575 GHz
28 GHz	27.8285 - 28.4445 GHz 28.8365 - 29.4525 GHz
32 GHz	31.8 - 33.4 GHz
40 GHz	40.5 - 43.5 GHz

2.3 The wide range of bands used by fixed wireless links is due to a number of factors that need to be taken into consideration when planning a link. These include the path length, the propagation availability requirement (i.e. how resilient the signal needs to be against the impact of precipitation such as rain), and the capacity of the connection. Generally, as the frequency increases, link lengths get shorter as the signal becomes more susceptible to rain fade. However, while links become shorter with increasing frequency the capability of carrying more information increases as the bandwidth available also increases. Planners of fixed wireless links therefore take such properties into account, alongside other parameters such as antenna size, when deciding on the optimum band to choose for their fixed wireless link.

2.4 An indication of the mix of spectrum management approaches is shown in Figure 1. Within the UK, there are currently around 45,000 fixed wireless links¹⁹ deployed in both Ofcom managed spectrum and block assigned spectrum.

¹⁹ Most of these are bi-directional fixed wireless links.

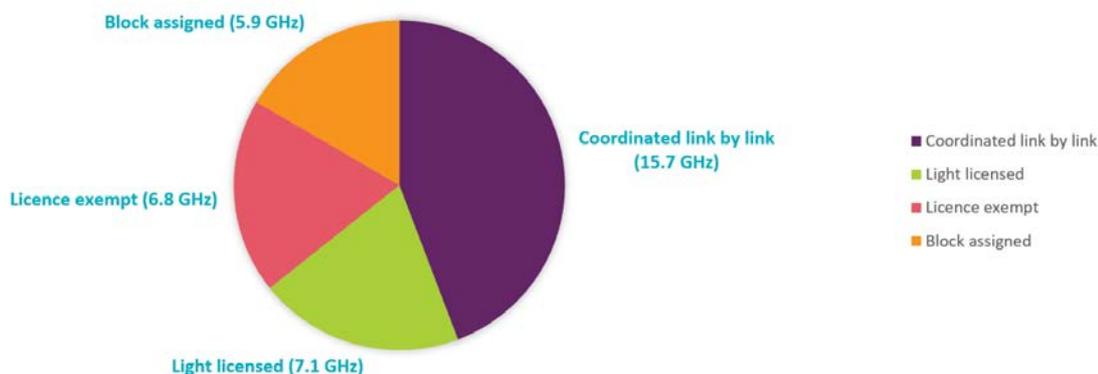


Figure 1: Current spectrum management split

2.5 Figure 2 provides a high-level view of the variety of uses of fixed wireless links across a range of available Ofcom managed bands, along with a comparative indication of how much a given band is used in the UK.



Figure 2: Indicative categorisation of Fixed Service spectrum²⁰ managed by Ofcom with usage shown by user types – the size of the circle is relative to the number of fixed wireless links licensed in the UK (based on fixed wireless link data of June 2016)

Our approach to the review

- 2.6 As set out in our CFI, we have taken a phased approach to our review of the sector:
- a) We have sought to understand the key drivers of changes in demand for the spectrum used for fixed wireless links and how this demand might change over the next 5-10 years.

²⁰ There is limited use in the 31 GHz band (31.0-31.3 GHz and 31.5-31.8 GHz).

- b) In light of this, we have considered whether there would be benefits in changing aspects of our spectrum policy or the way in which spectrum is managed to enable future uses of fixed wireless links.
- 2.7 To help us understand the future demand drivers, we asked specific questions in our CFI on the range of uses of fixed wireless links and met with stakeholders wishing to engage with us. These views have enabled us to consider the implications for spectrum used for fixed wireless links and make specific proposals for consultation.
- 2.8 In our CFI, we highlighted developments that we consider have significant impact on the use of fixed wireless links in the UK requiring us to undertake a strategic review of this sector now; notably the growing consumer demand for mobile broadband, greater capacity and better coverage leading to an increased demand for backhaul capacity. We also recognise that different users of fixed wireless links have different spectrum requirements.
- 2.9 In parallel, several frequency bands used by fixed wireless links are being considered for mobile access, including for 5G²¹ (see Figure 3), which could impact the future nature of availability of these spectrum bands for fixed wireless links.

²¹ As part of the World Radio Conference 2019 Agenda Item 1.13, 8 out of the 13 bands currently available for fixed wireless links are being studied for potential identification of frequency bands for the future development of International Mobile Telecommunications (IMT), including possible additional allocations to the mobile service on a primary basis, in accordance with Resolution 238 (WRC-15).

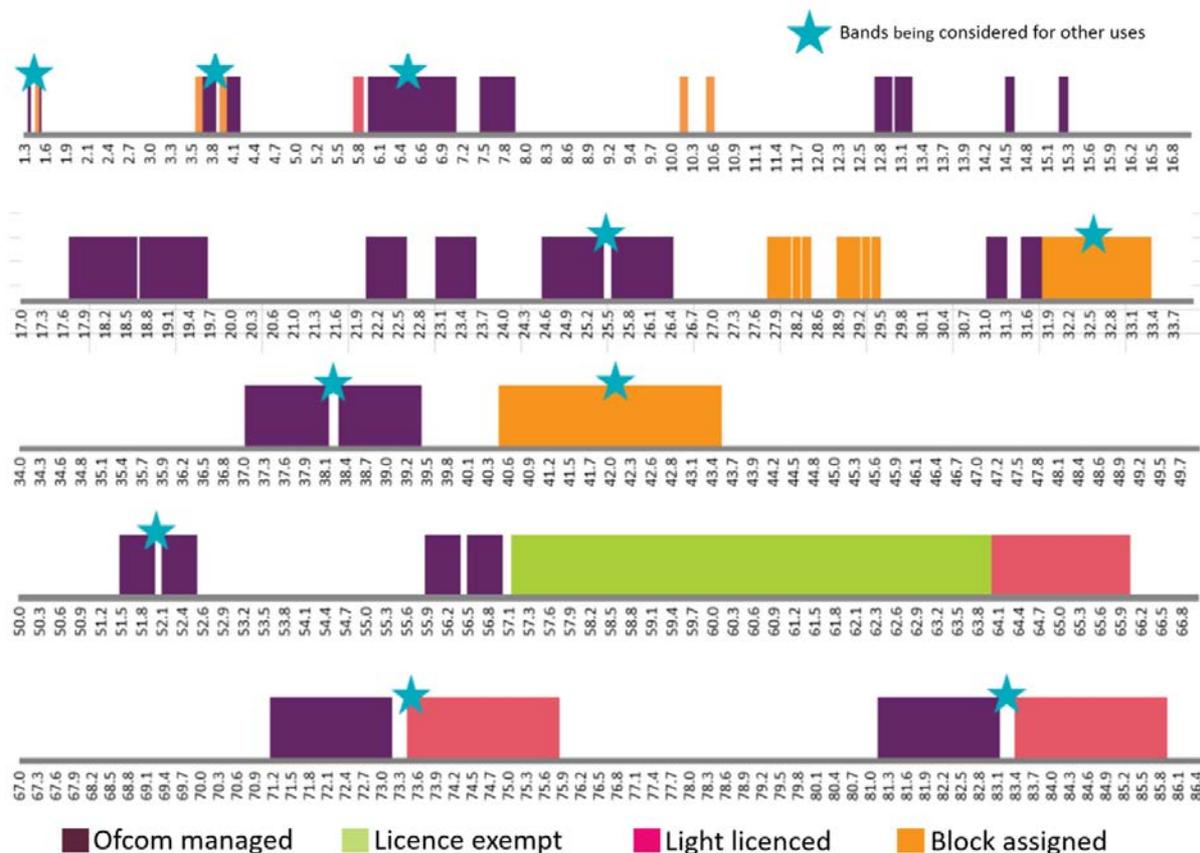


Figure 3: Bands used for fixed wireless links with an indication of those being considered for other uses (frequency shown in GHz)

Statutory framework

- 2.10 Our consultation proposals were developed with regard to Ofcom’s spectrum management key principles, which are set out in legislation and summarised below.
- 2.11 Section 3(1) of the Communications Act 2003 (the “Act”) provides that our principal duties in carrying out our functions are:
- to further the interests of citizens in relation to communication matters; and
 - to further the interest of consumers in relevant markets, where appropriate, by promoting competition.
- 2.12 Ofcom is required to secure the optimal use of spectrum. In carrying out our spectrum management duties, Ofcom must have particular regard to the different needs and interests of all persons who wish to make use of spectrum.
- 2.13 Ofcom must also have regard to the principles under which regulatory activities should be transparent, accountable, proportionate and consistent and targeted only at cases in which action is needed.
- 2.14 In carrying out our radio spectrum functions, we must have particular regard to:

- availability of spectrum for use, or further use, for wireless telegraphy; and
- current and likely future demand for the use of the spectrum for wireless telegraphy.

2.15 And to the desirability of promoting:

- efficient management and use of the spectrum available for wireless telegraphy;
- economic and other benefits arising from the use of wireless telegraphy;
- development of innovative services; and competition in the provision of electronic communications services.

Impact analysis

2.16 The analysis presented in this document represents an impact assessment, as defined in section 7 of the Communications Act 2003 (the Act).

2.17 Ofcom is separately required by statute to assess the potential impact of all our functions, policies, projects and practices on equality. Equality Impact Assessments (EIAs) also assist us in making sure that we are meeting our principal duty of furthering the interests of citizens and consumers regardless of their background or identity. We do not consider the impact of the proposals in this consultation to be to the detriment of any group within society.

This publication

2.18 This publication provides stakeholders with the key messages and issues that have been raised as part of this review:

- Section 3 summarises the main drivers of change that we consider will impact demand for spectrum and how we believe this will change over the next 5-10 years;
- Section 4 gives our conclusions on demand and future fixed wireless spectrum requirement;
- Section 5 provides our next steps and proposals for consultation including specific proposals for regulatory change in the 57 – 66 GHz band; and
- Annex A2 gives a summary of the key messages received from the CFI.

3. How demand for spectrum is likely to change over the next 5-10 years

Introduction

- 3.1 In this section, we summarise the key market trends and demand drivers we have drawn out from the CFI process that are likely to affect the future use of fixed wireless links. We have extracted those that we consider are most likely to have a material impact on future spectrum requirements. Where we have identified a trend that is less clear in terms of its spectrum impact, we consider that we should closely monitor such trends to gain a clearer picture.
- 3.2 A full summary of the key messages from stakeholders to our CFI is given in Annex A2.
- 3.3 While fibre remains the first choice for connectivity where cost effective and available, the consistent message indicated by stakeholders was that fixed wireless links will continue to be relied on where the cost of laying fibre is prohibitive, quick deployment is important or where a backup route to fibre is required. The requirement for backup diversity was indicated as particularly important for some sectors like the utilities.

Usage trends since our last review

- 3.4 Since our last review in 2012, we have observed an increase in capacity carried over fixed wireless links. Our discussions with stakeholders indicate this trend is mainly due to changes in the mobile backhaul network sector where much greater capacity is being planned to meet anticipated future demand.
- 3.5 Over this period, we have observed less reliance on Ofcom managed bands with a decrease in the number of fixed wireless links authorised by us in these bands. However, overall numbers of fixed wireless links in the UK have remained approximately the same reflecting greater infrastructure sharing between MNOs along with increased use of block assigned spectrum.

Demand drivers over the next 5-10 years

Increasing demand for mobile services including 5G

- 3.6 Stakeholders have indicated that the key drivers for the evolution envisaged in mobile backhaul networks to deliver 5G services would be to provide greater reach, capacity and service availability to the end consumer.
- 3.7 To enable this, we expect the mobile backhaul networks to be much denser than they are now with greater deployment of small cells and potentially using alternative topologies such as fixed wireless access for last mile connectivity from fibre point of presence. While fibre will be a key enabler to these new network topologies, MNOs have also indicated

that connectivity using fixed wireless links will continue to be required where fibre is not available, particularly in the rural areas or hot spots where many small cells will be deployed.

- 3.8 MNOs further indicated they are already planning capacity upgrades to their existing fixed wireless links in readiness for 5G, with deployment of higher order modulation, wider channels, use of more data compression techniques, multiband operation and cross polarisation. However, in certain use cases, the greater capacity requirements of the future (e.g. $n \times 1\text{Gbps}$ and $n \times 10\text{Gbps}$) can only be met in millimetre bands that have much wider channel bandwidths.
- 3.9 The expectation is that the millimetre bands above 60 GHz (i.e. V, E, W and D bands) would provide the ability to carry the data required as these bands offer around 10 times or more bandwidth available per channel than traditional bands offer. MNOs have indicated they expect these bands to be capable of carrying traffic capacities of 10 Gbps and are expecting this to increase to 30-50 Gbps over time. We consider that the majority of current available channel sizes in the lower bands do not offer enough spectrum to deliver such capacities.
- 3.10 Respondents also provided information on capacity enhancing techniques that were being considered and in some cases with trials underway to demonstrate the validity of these approaches; techniques such as full duplex operation and multi-band working which are detailed in Annex A2. We intend to seek further information on the use of such techniques. We consider this further later in this section.

Changes in backhaul architecture for 5G will still need fixed wireless links

- 3.11 The responses to our CFI indicated that the evolved architecture to deliver future 5G services could lead to a different functional split in the radio access network to the current distributed radio access network. The different functional split would consist of a centralised radio access network (C-RAN) concept where the radio unit would no longer be located at the same site as the base band unit. The two would instead be connected by a “fronthaul” interface of either fibre or fixed wireless links. This concept could provide efficiencies in network management by enabling all the processing of multiple cell sites to be conducted in a centralised manner rather than at each individual cell site.
- 3.12 However, due to challenges in terms of latency and linearity, respondents indicated they were looking to develop backhaul architectures using solutions that could lead to something in between the current generation IP backhaul and next generation C-RAN, referred to as “x-haul”. While all these changes would result in the future network architectures looking different, stakeholders indicated that they would still require the need for high capacity connectivity and that fixed wireless links are a key component to delivering this as a complementary technology to fibre.
- 3.13 The other change noted was that with the greater availability of fibre the requirement for fixed wireless links was moving further to the edge of the networks i.e. providing last mile

connectivity from fibre point of presence, particularly in urban areas with high fibre penetration.

More capacity in broadband provision, particularly for last mile connectivity and in rural areas

- 3.14 One of the uses of fixed wireless links is to provide backhaul to support broadband delivery to citizens and consumers. Fixed network operators, like MNOs, use fixed links in combination with fibre to provide connectivity. Stakeholders make use of most bands in Table 1 and if available also those in Table 2. This includes the use of spectrum such as 5.8 GHz for providing fixed wireless access.
- 3.15 Due to initiatives from the UK government and devolved nations to increase superfast broadband coverage across the UK²², some SMEs indicated that they are also including such initiatives as part of their strategy to increase broadband reach to remote regions of the UK. To enable this, fixed network operators tend to use fixed wireless links in all fixed wireless link bands and indicate that they expect that this requirement will continue over the next 5-10 years as fixed wireless links still offer the necessary reach to the rural areas and are often more cost effective and faster to deploy than fibre. For some stakeholders, the use of fixed wireless links is preferred to maintain network ownership and reduces reliance on access to third party networks.

Potential changes in electricity distribution in future utility networks

- 3.16 As indicated in our stakeholder engagement and responses to the CFI, the key driver of change envisaged in future demand by the utility sector is the move from a centralised electricity generation model to a distributed electricity generation model. The distributed model would encompass a variety of ways in which electricity is generated including a drive towards renewable energy sources. Energy distribution along with all the necessary communications and network management, monitoring and control functions all require high reliability communications infrastructures. A change to a more distributed model would require:
- more points of presence along with the necessary connectivity infrastructure; and
 - increased network capacity to facilitate other data services and security applications such as monitoring using CCTV.
- 3.17 In addition, responses outlined a requirement to replace obsolete services and that the new “smart grid” would require connectivity to between 100 to 1000 times more devices than current connections. The specific technology to deliver this was still under discussion at the time of our CFI. However, it was indicated that this would likely require connectivity to centralised control points using wireless solutions which would most likely be in the form of fixed wireless links.

²² <https://www.gov.uk/guidance/broadband-delivery-uk>

- 3.18 The water industry indicated that their networks could require more real-time monitoring and control of their networks. They indicated that their networks would also likely require increased data delivery, the use of adaptive modulation techniques as well as a move towards carrier Ethernet technology. They also indicated that their fixed wireless links would probably need an increase in their capacity capability, with capacity enhancing measures such as the use of co-channel cross polarisation systems.
- 3.19 In terms of the need for spectrum, although alternative means such as fibre or satellite links are considered for utility networks, frequency bands between 7.5 GHz and 38 GHz continue to be used to deliver telemetry, voice, data and video services to many electricity, gas and water installations. Indications from the sector are that demand for resilient links will continue. Respondents have indicated they are considering trials of TDD equipment at 1.4 GHz and that the lower 1.4 GHz band duplex (1350 – 1375 MHz) should be considered for future low capacity fixed wireless link applications.

Impact of changes in delivery of the public safety network

- 3.20 The current provider of the public safety network (Airwave) covering Great Britain will cease its service provision as the network transitions to LTE technology using the EE network. At this point, Airwave would no longer require their fixed wireless links. However, they suggested that in the time period leading to this there is likely to be a large increase in fixed wireless links as the new emergency service network rolls out into rural and isolated areas, as both networks would need to be up and running in parallel to ensure a smooth transition and switch over.
- 3.21 In preparation for the transition to EE's network, EE indicated that it is deploying additional backhaul links to enhance the overall network availability.

Potential use of high altitude platform stations to deliver connectivity

- 3.22 One of the new technology areas that has recently increased in international interest is connectivity via High Altitude Platform Stations (HAPS)²³. These include use cases such as delivering broadband in underserved areas, extending backhaul reach and for emergency and disaster recovery situations. Our understanding is that these developments are mainly focussed on equatorial countries at this stage and may evolve to other areas in the future. The key application indicated for HAPS is to extend coverage and capacity to areas where other technologies may not be available or suitable.
- 3.23 The topic is currently under discussion as part of the preparations for WRC-19²⁴. The WRC-19 agenda item is aimed at enabling greater harmonisation of the existing HAPS frequency designations and looking at possible additional harmonised spectrum on a

²³ High Altitude Platform Station (HAPS) is defined in the Radio Regulations as a station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth and is used to provide wireless connectivity.

²⁴ WRC-19 Agenda Item 1.14 - to consider, on the basis of ITU-R studies in accordance with Resolution 160 (WRC-15), appropriate regulatory actions for high-altitude platform stations (HAPS), within existing fixed-service allocations.

regional/global level. Preparations for this agenda item are being managed as part of our ongoing preparations for WRC-19.

Trends in the financial sector

- 3.24 We identified trends in newer uses of fixed wireless links for the financial sector as this sector has seen one of the largest increases in the number of links since our 2012 review. Our stakeholder engagement on this indicated that the use of fixed wireless links by the financial sector were now expected to remain stable in terms of capacity requirements. Fixed wireless links are mainly used in the south east of England and across the English Channel. Demand from this sector for access to direct paths between data centres is expected to remain.

Question 1:

Do you agree that we have identified the key drivers likely to have a significant impact on the spectrum demand for fixed wireless links? If not, please provide further detail and evidence to support your answer.

Do you have other comments to make/points to raise with us on these issues?

4. Our preliminary conclusions on demand and future fixed wireless spectrum requirements

Introduction

- 4.1 In this section, we provide our view of what the key drivers identified in the previous section mean for spectrum requirements for fixed wireless links over the next 5-10 years.
- 4.2 Relevant to this consideration are the future potential changes in spectrum use and availability for fixed wireless links as some bands are being considered for mobile access in international discussions and by the UK.
- 4.3 Taking both the future demand drivers and potential changes in the spectrum landscape into account, we provide our views on the impact on future spectrum requirements for fixed wireless links set out by bands. These are as follows:
- Bands below 20 GHz;
 - Bands between 20 GHz and 45 GHz; and
 - Bands above 45 GHz
- 4.4 Based on the CFI responses received, the following subsections draw out the key high-level drivers of demand.

Bands below 20 GHz

Potential change in spectrum availability

1492 – 1517 MHz (“1.4 GHz”)

- 4.5 In our discussion of this band in the CFI, we had indicated that the 1492-1518 MHz band was considered a ‘high priority’ for mobile, as set out in our June 2016 Mobile Data Strategy (MDS)²⁵. We also indicated in the June 2016 MDS that the UK had a large number of fixed wireless links in this band, supporting a range of applications and that we would consider the options on whether and how to make this band available for mobile.
- 4.6 CEPT has recently completed a series of technical studies in response to a European Commission Mandate on 1.4 GHz²⁶ on harmonised technical conditions of use. There are current plans for the band to be harmonised on a EU wide basis under EU harmonisation measures²⁷ for SDL in the 1427 – 1452 MHz and 1492 – 1518 MHz bands.

²⁵ <https://www.ofcom.org.uk/consultations-and-statements/category-1/mobile-data-strategy>

²⁶ http://ec.europa.eu/newsroom/document.cfm?doc_id=45863

²⁸ https://www.ofcom.org.uk/_data/assets/pdf_file/0017/103355/3-6-3-8ghz-statement.pdf

- 4.7 While we accept that this creates uncertainty for existing uses of 1492-1517 MHz, we note that alternatives are being considered in CEPT at around 6 GHz which is also being studied for RLAN. We also note the possible interest in utilising the lower duplex portion of the band on its own for possible future low capacity applications on a TDD basis.

3.6 – 3.8 GHz

- 4.8 On 26 October 2017 we published a statement on improving consumer access to mobile services at 3.6 - 3.8 GHz²⁸. This confirmed Ofcom's intended approach to expanding spectrum access for future mobile services in the 3.6 GHz to 3.8 GHz band in order to enable consumers and citizens across the UK to benefit from future mobile services including 5G. The statement explained that Ofcom would commence the statutory process to:
- a) propose to revoke current authorisations for fixed links in the 3.6 GHz to 3.8GHz band, with a notice period of 5 years; and
 - b) propose to vary existing authorisations for receiving satellite earth stations operating under Permanent Earth Station licences and grants of Recognised Spectrum Access for Receive Only Earth Stations such that, with effect from 1 June 2020, we would no longer take registered satellite earth stations with a receive component in this band into account for frequency management purposes.
- 4.9 The statement also set out that we would aim for these fixed links operations to migrate to alternative frequencies by 1 June 2020 where possible.
- 4.10 Ofcom is currently considering representations from affected licensees and grantholders on its proposals and will notify affected licensees and grantholders of its decisions on these proposals by the end of this year.

3.8 - 4.2 GHz

- 4.11 In April 2016 we sought input from stakeholders through a CFI²⁹ which introduced the 3.8 GHz to 4.2 GHz band as a candidate band for enhanced spectrum sharing, for potential new innovative applications.
- 4.12 Stakeholder feedback included information on the potential types of new applications that could possibly share with incumbents, as well as the associated technical challenges. In light of the responses we indicated in our update in August 2016 that we believed there was potential for further exploring enhanced sharing based on geographically defined authorisations while continuing to allow current and future deployments of incumbent Fixed and Fixed Satellite Services.
- 4.13 We plan to consult on enabling further sharing in the 3.8GHz to 4.2GHz band in 2018, with a view to enabling innovative uses. Our preliminary view, as indicated in our 2016 Call for Input and subject to further consultation, is that in any future framework all existing and

²⁸ https://www.ofcom.org.uk/data/assets/pdf_file/0017/103355/3-6-3-8ghz-statement.pdf

²⁹ [3.8 GHz to 4.2 GHz band: Opportunities for Innovation](#)

new users of the band (including variations to existing fixed links) would be authorised on the basis of first-come first-served coordination mechanisms, as is the case in the band now. We will continue to engage with stakeholders as we develop proposals for consultation.

Lower and Upper 6 GHz

- 4.14 There is increasing interest at the International level in finding new spectrum for RLANs. CEPT has recently created two new project teams, SE45³⁰ and FM57³¹ to study the feasibility of RLAN use at 6 GHz and the different coexistence issues with incumbent services.
- 4.15 In addition, in the Radio Spectrum Committee (RSC), the European Commission and Member States are discussing a possible mandate to CEPT to look at the feasibility of RLAN use at 6 GHz, the different coexistence issues with incumbent services in these bands and the potential mitigation techniques if RLAN services were to coexist.

Our preliminary conclusion on future spectrum requirements for bands below 20 GHz

- 4.16 For most uses, we expect that the increased capacity and future demand can be met by using the existing bands along with capacity enhancement techniques such as use of wider channel bandwidths and cross polarisation where available.
- 4.17 Regarding the 1.4 GHz band no UK decisions have been taken yet on whether the band will be made available for mobile use in the UK. However, as noted above, discussions are currently underway at the EU level and there is potential for the band 1492-1518 MHz to be harmonised for SDL on an EU wide basis under mandatory harmonisation conditions. Depending on the outcome of these discussions in the RSC, implementation of the EU measures could involve clearance of fixed wireless links from the 1.4 GHz band, on a timeline that would be set by the European Commission decision. Our current view is that there will continue to be demand for narrow band fixed link channels to support niche, low capacity applications in the UK. Therefore, if clearance of 1.4 GHz were to become necessary in the future, alternatives for low capacity connectivity would need to be considered further.
- 4.18 We would therefore like to seek further views and information about potential alternatives to the 1.4 GHz band which we cover in the next section.
- 4.19 Given the current use of the 6 GHz band for long range high capacity connectivity, particularly between remote islands and between oil platforms, we are of the view that the international co-existence studies will first need to be completed to understand the

³⁰ <https://cept.org/ecc/groups/ecc/wg-se/se-45/client/introduction/>

³¹ <https://cept.org/ecc/groups/ecc/wg-fm/fm-57/client/introduction/>

feasibility of sharing before any decisions are taken regarding the use of RLANs in these frequency bands.

Bands between 20 GHz and 45 GHz

Potential change in spectrum availability

24.5-26.5 GHz

- 4.20 In the February 2017 update on 5G³², we provided an overview of the international process which led to the identification of 26 GHz as the pioneer band for 5G in Europe.
- 4.21 The 26 GHz band covers the 3.25 GHz of spectrum between 24.25 GHz and 27.5 GHz and is being prioritised across Europe as the first high frequency band for 5G.
- 4.22 To establish the level and type of stakeholder interest in 5G within this band and to explore the different options we published a Call for Input³³ in July 2017 aimed at gathering input from stakeholders on all aspects related to making the 26 GHz band available for 5G. This will be followed by a consultation in due course.

37.5-39.5 GHz

- 4.23 The 38 GHz band falls within one of the frequency bands being studied under WRC-19 Agenda Item 1.13. The Radio Spectrum Policy Group (RSPG) has identified the 40.5 – 43.5 GHz band as a promising and a priority band for study for 5G in Europe.
- 4.24 As part of the roadmap for further bands for 5G mobile use, we consider that the 40.5-43.5 GHz band together with the lower 37 - 40.5 GHz band have the potential to become a globally harmonised tuning range for 5G equipment. This would allow individual countries flexibility to make all or a sub-set of the frequencies available, depending on their own needs whilst still enabling global economies of scale for equipment.

Our preliminary conclusions on the future spectrum requirements between 20 GHz and 45 GHz

- 4.25 Mobile backhaul is the main application of fixed wireless links in this range. Stakeholders who have access to block assigned (award) spectrum in this frequency range have indicated that their preference is to use this spectrum first which enables them to provide flexible, fast and cost-effective deployment.
- 4.26 Given the above and with the changing network requirements expected in the future, we consider there will be less demand in the Ofcom managed bands between 23 GHz and 45 GHz. This is due to both the increased use of block assigned spectrum in the short term and migration to higher bands in the medium to longer term in order to exploit the

³² https://www.ofcom.org.uk/data/assets/pdf_file/0021/97023/5G-update-08022017.pdf

³³ https://www.ofcom.org.uk/data/assets/pdf_file/0014/104702/5G-spectrum-access-at-26-GHz.pdf

- availability of wider channel bandwidths, particularly for very high capacity links in urban areas.
- 4.27 Based on the responses to the CFI and our stakeholder discussions we consider that the future requirements in Ofcom managed spectrum between 23 and 38 GHz for mobile backhaul will mostly likely be for the wider channels bandwidths (e.g. 56 / 112 MHz) to meet additional capacity requirements particularly in rural and suburban areas if demand cannot be fulfilled in the block assigned bands. The expectation is that over the period covered by this review, although fibre presence will likely increase, fixed links will continue to play a key role. We consider that a similar migration trend could also apply to existing links in the block assigned 28, 32 and 40 GHz bands with a possible shift towards deployment of alternative topologies such as fixed wireless access as networks evolve towards 5G, particularly in the urban areas.
- 4.28 We expect that the bands within this frequency range being considered for 5G will also include elements of self-backhauling, and therefore further reduce the likelihood of spectrum scarcity in this range for the provision of backhaul.
- 4.29 The second largest user type in the 26 GHz band is public safety. As noted above, Airwave has indicated that its existing backhaul infrastructure to support the public safety network would be decommissioned after the transition to the LTE network is completed. While the existing LTE network may require additional backhaul to enhance the overall network availability for public safety provision, we don't expect this to be at the same scale³⁴ as the current Airwave network. Therefore, the overall fixed wireless link requirement to meet the future public safety network in Great Britain will likely be less in these bands after the Airwave network is switched off.
- 4.30 For all other uses of fixed wireless links, we expect a continued dependency on bands up to 38 GHz but not to the same scale that mobile backhaul would require.
- 4.31 Our preliminary view is that making the 26 GHz band available for mobile is unlikely to have an adverse impact on the overall ability to provide connectivity by fixed wireless links given the greater use of self-managed spectrum and shift in focus to higher bands for higher capacity shorter hop systems.
- 4.32 Finally, in this frequency range, although we haven't directly received comments on the 31.3-31.5 GHz and 31.5-31.8 GHz band through our CFI, we consider that this spectrum should also be reviewed at some point in the future given the current low usage for analogue CCTV backhaul and that many new CCTV systems are now based on digital technologies.

³⁴ EE is deploying additional backhaul radio links the new network to enhance the overall network availability and in some cases existing links are being provided with equipment protection.

Bands above 45 GHz

Potential change in spectrum availability

70/80 GHz

- 4.33 The 66-76 GHz frequency range is being studied for future mobile use by WRC-19 under Agenda Item 1.13. This range includes part of the 70/80 GHz band which as indicated by this review is being targeted by MNOs to meet the macro cell and small cell backhaul capacity requirements in urban areas in the short/medium term.
- 4.34 In our 5G roadmap to identify further bands for mobile access, we have taken the view that we should focus on promoting the 66-71 GHz portion of the band for 5G in the UK, rather than the wider 66-76 GHz frequency range, due to the strategic importance of the 70/80 GHz band for mobile backhaul. In section 5 of this consultation, we are also seeking initial views on the potential applications and use cases in the 66 -71 GHz band, along with the likely technical parameters to inform our 5G programme of work.

Our preliminary conclusion on future spectrum requirements in bands above 45 GHz

- 4.35 As indicated in the previous section, we have noted a clear trend towards the use of the higher bands for very short hop high capacity links. We note the drive to exploit these higher bands is due to limited availability of wide channel bandwidths in bands below 45 GHz. This in turn is leading to greater focus on the 60/65 GHz and 70/80GHz bands that have much wider channel bandwidths³⁵ and therefore provide the increased capacity option.
- 4.36 70/80 GHz band is currently the fastest growing band in the UK for fixed wireless links. Use is mainly within the enterprise market for applications such as broadband delivery as well as providing connectivity for high frequency trading networks.
- 4.37 We are also now starting to see the emerging use for mobile backhaul as noted in our previous review. Stakeholders provided consistent message with respect to the future demand for 70/80 GHz band for both urban and suburban mobile macro cell backhaul as well as provision of high capacity broadband as noted above.
- 4.38 70/80 GHz band is also being considered as part of a multi-band solution coupled with a lower frequency band to provide capacity enhancements in the suburban and rural areas, where longer link lengths are required, and path resilience is important. W band has been indicated as the possible complement for 70/80 GHz band when the latter reaches saturation.

³⁵ Channel sizes in V and E band are typically much larger i.e. 250 MHz / 500 MHz and greater compared to the available channel sizes in the lower bands where the current maximum size is 112 MHz.

- 4.39 As noted in the previous section, with increased fibre reach and denser networks (particularly for 5G small cells), the need for fixed wireless connectivity will move further towards the edges of the networks in order to provide short hop extensions to fibre point of presence. This could also potentially be in the form of alternative topologies such as point to multipoint and mesh architecture to connect 5G small cells to macro cells and to provide last mile fixed wireless access broadband connectivity. This is currently being explored in the V band with D band being suggested as a possible additional band in the future.
- 4.40 In the short to medium term, we therefore expect the 60/65 GHz and 70/80 GHz bands to play a key role in providing the required capacity increases for the different use cases. There will be a need to consider additional spectrum at W and D band when demand can no longer be met in the 60/65 GHz and 70/80 GHz bands. We expect the requirement for additional spectrum at W and D band to largely depend on the speed of 5G rollout.
- 4.41 The growing interest to use 60/65 GHz band for street level small cells using point to multipoint or mesh architecture with self-organising network (SON) technology has required us to further consider the regulatory framework to enable this as point to multipoint/mesh deployment is not currently enabled under existing authorisation approaches. This is considered further in the next section.
- 4.42 In the long term, D band has been indicated by some stakeholders as the preferred option for future 5G small cell infrastructure with a preference for a regulatory framework that allows for a managed interference environment.
- 4.43 Finally, we observed that the frequency bands 52 GHz and 55 GHz continue to be unused and responses indicated limited interest in using these bands under the present arrangements. While equipment is available at 52 GHz, we are not aware of any current manufacturers' plans to develop equipment in the 55 GHz band. The 52 GHz and 55 GHz bands are both bands that are identified as available for high density applications in the fixed service within the Radio Regulations³⁶ and have harmonised channel arrangements in CEPT³⁷. In this consultation, given the emerging interest in utilising spectrum in the 60 GHz range for high capacity short hops, we would also like to explore further with stakeholders whether there would be any interest in using these two bands if an alternative approach to authorisation was considered, such as block assignment, and if this is something that would allow for this spectrum to be utilised in the future.

Equipment innovation to support capacity enhancement

- 4.44 We note that existing users are already introducing adaptive and higher order modulation technology, packet compression and cross polarisation³⁸ operation to enhance capacity and improve the spectral efficiency of their fixed wireless links.

³⁶ Article 5.547 in the Radio Regulations

³⁷ 52 GHz: CEPT/ERC/REC 12 – 11 E and 55 GHz: CEPT/ERC/REC 12 – 12 E

³⁸ Cross polarisation enables doubling of capacity on the same channel.

- 4.45 In addition, we note that stakeholders have referred to new ways of increasing capacity such as carrier or band aggregation techniques. Vendors have indicated that multiband equipment is being trialed for example to aggregate a longer (high propagation availability) link in 18 GHz with a (high capacity) link in 70/80 band using a single dual band antenna (similar to carrier aggregation in mobile access networks) to maximise availability and capacity according to the propagation environment.
- 4.46 We also note that although higher order modulation equipment up to 2048 QAM is already available, most stakeholder views have indicated that modulation rates above 512 QAM would be unlikely to deliver much greater benefit in practice given the greater link margins required and the increased sensitivity of such systems to unwanted signals i.e. requiring large wanted to unwanted (W/U) protection ratios.
- 4.47 Some vendors have also indicated that they are developing full duplex capabilities within their radios (simultaneous same frequency transmission at both ends of the link) to maximise spectral efficiency.
- 4.48 We would like to further our understanding of such capacity enhancing techniques as part of this work. Specifically, we would like to understand how much demand there would be for such capabilities in fixed wireless link equipment. This is to enable us to assess the impact and whether further work would be required to our current fixed wireless link assignment process. We consider this further in our section on next steps.

Overall conclusion for each band based on our view of the future spectrum requirements

- 4.49 We conclude from our findings that a mix of spectrum bands will continue to be required to meet the future needs of the fixed wireless sector.
- 4.50 We summarise these in Table 3 and Table 4 below.

Table 3: Proposed future strategy for existing Ofcom managed bands

Frequency band	Frequency range ³⁹	Proposed future strategy for this band or further action required
1.4 GHz	1350 - 1375 MHz 1492 – 1517 MHz	1492-1517 MHz: Currently under consideration for international mobile harmonisation for downlink only wireless broadband operation. Seek stakeholder views on suitability of 1350-1375 MHz for future low capacity applications.

³⁹ Note that the ranges given may include edge guard bands and centre gaps. Specific band edges are defined in Ofcom document OfW48

Frequency band	Frequency range ³⁹	Proposed future strategy for this band or further action required
4 GHz⁴⁰	3815 - 3875 MHz 4135 - 4195 MHz	3.6-3.8 GHz: Closed to new fixed wireless links. 3.8 – 4.2 GHz: Being considered for increased sharing.
5.8 GHz	5725 – 5850 MHz	Ofcom has recently published ⁴¹ the statement to remove the 20 MHz frequency ‘notch’ between 5795 and 5815 MHz to allow FWA to access these frequencies, enabling a greater number of higher capacity channels within the 5.8 GHz band.
Lower 6 GHz	5925 - 6425 MHz	Continue access for fixed wireless links
Upper 6 GHz	6425 - 7125 MHz	Continue access for fixed wireless links
7.5 GHz	7425 - 7900 MHz	Continue access for fixed wireless links
13 GHz	12.75 -13.25 GHz	Continue access for fixed wireless links
15 GHz	14.5 - 15.35 GHz	Continue access for fixed wireless links
18 GHz	17.7 - 19.7 GHz	Continue access for fixed wireless links
23 GHz	22 - 23.6 GHz	Continue access for fixed wireless links.
26 GHz⁴²	24.5 - 26.5 GHz	Being considered as a pioneer band for 5G mobile access.
31 GHz	31.0 - 31.3 GHz 31.5 - 31.8 GHz	Candidate band for review due to reduced/no demand for analogue CCTV backhaul
38 GHz	37 - 39.5 GHz	Continue access for fixed wireless links.
52 GHz	51.4 - 52.6 GHz	Possible consideration for alternative authorisation approaches.
55 GHz	55.78 – 57 GHz	Possible consideration for alternative authorisation approaches.

⁴⁰ It should be noted that the 3.6-3.8 GHz band is currently being considered separately: https://www.ofcom.org.uk/data/assets/pdf_file/0017/103355/3-6-3-8ghz-statement.pdf. The 3.6-3.8 GHz frequency range (channels 1-7 on the 30MHz channel plan) is closed to new applications for fixed link licences.

⁴¹ <https://www.ofcom.org.uk/consultations-and-statements/category-2/improving-access-5.8-ghz-broadband-fixed-wireless-access>

⁴² The 26 GHz band is being considered in https://www.ofcom.org.uk/data/assets/pdf_file/0014/104702/5G-spectrum-access-at-26-GHz.pdf

Frequency band	Frequency range ³⁹	Proposed future strategy for this band or further action required
60 GHz (“V” band)	57 - 64 GHz	Propose regulatory changes to enable point to multipoint/mesh technologies on a licence exempt basis
65 GHz (“V” band)	64 - 66 GHz	Propose to change to licence exempt authorisation with similar technical conditions as the 57-64 GHz band.
70/80 GHz (“E” band)	71.125 - 75.875 GHz 81.125 - 85.875 GHz	Continue access for fixed wireless links.

Table 4: Proposed strategy for additional band for fixed wireless

Frequency Band	Frequency Range	Proposed future strategy for this band or further action required
“W” band	92-114.5 GHz	Consideration for future uses of fixed wireless links and seek views on appropriate authorisation approach
“D” band	130-174.8 GHz	Consideration for future uses of fixed wireless links and seek views on appropriate authorisation approach

Question 2:

Do you agree with our conclusions on spectrum implications and our proposed strategy/next steps for each band?

Are there any other considerations of significance that you feel we should have included or do you have other comments to make/points to raise with us on these issues?

Please provide as much detail as possible to support your answer.

5. Our proposed next steps

Introduction

- 5.1 Based on our understanding of the changing demand for fixed wireless links, we have identified an area where we believe specific proposals for regulatory change are required now and other areas where further information is required to assist us in further developing our approach and priorities.

Specific proposals

- 5.2 We are making specific proposals as part of this consultation on the regulatory framework for the 57 – 66 GHz band (V band).
- 5.3 We consider the need to review the technical framework in V band as a high priority work item. There is equipment innovation in this range and indications of likely demand for alternative fixed wireless topologies such as point to multipoint and mesh which will require a change to the technical framework to enable these new use cases.

Areas in which we are seeking further information

- 5.4 We also consider the areas that require further work, or where we need to seek further information as part of this review. These are as follows:
- i) **further information about low capacity spectrum at 1350 - 1375 MHz and smaller channels at 6 GHz.** Based on views expressed by the sectors that require low capacity connectivity, we are seeking further information regarding the possibility of making the 1350 - 1375 MHz band available for low capacity TDD fixed link applications noting current plans for 1492-1518 to be harmonised on a EU wide basis under EU harmonisation measures. We are also considering small channels based on CEPT channel plans at 6 GHz to enable such applications in the future.
 - ii) **Consideration of alternative authorisation approaches for 52 GHz and 55 GHz.** We note the significant interest in utilising spectrum around 60 GHz. We further note that the nearby spectrum currently available at 52 GHz and 55 GHz, both with harmonised channel arrangements and made available for HDFS⁴³ applications worldwide, remains unused in the UK. We therefore seek views on whether alternative authorisation approaches would increase interest and use of these bands.
 - iii) **Consideration of spectrum at W band and D band for future fixed wireless links.** There has been a consistent message on the need for very high capacity spectrum to meet future requirements for mobile backhaul connectivity, particularly at the

⁴³ RR 5.547 High density applications in the fixed service

edges of the network. Both W and D band spectrum is also being studied in Europe and by various specialist groups as key spectrum to enable such applications. We are therefore seeking further information on the likely use cases and timescales for these bands to allow us to further consider if and when this spectrum should be made available.

- iv) **New capacity enhancing techniques** - here we seek information on new approaches to enhancing capacity and information about the likelihood of implementation.

5.5 We take each item separately in the rest of this section, although the main substance of the proposals will be on the V band which we consider to be a high priority for regulatory action. On the other work items, we will establish a priority based on our consultation findings.

Question 3:

Do you agree with the items we have identified for further consideration? Are there any other significant areas that you believe should be included? If so, please include all necessary evidence to support your view.

Review of the technical framework at 57 – 66 GHz band

- 5.6 In section 3, we concluded that future demand for fixed wireless links is expected to move towards the edge of the network to facilitate dense small cell backhaul and last mile fixed wireless access connectivity. This is expected to require very high capacity links at millimetre wave frequencies and which stakeholders indicated, could be in the form of alternative topologies such as point to multipoint/mesh. As indicated in this consultation, stakeholders provided a strong indication that V band is being targeted for such point to multipoint/mesh topology.
- 5.7 The existing fixed wireless authorisation approaches in the 57 – 66 GHz band are designed for point to point links and do not facilitate point to multipoint/mesh topologies. We are therefore making proposals in this consultation for changes in the regulatory framework in the 57 – 66 GHz band that would facilitate this future demand.
- 5.8 In addition, because of such demand, CEPT⁴⁴ is also currently reviewing the regulatory framework in the 57 - 66 GHz band with the aim to establish less restrictive technical conditions that would facilitate outdoor use cases, particularly small cell backhauling and fixed wireless access.

⁴⁴ http://eccwp.cept.org/WI_Detail.aspx?wiid=642 and http://eccwp.cept.org/WI_Detail.aspx?wiid=563

full 57 – 66 GHz band to facilitate all the intended use cases. This would enable a more streamlined and simplified approach for V band and the ability to have access to a wider contiguous amount of spectrum under one approach.

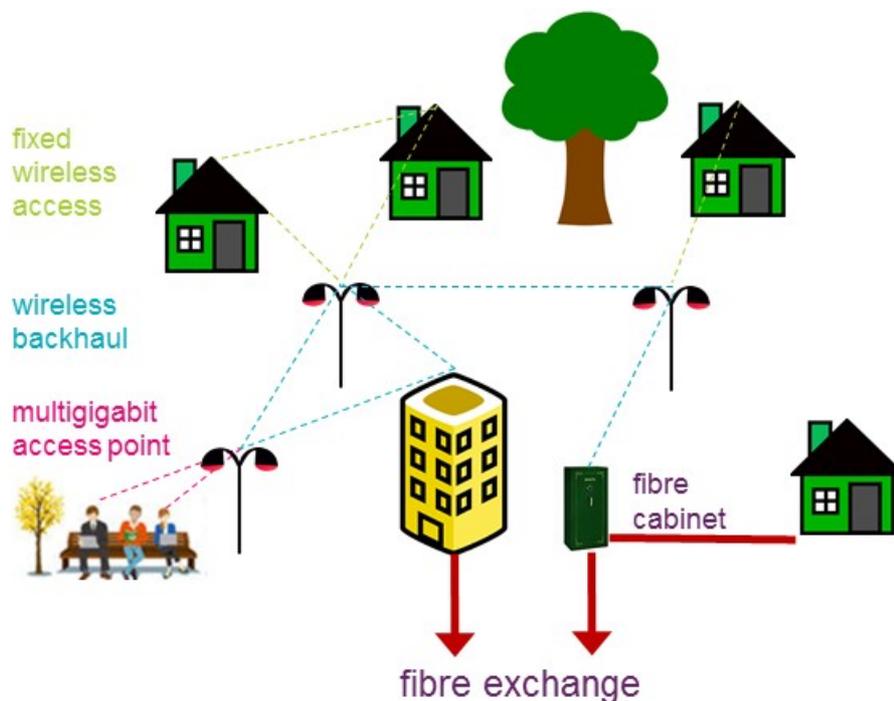


Figure 5: Potential network topology and use cases in V band

- 5.14 This consultation only addresses the relaxation in technical conditions to facilitate new fixed outdoor installation use cases such as those shown in Figure 5, including fixed wireless access, wireless backhaul and wireless multigigabit access points.
- 5.15 We consider that the current technical conditions for wideband data transmission (SRD) with a maximum eirp of 40 dBm for operation in a non-fixed outdoor installation remain appropriate to facilitate outdoor mobile/portable devices.
- 5.16 The use of outdoor fixed wireless multigigabit access points that could communicate with these mobile/portable devices would be facilitated by the proposed changes in the technical conditions in this consultation document.

Proposed change to the authorisation regime in the 64 – 66 GHz band

- 5.17 Our provisional view is that in order to achieve a single authorisation approach to facilitate fixed outdoor use across the full 57 – 66 GHz band, it would be appropriate to change the current light licensed authorisation regime for fixed point to point use in the 64 – 66 GHz band to a licence exempt approach. Table 5 below sets out our impact assessment for this change along with the different options we have considered in coming to this view.

Table 5: Impact assessment of authorisation options at 64 – 66 GHz band

Authorisation options	Pros	Cons
Do nothing (maintain existing light licence regime in 64 - 66 GHz)	No regulatory action required by Ofcom	<p>Does not facilitate deployment of new point to multipoint/mesh equipment as current registration system only applies to fixed point to point links.</p> <p>Even if the registration system were to be changed to allow registration of point to multipoint links, we consider that in practice, it is likely to be challenging and impracticable to coordinate dense street level multipoint mesh deployments with very short LOS distances and unpredictable propagation environment.</p> <p>Potentially inefficient use of spectrum as to date there have been no registrations / deployments of fixed point to point links in this band and whilst there have been some indications in our CFI responses that 65 GHz may be used in the future this would not be prevented under a licence exempt environment.</p>
Licence exempt	Would enable a single streamlined regulatory approach along with the 57 – 64 GHz band, making it easier and more cost effective for users to deploy high capacity wireless connectivity infrastructure (no formal co-ordination required or spectrum fees under a licence exempt approach) and with access to additional 2 GHz of	<p>There is no absolute guarantee of interference free operation in a licence exempt environment (i.e. where terminals are not individually coordinated) and it would be difficult to change to a different licensing regime should the expected benefit of a licence exempt approach fail to materialise.</p> <p>Inappropriate specification of technical conditions could result in ‘tragedy of the commons’ in which no users want to operate due to the</p>

Authorisation options	Pros	Cons
	<p>spectrum leading to 9 GHz of contiguous spectrum.</p> <p>Additional contiguous spectrum would allow for a wider range of applications including the option for further innovation i.e. the spectrum is more likely to be used.</p> <p>Ensures consistency with CEPT and European harmonisation regulations as CEPT is currently studying the full 57 – 66 GHz band.</p> <p>Manufacturers/stakeholders/ citizen consumers will benefit from economies of scale provided by a harmonised availability of spectrum across the wider European market.</p>	<p>perception / concern over potential interference risks. We intend to mitigate this risk by consulting on the appropriate technical conditions that would enable deployment of and facilitate coexistence between point to multipoint/mesh equipment as part of this consultation.</p>
Block assigned	<p>Provides a more certain interference management approach for the individual block licensees i.e. a block licensee can determine how they coordinate their own terminals without having to coordinate with third party terminals.</p>	<p>Dividing the spectrum into smaller blocks suitable for an award would lose the ability to leverage the wide bandwidth properties of this band. i.e. blocks of spectrum would likely have to be limited to smaller blocks to allow for competition e.g. a 4 x 500 MHz block approach which would not provide the benefit of contiguous bandwidth available and required at these frequencies for very high capacity / wide bandwidth applications.</p> <p>Limited number of users in a block assigned band would limit the number of users with access to the spectrum which could result in potential competition concerns,</p>

Authorisation options	Pros	Cons
		<p>prevent smaller enterprise operators to gain access and reduce innovation.</p> <p>This approach would take longer to deliver and the design of the appropriate block assigned authorisation approach along with the need to take into account any competition aspects would delay the benefit that could be provided by early deployment in a licence exempt environment.</p> <p>A multiple spectrum block approach runs the risk of fragmenting this spectrum and would be inconsistent with potential new European harmonisation regulations.</p> <p>Existing equipment / standards may not be optimised / suitable for this type of arrangement.</p> <p>Taken together the above considerations, this is likely to create a significant risk of non-optimal use of this spectrum and blunting the ability for new technology innovation.</p>

- 5.18 Taking into account the different pros and cons for each of the options given in the above table, we consider that the most appropriate way forward would be to change the authorisation approach within the 64-66 GHz band from a light licensed, self-coordinated approach to a licence exempt approach. This will enable the 64 - 66 GHz band to be aligned with the lower adjacent band along with a single set of technical conditions.
- 5.19 As there are currently no users in the band, (nor have we identified any potential future users under the existing framework), the costs in taking this approach are likely to be low, potentially even zero. We consider that the risk of interference can be sufficiently mitigated by a single set of minimal technical conditions as set out below.
- 5.20 Making available the entire 57 – 66 GHz band on a licence exempt basis would also provide a single technical condition for fixed outdoor installation use consistent with the study underway in CEPT as part of a wider harmonisation initiative.

- 5.21 In order to implement the change in the 64 – 66 GHz regulatory regime, Ofcom will be required to vary Schedule 1 of the self-coordinated licence⁴⁹ to remove reference to the 64 – 66 GHz band. The self-coordinated licence currently includes both the 64 – 66 GHz band and the 70/80 GHz band. This would have the effect of removing the ability of existing licensees to register links in the 64 – 66 GHz band.
- 5.22 However, as there are no links currently registered in the 64 – 66 GHz band, we consider that there is no impact to existing self-coordinated licensees. Should these licensees intend to deploy links in the 64 - 66 GHz band in the future, they could do so without the need to register and pay for each registered links, thereby removing costs and administrative burden for future access to the band.
- 5.23 We therefore consider that the licence variation to the self-coordinated licence to be an administrative change which has no impact on existing licensees' ability to access the 64 - 66 GHz band in the future.

Question 4:

Do you agree with our proposal to change the authorisation regime in the 64 – 66 GHz band to licence exempt to create a common authorisation approach across the 57 – 66 GHz band for fixed outdoor installation use and that this would be a benefit to UK citizens and consumers?

Proposed change to the technical conditions in the 57 – 66 GHz band for fixed outdoor installation

- 5.24 Regarding the appropriate technical conditions across the 57 – 66 GHz band to facilitate new outdoor use cases, we consider some small changes to the existing technical conditions will be required.
- 5.25 Our primary objective is to ensure that users of equipment installed outdoor can operate with a low probability of interference under a licence exempt approach.
- 5.26 Taking the existing fixed point to point authorisation approach in the 57 – 64 GHz band as a starting point, we propose to relax the existing minimum antenna gain requirement of 30 dBi to 20 dBi and to remove the maximum output power limitation for equipment operating at eirp level of 40 dBm and below. From our discussions with stakeholders and material they have presented to us, our understanding is that current phase array antennas in point to multipoint/mesh equipment typically have a gain of at least 20 dBi. We also believe there could be continued merit to specify a minimum antenna gain value to help aid co-existence between different systems.
- 5.27 For higher power operation, we propose to retain the existing minimum antenna gain requirement of 30 dBi and maximum output power of 10 dBm for equipment operating at eirp above 40 dBm to 55 dBm. This will maintain the current co-existence environment

⁴⁹ https://www.ofcom.org.uk/_data/assets/pdf_file/0021/84018/ofw_369_guidance_notes_65_70-80ghz_final.pdf

as is presently in place for higher power operation. Our proposal is summarised in Table 6.

Table 6: Proposed change to the technical condition for fixed outdoor installation⁵⁰

Transmit eirp	Requirement	Note
≤ 40 dBm	Minimum antenna gain of 20 dBi	New technical condition
40 dBm < eirp ≤ 55 dBm	Minimum antenna gain of 30 dBi Maximum output power of 10 dBm	Existing technical conditions

5.28 In Figure 6, we show the change to the technical conditions in comparison with the existing point to point authorisation approaches in the 57 – 64 GHz band. The purple shaded area represents the relaxation to the existing technical conditions for point to point fixed wireless links to enable new outdoor use cases.

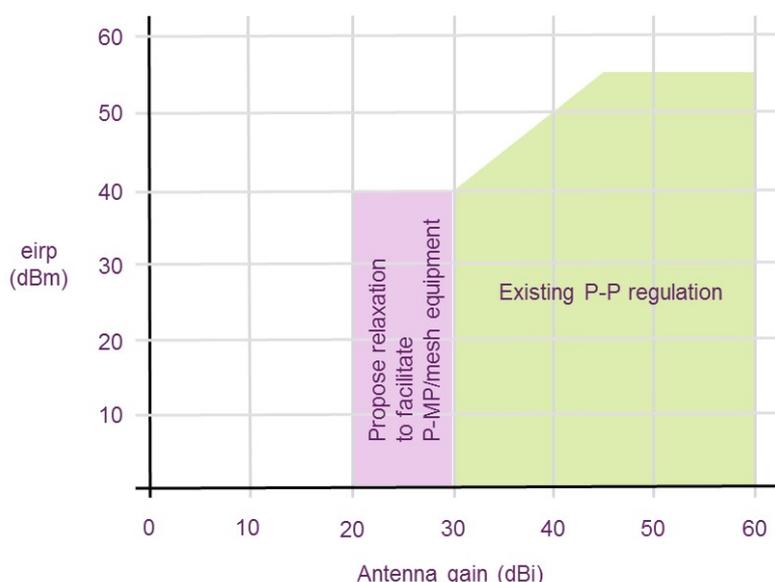


Figure 6: Summary of proposed new technical conditions for fixed outdoor installation

5.29 The proposed relaxation of the technical conditions for use in fixed outdoor installations could potentially increase the risk of interference with respect to other outdoor users compared to the current interference environment. However, we believe that the overall coexistence environment remains possible for the different use cases given the availability of multiple channels and high atmospheric attenuation across the majority of

⁵⁰ Mandatory exclusion zones for 59-63.9 GHz as given in section 4 of [IR2048](#) (October2010) would continue to apply.

the band. In addition, the next generation of equipment is expected to have intelligent self-organising capabilities to improve interference mitigation.

5.30 Furthermore, we consider that this relaxation to enable point to multipoint/mesh use cases on a licence exempt basis will complement other block assigned bands to provide a lower cost spectrum solution.

5.31 Next, we consider the impact of the proposed new technical conditions on existing use in the 57 – 66 GHz band.

a) Fixed point to point use in the 57 – 64 GHz and 64 – 66 GHz bands

To date, our understanding is that there has been limited deployment in the 57 – 64 GHz band and there are no fixed wireless links registered in the 64 – 66 GHz band. Therefore, we consider that the impact of the proposed new technical conditions to the existing fixed point to point users will be minimal. We recognise that future coexistence between adaptive point to multipoint/mesh equipment and non-adaptive point to point fixed wireless links could be a slightly higher risk scenario from an interference management perspective. However, we consider that it will be for the users to assess the cost/performance trade-off between both technologies recognising that interference free operation cannot always be guaranteed in a non-protected licence exempt environment, irrespective of technology deployed.

b) Short range devices in the 57 – 66 GHz band

We consider that the impact to mobile/portable SRD will not be greater than that experienced currently. Wireless multigigabit access points that could be installed outdoor to provide access and offload would be enabled by the proposed relaxation in technical conditions. These would operate in a similar interference environment to other outdoor uses such as small cell backhaul and fixed wireless access.

c) Road transport and telematics in the 63 – 64 GHz band (also known as intelligent transport systems, ITS)

The licence exempt road transport and telematics authorisation within the 63 – 64 GHz band already operates alongside the existing licence exemptions for SRDs and point to point links. We believe our proposals do not alter in a significant way the overall co-existence environment with road transport and telematics. We are also not aware of any current deployment in this band so there is unlikely to be any impact to existing use. Furthermore, we note that a new work item⁵¹ has recently been initiated in ETSI on technical characteristics of multiple gigabit wireless systems (MGWS) in radio spectrum between 57 GHz and 71 GHz including proposal to move the existing ITS allocation to a single MGWS channel.

5.32 Given the above, we are of the view that the proposed technical conditions in the 57 – 66 GHz band to facilitate new fixed outdoor installation use cases are not likely to have any

⁵¹ <https://www.efis.dk/documents/73635>

significant change in impact on existing users. The proposed changes achieve the right balance between relaxing existing technical conditions to enable new use cases whilst managing the interference environment for the different outdoor use cases in a pragmatic way.

- 5.33 We intend to use the responses to this consultation document to consider this matter further and as input to develop our position for the ongoing work in CEPT. The current timetable for completion of the CEPT work is in 2018. Depending on the actual completion date, we may proceed to implement the regulatory changes proposed in this consultation document prior to completion of the CEPT work. This avoids further delay the benefit provided by the applications enabled through the revised regulatory framework.

Question 5:

a) Do you agree with the proposed new technical conditions in Table 6 to facilitate equipment intended for fixed outdoor installation in the 57 – 66 GHz band? Please provide evidenced views /alternatives if you disagree with our proposal. Do you consider any additional conditions should be mandated as part of a licence exemption to manage the interference environment?

b) Do you agree with our assessment that the proposed changes in technical conditions will have minimal impact on existing use and are appropriate to manage the future outdoor interference environment?

c) Are there likely to be any fixed outdoor installation use cases that will require operation at eirp levels above 55 dBm? If so, please provide evidence of how the coexistence with the different outdoor users could be ensured?

Potential use of the 66 – 71 GHz band

- 5.34 In our CFI on 5G spectrum access at 26 GHz and update on bands above 30 GHz⁵², we indicated our current assessment that the 66 - 71 GHz should be promoted as a priority band for study for 5G services and made available on a licence exempt basis. Given its proximity to the 57 – 66 GHz band that is being made available in many countries for licence exempt use by multigigabit applications, equipment could potentially be available in this band relatively early by building on the existing multigigabit ecosystem.
- 5.35 The 5G applications envisaged in the 66 – 71 GHz band are likely to encompass both fixed and mobile use cases. For example, the network topology and the broadband fixed wireless access/ wireless backhaul use cases shown in Figure 5 could also be envisaged in the 66 – 71 GHz range. The lower atmospheric attenuation⁵³ in the 66 – 71 GHz band may

⁵² <https://www.ofcom.org.uk/consultations-and-statements/category-2/5g-access-at-26-ghz>

⁵³ Attenuation due to atmospheric gases peak at around 16 dB/km at 60 GHz and reduce to around 3 dB/km at 65 GHz and 0.6 dB/km at 70 GHz respectively.

facilitate longer range outdoor applications but with a potentially slightly higher risk of interference due to the lower amount of attenuation.

- 5.36 As indicated in 5.33 above, we will further consider this band for 5G and are taking the opportunity in this consultation to seek initial views on the potential applications and use cases in the 66 -71 GHz band, along with the likely technical parameters to inform our programme of work.

Question 6:

a) What are the use cases and technical parameters envisaged for the 66 - 71 GHz band? Are they likely to be similar to those in the 57 – 66 GHz band? If so, what are your views on extending the same or similar technical conditions as described above for the 57 - 66 GHz band (both existing wideband data transmission (SRD) and new fixed outdoor technical conditions) to the 66 – 71 GHz band to facilitate both fixed and mobile use cases.

b) Please provide your view on whether the technical parameters of wideband data transmission (SRD) as shown in Figure 4 are suitable to facilitate mobile/portable equipment including use outdoor? If you do not consider they are suitable, what alternative technical parameters do you think should be considered?

Please provide as much detail to your answer as possible and your considerations on the co-existence aspects.

Consideration of spectrum for the provision of low capacity fixed wireless links

- 5.37 We note the significant use of the 1.4 GHz band for low capacity fixed wireless links. We also provided an update in this consultation that to date no further decisions on the mobile use of 1492 - 1518 MHz in the UK have been taken. However, there are current plans for the band 1492-1518 to be harmonised for SDL on a EU wide basis under an EU harmonisation measure. Our current conclusion is that low capacity applications will continue to be required over the period covered by this strategy.
- 5.38 We also note that some stakeholders have expressed an interest in possibly utilising spectrum in the remaining sub band 1350 - 1375 MHz for future low capacity application on a TDD basis.
- 5.39 We are therefore seeking further information about future possible low capacity requirements should the upper 1.4 GHz sub band (1429 – 1517 MHz) be made available for future mobile use.
- 5.40 Although our CFI reported limited interest in the use of smaller channels in the gaps within 6 GHz spectrum, this was mainly due to lack of equipment availability. However, the need for low capacity connectivity, as indicated by some stakeholders (e.g. for utility

uses) remains. We therefore also plan to explore smaller bandwidth channels (3.5 MHz and below) in the band gaps at 6 GHz.

Question 7:

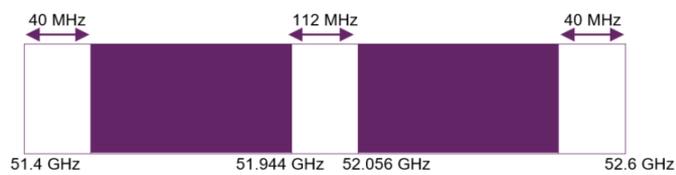
Do you agree that there is a continued need for future low capacity fixed link applications?

If so, please provide information to support your view and what alternatives you would consider appropriate should the upper 1.4 GHz band no longer be available.

Please provide clear evidence to support the reasons for your views.

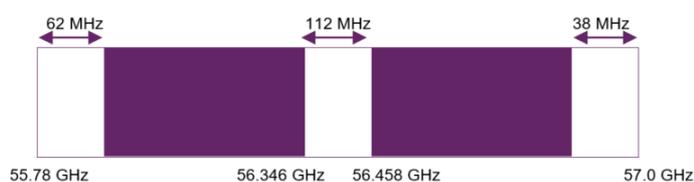
Consideration of alternative authorisation approaches for 52 GHz and 55 GHz

- 5.41 In our CFI, we referred to currently available spectrum that remained unused in bands around 52 GHz and 55 GHz. The bands each offer 2 x 504 MHz of spectrum as shown in Figure 7 below. As we have indicated, both these bands have harmonised CEPT channel arrangements and are available for high density applications in the fixed service.
- 5.42 These bands are currently available for assignment under Ofcom's frequency assignment methodology. There remains limited or no equipment development for these bands and until now no use has been observed in the UK.
- 5.43 Due to emerging interest in the use of new applications for the fixed wireless service in spectrum around 60 GHz, we consider there is merit in looking at possible alternative authorisation approaches to make this spectrum available, such as block assignment, and are seeking stakeholder views on this.



CEPT/ERC/REC 12 – 11 E

Channel Duplex Spacing: 616 MHz



CEPT/ERC/REC 12 – 12 E

Channel Duplex Spacing: 616 MHz

Figure 7: 52 and 55 GHz band plans

Question 8:

Do you consider there is merit in considering making the bands 52 GHz and 55 GHz available under alternative authorisation approach(es) such as block assignment? If so, what would you consider to be the best approach(es)? Please provide detailed views to support your response.

Question 9:

Do you think we should review our authorisation approach to any other band used for fixed wireless links?

Consideration of spectrum at W band and D band for future fixed wireless links

- 5.44 As indicated in our findings, there has been a strong interest in exploiting the higher millimetre wave spectrum at W band and D band for future mobile backhaul applications. The spectrum at these frequencies offers the potential to enable very high capacity connectivity. Channel arrangements are also being considered within CEPT to enable such applications on the basis of 250 MHz channels which could have the potential to be aggregated to enable greater capacity.

- 5.45 To help inform our further consideration on how this spectrum could be made available we are asking for information about how these bands will likely be used for mobile backhaul and views on the most appropriate licensing approach(es) that should be considered.

Question 10:

a) How do you envisage W band and D band will be used for mobile backhaul provision and the likely timescales? Please provide as much detail as possible on deployment scenarios and whether this would include indoor use. Are there any other types of applications (other than mobile backhaul) that could be suited for these bands?

b) What are your views on the most appropriate authorisation approach for the W and D bands? Please provide as much detail and technical evidence as possible in your answer.

New capacity enhancing techniques

- 5.46 A number of capacity enhancing techniques were raised through the CFI to provide capacity for future mobile networks. The responses seemed to suggest an interest from some operators in further exploring some new techniques. Specifically, we draw out the following the approaches that have been described in stakeholder responses (Annex A2):

- Band aggregation
- Full duplex operation

- 5.47 Several operators indicated interest to deploy band aggregation which aggregates a higher band link with lower band link to create a single combined link through a single antenna.

- 5.48 Regarding full duplex operation it is noted that it is unlikely that this type of operation could be deployed in the current Ofcom managed technically assigned fixed links bands without significant replanning, particularly due to high-low⁵⁴ clashes that would be generated with such configurations. We therefore consider that full duplex can only be introduced in new bands such as W and D and welcome further views on this and the appropriate technical and regulatory aspects needed to facilitate it.

Question 11:

Which capacity enhancing technique(s) are you using or planning to use? Please provide detail / evidence and clearly explain why and how each technique is planned to be used and if you consider there are any other aspects that should be considered.

⁵⁴ Clashes to manage interference between transmitter locations that are designated to transmit in the lower half of a duplexed band plan against those that are designated to deploy in the upper half of a duplexed band plan

A1. Non-confidential responses

Airwave

Arqiva

British Telecommunications plc and EE Ltd

Ericsson

Facebook

Horsebridge Network Systems

Huawei

Joint Radio Company

Metronet UK

NEC

Nokia

Phonak UK

Siae Microelecttonica SpA

Vodafone

WHP Telecoms Ltd

A2. Summary of our findings

Introduction

A2.1 We received 22 responses to our CFI and engaged with 13 stakeholders or stakeholder associations. We sought views on how specific industry and service sectors would see their use of fixed wireless links change, as well as potential demand arising from new uses that currently do not have access to the spectrum used for fixed wireless links. In this section, we summarise our main findings of the CFI and meetings with stakeholders.

Specific sectoral changes and international developments

Mobile backhaul

Greater capacity requirements

- A2.2 Within this sector stakeholders indicated that backhaul networks would continue to evolve to provide significantly greater data traffic at higher data rates. They expect this to occur in all parts of their network from rural to urban demanding access to more capacity.
- A2.3 They expect that the main means of providing the backhaul capacity required is through the use of fibre which is continuing to have an increased presence. The impact of this reach means that there would be less reliance on the need for spectrum in all parts of the network. However, stakeholders indicated that the need for sufficient wireless backhaul spectrum would remain as an important complement, particularly at the edges of the network (to backhaul small cells) and in areas where fibre connectivity is not available or economical.
- A2.4 The general message from stakeholders that have access to block assigned spectrum was that there would likely be a continued shift from Ofcom managed spectrum between 23 - 38 GHz to increased use of block assigned spectrum in similar frequency bands.
- A2.5 To meet future capacity enhancement, respondents also indicated that a strong drive should be expected in the demand for fixed wireless links in spectrum above 60 GHz where stakeholders specifically referred to the need to have access to 70/80 GHz, and new spectrum in higher frequency bands in the longer term at W and D bands⁵⁵. In addition, there were views that expressed the need to take a further review of the authorisation approaches for spectrum at 60 GHz to enable more effective use and to accommodate changes in network topology.
- A2.6 In the interim period, most respondents indicated that there would likely be a trend in increased use of wider channels to deliver gigabit capacity and that the networks would evolve to meet these requirements, with some licensees already future proofing their fixed wireless links to carry the maximum data traffic possible with existing technology and

⁵⁵ W: 92-114.5 GHz and D: 130-174.8 GHz

available spectrum. In addition, users were taking advantage of techniques such as the use of higher order modulation, wider channels and cross polarisation operation where available.

Denser networks and alternative topologies

- A2.7 Respondents' views indicated that the existing network architecture would likely evolve to meet the requirements for next generation mobile networks. During this evolution, there is likely to be a hybrid network with the existing network as well as the next generation network co-existing in the same area for some time.
- A2.8 The responses indicated that the evolved architecture could lead to a different functional split in the radio access network to the current distributed radio access network which co-locates the radio unit and the baseband unit at the same cell site. This different functional split would consist of a centralised radio access network (C-RAN) concept where the radio unit would no longer be located at the same site as the base band unit. The two would instead be connected by a "fronthaul" interface of either fibre or fixed wireless links. This concept could provide efficiencies in network management by enabling all the processing of multiple cell sites to be conducted in a centralised manner rather than at each individual cell site. However, the protocols supporting the C-RAN concept were indicated as challenging in terms of latency and linearity and therefore MNOs were looking to develop backhaul architecture using solutions that could lead to something in between the current generation IP backhaul and next generation C-RAN, referred to as "x-haul". Stakeholders further indicated that discussions were still ongoing regarding the appropriate standards developments. Our discussions with stakeholders also suggested that networks would require greater flexibility and programmability through software definition (SDN) with self-organising capabilities (SON).
- A2.9 Stakeholders expect that the requirements for greater capacity and connectivity would mean that the mobile networks would become denser. This densification is expected to need increased connectivity to backhaul small cells and macro cells. Again, as indicated for greater capacity needs, the densification of the network would lead to the need for spectrum requirements by network topology as follows:
- **Urban** – connectivity using conventional microwave spectrum would decrease with fibre having greatest reach in urban areas. Here E⁵⁶ band is expected to increasingly be used to provide connectivity at a macro cell level. V⁵⁷ band is also likely to play a part in urban areas at street level using point to multipoint or mesh configurations. In the longer term, W⁵⁸ band is expected to complement and provide enhanced capacity for E band connections and D⁵⁹ band for V band connections.

⁵⁶ 71-76 GHz and 81-86 GHz

⁵⁷ 57-66 GHz

⁵⁸ 92-114.5 GHz

⁵⁹ 130-174.8 GHz

- **Sub-urban** – fixed wireless links are likely to increase in capacity using capacity enhancing techniques such as the use of wider channels, cross polarisation operation and higher order modulation schemes with some stakeholder referring to multiband/band aggregation approaches which we describe further below in A2.12. Spectrum below 20 GHz (with some licensees indicating 23 GHz) remain important provisions for macro cell connectivity in sub-urban regions where fibre is not available. Millimetre wave spectrum (i.e. bands above 38 GHz) could be used in some cases e.g. the use of band aggregation. Stakeholder indication suggests greater use of block assigned spectrum between 20 GHz to 45 GHz.
- **Rural** – in rural areas conventional microwave spectrum is likely to have the greatest requirement with presence of spectrum from 6 GHz-18 GHz. Capacity enhancing techniques are also expected to be increasingly used for rural backhaul connectivity.

A2.10 For possible new spectrum at W and D bands, we asked stakeholders for their views on the authorisation approach. Most respondents indicated that for the types of deployments envisaged, it would be impractical to follow a conventional regulator managed link by link approach. Some views tended to favour a form of block assignment.

Developments in technology

A2.11 We sought information in our CFI on how technology could develop to meet the increasing capacity requirements envisaged for next generation backhaul networks. Responses referred to:

- the need to use more cross polarisation operation;
- making available wider channels and;
- the use of more data compression techniques.

A2.12 Respondents provided information on some approaches that were being considered and in some cases with trials underway to demonstrate the validity of these approaches. The responses suggested that moving to higher order modulation schemes could provide limited advantages because of both increased equipment complexity and increased impact to the link budget (where increasing the transmit power could only provide limited gains). We briefly mention the approaches below:

- **Band aggregation** – This technique would aggregate high frequency, high capacity spectrum (such as E band) with lower frequency spectrum bands which can provide longer, resilient paths. The aggregation of such bands would enable the use of spectrum providing limited capacity and high propagation availability with high capacity spectrum with low propagation availability, through which the highest availability would be reserved for high priority traffic and lower availability for low priority traffic.
- **Full duplex operation** – this technique was described as an approach that would enable the use of the same frequency for simultaneous continuous transmission in both directions of the fixed wireless link path thereby potentially doubling the capacity

using one typical channel. The technique would require the use of two separate antennas for transmission and reception.

- **Orbital angular momentum (OAM)** – this was described as a capacity enhancing technique without the need to increase bandwidth though the technique could only be applicable to relatively short fixed wireless links.

A2.13 Although these techniques were mentioned in our responses, there was limited information to suggest the extent to which demand would arise for these techniques. We will therefore consider this further in this consultation. We also found that there was limited interest for line of sight MIMO applications.

Utilities

Use of fixed wireless links in utility networks

- A2.14 Stakeholder responses provided an overview of how fixed wireless links are used for utility applications. Responses indicated that utility networks are used to ensure the safe, reliable and continuous supply of electricity, water and gas in the UK where the use of fixed wireless links include carrying data to monitor a range of electrical distribution equipment, gas compressors, pumping stations, reservoirs and sewerage treatment plants. Key monitoring and measurement indicators which are transmitted over the fixed wireless links include gas and water pressure, and voltage and plant status. Utility networks also make use of other connectivity options such as copper cables or fibre.
- A2.15 Stakeholder responses also explained that a key application in electricity networks is “teleprotection” or “intertripping”. This involves the remote monitoring and control of plants where fixed wireless links are used to connect specific pieces of electricity equipment. Such a network enables fault events to be avoided or addressed in the shortest possible time. This includes the safe disconnection of faulty equipment without which the damage sustained by an electrical plant could lead to the dissipation of a large amount of heat energy to other parts of the network where there is no fault. These functions are time critical and therefore rely on a robust low latency infrastructure to limit the dissipation of heat energy under fault conditions.
- A2.16 The utility industry also use fixed wireless links for security including CCTV backhaul, corporate communications and backhaul to telemetry links.

Choice of frequency band and the 1.4 GHz band

- A2.17 Stakeholders reported that the frequency bands used by the utility industry for fixed wireless links range from 1.4 GHz to 38 GHz from which the choice of a specific band would primarily be determined by the specific application required. The choice is usually made based on the distance of the path, the availability requirement, the amount of data that the connection would need to support and equipment availability against the properties of a particular band. The availability of the spectrum from Ofcom and the cost of licence fees is also considered.

- A2.18 In stakeholder responses and our conversations with them, the 1.4 GHz band was highlighted as an important band. Utility applications tend to be the largest user type in the 1.4 GHz band which was indicated as typically used by electricity companies for teleprotection as well as other applications such as alternative path routing for resilience, connecting base station radio sites as well as remote electricity sites to the core network. While there was clear focus on this band by the utility sector as a whole, we also noted that one electricity company made no use of the 1.4 GHz band and instead used frequencies around 7.5 GHz for similar applications.
- A2.19 The water industry tends to use 1.4 GHz for connectivity over long distance and where high availability and resilience to adverse weather conditions would be required. The water industry also indicated that the equipment at 1.4 GHz had good inter-operability with their own legacy systems. The applications in this band tend to use low data rates with typical channel bandwidths being less than 2 MHz. Such small channels are only available in this particular fixed wireless link band.
- A2.20 Stakeholders also indicated that the withdrawal of support for the BT leased line low capacity product⁶⁰ would result in more reliance on 1.4 GHz. They further stated that the other advantage of the 1.4 GHz band was the ability to install the use of less obtrusive antennas (many 1.4 GHz antennas are Yagi or flat plate) which were likely to attract less objection in the planning process.
- A2.21 Our CFI referred to the potential use of part of the 1.4 GHz band (1492-1518 MHz) for future mobile applications and asked whether the introduction of smaller channels in the band gaps at 6 GHz could provide suitable alternative spectrum. On this, stakeholders indicated that although they were not opposed to the use of 6 GHz, there was no commercial equipment available and if there was, that further work would need to be considered in terms of associated costs. Some responses also referred to the possibility of utilising the spectrum that would remain at 1.4 GHz (1350-1375 MHz) for future TDD applications.
- A2.22 In terms of other bands in the 1.4 - 38 GHz range used by utilities, some responses indicated that applications tended to favour frequencies below 20 GHz.

How utility networks are expected to change in the future

- A2.23 Stakeholders in this sector felt that there is likely to be a step change in the demand placed on the communications infrastructure for electricity networks and that within the UK there is a drive towards the use of more renewable sources of electricity generation. The responses further indicated that the production of electricity using a variety of different means is likely to lead to a move away from the current centralised generation model towards more distributed renewable generation, which would require increased connectivity to many locations. Responses also indicated that this would require increased

⁶⁰ The support for BT's low capacity "KiloStream" leased line service will cease in 2020 which has led to a number of stakeholders migrating to 1.4 GHz.

monitoring of networks from a security aspect which in turn would lead to the need for more connectivity to provide CCTV.

- A2.24 In addition, responses outlined a requirement to replace obsolete services and that the “smart grid” would require connectivity to between 100 to 1000 times more devices than current connections. While the specific technology to achieve this was still under discussion at the time of the CFI, existing networks could require major evolution with the introduction of many aggregation nodes requiring connectivity to centralised control points. This could require the installation of a significant number of new fixed wireless links.
- A2.25 The water industry indicated that their networks would likely face an increased requirement for more real time monitoring and control which would affect their use of fixed wireless links. They indicated that their networks could also require increased data delivery, the use of adaptive modulation techniques as well as a move towards carrier Ethernet technology. They also indicated that their fixed wireless links could need an increase in their capacity capability, with capacity enhancing measures such as the use of co-channel cross polarisation systems.
- A2.26 In terms of the need for spectrum, although alternative means such as fibre or satellite links are considered for utility networks, frequency bands between 7.5 GHz and 38 GHz continue to be used to deliver telemetry, voice, data and video services to many electricity, gas and water installations. Indications from the sector are that demand for resilient links will continue. Respondents have indicated they are considering trials of TDD equipment at 1.4 GHz and that the lower 1.4 GHz band duplex (1350 – 1375 MHz) should be considered for future low capacity fixed wireless link applications. In terms of capacity requirements in this band, there is an expectation that data carried on the fixed wireless links would increase using capacity enhancing techniques rather than the need for increased channel bandwidths.

Fixed network operators

- A2.27 Fixed network operators (“FNOs”) use fixed wireless links for the provision of voice and data services for a range of applications and customers including small to medium enterprises and mobile network operators. Services provided include broadband internet access, mobile backhaul, CCTV, WiFi, public safety, broadcasting, transport, fixed wireless access (FWA) and wireless infrastructure deployment.
- A2.28 Fixed network operators also provide network management services and support for services supplied. FNOs use a variety of connectivity options including fibre. There is also use of wireless connectivity using multi-channel fixed wireless links particularly in lower frequency bands such as the 6 GHz band to serve rural communities and connecting to islands. These links provide both broadband delivery infrastructure as well as broadcasting infrastructure where fibre is not available.
- A2.29 The fixed wireless links deployed by fixed network operators therefore generally cover all potential applications possible using fixed wireless links. Consequently, the spectrum

currently used for their fixed wireless links cover all the bands available. Some FNOs have access to spectrum through block assignment and others that do not have such access make use of block assigned spectrum through a spectrum leasing arrangement with the licensee.

- A2.30 For the provision of services, a key aspect that was indicated by respondents was the need to gain fast access to spectrum from Ofcom for fixed wireless links and this was particularly the case for smaller FNOs. Although responses agreed that Ofcom consistently overachieved against stated licence turnaround times, some stakeholders would welcome a further discussion on the how this could be improved.
- A2.31 Smaller FNOs have indicated that the provision of rural broadband delivery was a key aspect of their service provision. They tend to focus on providing connectivity in specific areas to provide broadband access where backhaul provision using 1 Gbps connections is becoming typical.

How fixed network operator requirements are expected to change for the future

- A2.32 As one of the applications that FNOs provide is mobile backhaul, the expectation of development in future needs is as described in section on mobile backhaul above including future spectrum requirements. The FNOs that responded indicated that they expect their requirement for fixed wireless links to increase. Those FNOs that have access to block assigned bands, indicated that they expect to make increased use of this spectrum e.g. the use of 28 GHz for 5G fixed wireless access or 32 GHz for mobile backhaul. They also indicated that there was a marked increase in the use of fixed wireless links for hybrid connectivity i.e. aggregating older generation networks to new IP based networks.
- A2.33 Some respondents have indicated that with the higher capacities envisaged for most applications they serve, the requirement for future fixed wireless links is likely to be focussed on bands above 38 GHz where greater bandwidth and capacities are possible, noting at the same time the need for continued access to bands above 6 GHz for the longer links. Again, stakeholders referred to the need for capacity enhancing techniques to boost overall network capacity to support the next generation of applications.
- A2.34 In addition, some fixed network operators are planning to use block assigned spectrum to provide broadband access to fixed locations (fixed wireless access). It is expected that in most FWA networks an external antenna would be attached to the outside of the target premises and the data traffic would likely be distributed to the target premises from a FWA antenna on street furniture such as lamp-posts or other buildings using a point to multipoint topology to provide connectivity. Similar applications are also envisaged at 60 GHz.

Public safety

Use of fixed wireless links for public safety networks

- A2.35 Stakeholder responses indicated that public safety networks carry a combination of voice, data and SMS applications for the emergency services in the UK. This includes networks

used for police, fire and ambulance services. The requirement to support such public safety services means that emergency services networks require high resilience with wide geographic reach. Responses indicated that fixed wireless links supporting these networks are typically planned to high levels of propagation availability (typically 99.999%), with spectrum at 38 GHz and below being used to carry the backhaul traffic.

How public safety networks are changing

A2.36 The emergency services network covering Great Britain currently provided by Airwave is expected to be decommissioned network after the transition to the LTE network is completed. At this time, Airwave indicated that the majority of fixed wireless links in the current emergency services network would no longer be required. However, they also indicated that in the years leading up to this, there would likely be a large increase in fixed wireless links as the new emergency service network rolls out into rural and isolated areas, as both networks would need to be up and running in parallel. However, to enable capacity enhancement in rural and isolated areas, they indicated that fixed wireless links have been planned to enable them be upgraded (such as to 256 QAM) without the need to swap out equipment. In such areas, they consider that greater use would be required of the lower frequency bands to deliver higher capacities.

Other sectors including new and emerging uses of fixed wireless links

Financial services including high frequency trading

A2.37 Our stakeholder engagement on this indicated that the use of fixed wireless links by the financial sector is expected to remain stable in terms of capacity requirements. Fixed wireless links are mainly used in the south east of England and across the English Channel. Demand from this sector for access to direct paths between data centres will remain and users have indicated that they would be willing to compromise the performance of the connection to achieve this.

A2.38 One stakeholder raised the need to review the protocol of transmit “high” and “low” separation distances at E band as they considered that systems were capable of much closer operation at E band. The stakeholder also requested that vertical separation of E band antennas on tall buildings and towers should also be taken into account.

High altitude platform stations and other aerial platforms

A2.39 A new application based on high altitude platform stations⁶¹ is emerging to provide connectivity including broadband in underserved areas and for emergency and disaster recovery situations. The topic is currently under discussion as part of the preparations for WRC-19⁶² to enable greater harmonisation of existing and additional harmonised spectrum

⁶¹ High Altitude Platform Station (HAPS) is defined in the Radio Regulations as a station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth and is used to provide wireless connectivity

⁶² WRC-19 Agenda Item 1.14 - to consider, on the basis of ITU-R studies in accordance with Resolution 160 (WRC-15), appropriate regulatory actions for high-altitude platform stations (HAPS), within existing fixed-service allocations

on a regional/global level for HAPS. We are gathering evidence as part of our ongoing activity in preparation for WRC-19 so that informed decisions can be made regarding feasibility of such approaches. In addition to these discussions other types of aerial platforms are also currently being considered.

New applications for fixed wireless access at 60 GHz

A2.40 Several responses and conversations with stakeholders have referred to alternative point to multipoint/mesh topologies developing at 60 GHz to provide connectivity at multi-gigabit speeds to provide small cell backhaul and last mile broadband fixed wireless access connectivity and that this is not currently facilitated under the existing authorisation approaches. We are making specific technical proposals in this consultation to facilitate this.

Ofcom managed bands that are being considered for mobile use

A2.41 Some stakeholders have indicated that sharing would be difficult if Ofcom managed bands were repurposed for 5G when multiple users and extensive existing networks are involved. Responses have indicated that a clear time plan and alternative bands would be required, taking into account the costs involved to incumbent stakeholders.

A3. Responding to this consultation

How to respond

- A3.1 Ofcom would like to receive views and comments on the issues raised in this document, by 5pm on 1 February 2018.
- A3.2 We strongly prefer to receive responses via the online form at <https://www.ofcom.org.uk/consultations-and-statements/category-2/fixed-wireless-spectrum-strategy>. We also provide a cover sheet <https://www.ofcom.org.uk/consultations-and-statements/consultation-response-coversheet> for responses sent by email or post; please fill this in, as it helps us to maintain your confidentiality, and speeds up our work. You do not need to do this if you respond using the online form.
- A3.3 If your response is a large file, or has supporting charts, tables or other data, please email it to fsreview@ofcom.org.uk, as an attachment in Microsoft Word format, together with the cover sheet (<https://www.ofcom.org.uk/consultations-and-statements/consultation-response-coversheet>). This email address is for this consultation only, and will not be valid after 1 February 2018.
- A3.4 Responses may alternatively be posted to the address below, marked with the title of the consultation:
- Fixed Wireless Spectrum Strategy Team
Ofcom
Riverside House
2A Southwark Bridge Road
London SE1 9HA
- A3.5 If you would like to submit your response in an alternative format (e.g. a video or audio file), please contact Mrinal Patel on 020 7981 3127, or email mrinal.patel@ofcom.org.uk
- A3.6 We do not need a paper copy of your response as well as an electronic version. We will acknowledge receipt if your response is submitted via the online web form, but not otherwise.
- A3.7 You do not have to answer all the questions in the consultation if you do not have a view; a short response on just one point is fine. We also welcome joint responses.
- A3.8 It would be helpful if your response could include direct answers to the questions asked in the consultation document. The questions are listed at Annex 6. It would also help if you could explain why you hold your views, and what you think the effect of Ofcom's proposals would be.
- A3.9 If you want to discuss the issues and questions raised in this consultation, please contact Mrinal Patel on 020 7981 3127, or by email to mrinal.patel@ofcom.org.uk.

Confidentiality

- A3.10 Consultations are more effective if we publish the responses before the consultation period closes. In particular, this can help people and organisations with limited resources or familiarity with the issues to respond in a more informed way. So, in the interests of transparency and good regulatory practice, and because we believe it is important that everyone who is interested in an issue can see other respondents' views, we usually publish all responses on our website, www.ofcom.org.uk, as soon as we receive them.
- A3.11 If you think your response should be kept confidential, please specify which part(s) this applies to, and explain why. Please send any confidential sections as a separate annex. If you want your name, address, other contact details or job title to remain confidential, please provide them only in the cover sheet, so that we don't have to edit your response.
- A3.12 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and try to respect it. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.
- A3.13 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's intellectual property rights are explained further at <https://www.ofcom.org.uk/about-ofcom/website/terms-of-use>.

Next steps

- A3.14 Following this consultation period, Ofcom plans to publish a statement in the first half of 2018.
- A3.15 If you wish, you can register to receive mail updates alerting you to new Ofcom publications; for more details please see <https://www.ofcom.org.uk/about-ofcom/latest/email-updates>

Ofcom's consultation processes

- A3.16 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in Annex 4.
- A3.17 If you have any comments or suggestions on how we manage our consultations, please email us at consult@ofcom.org.uk. We particularly welcome ideas on how Ofcom could more effectively seek the views of groups or individuals, such as small businesses and residential consumers, who are less likely to give their opinions through a formal consultation.
- A3.18 If you would like to discuss these issues, or Ofcom's consultation processes more generally, please contact Steve Gettings, Ofcom's consultation champion:

Steve Gettings
Ofcom
Riverside House
2a Southwark Bridge Road
London SE1 9HA
Email: corporationsecretary@ofcom.org.uk

A4. Ofcom's consultation principles

Ofcom has seven principles that it follows for every public written consultation:

Before the consultation

- A4.1 Wherever possible, we will hold informal talks with people and organisations before announcing a big consultation, to find out whether we are thinking along the right lines. If we do not have enough time to do this, we will hold an open meeting to explain our proposals, shortly after announcing the consultation.

During the consultation

- A4.2 We will be clear about whom we are consulting, why, on what questions and for how long.
- A4.3 We will make the consultation document as short and simple as possible, with a summary of no more than two pages. We will try to make it as easy as possible for people to give us a written response. If the consultation is complicated, we may provide a short Plain English / Cymraeg Clir guide, to help smaller organisations or individuals who would not otherwise be able to spare the time to share their views.
- A4.4 We will consult for up to ten weeks, depending on the potential impact of our proposals.
- A4.5 A person within Ofcom will be in charge of making sure we follow our own guidelines and aim to reach the largest possible number of people and organisations who may be interested in the outcome of our decisions. Ofcom's Consultation Champion is the main person to contact if you have views on the way we run our consultations.
- A4.6 If we are not able to follow any of these seven principles, we will explain why.

After the consultation

- A4.7 We think it is important that everyone who is interested in an issue can see other people's views, so we usually publish all the responses on our website as soon as we receive them. After the consultation we will make our decisions and publish a statement explaining what we are going to do, and why, showing how respondents' views helped to shape these decisions.

A5. Consultation coversheet

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing

Name/contact details/job title

Whole response

Organisation

Part of the response

If there is no separate annex, which parts? _____

If you want part of your response, your name or your organisation not to be published, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here.

Name

Signed (if hard copy)

A6. Consultation questions

Question 1:

Do you agree that we have identified the key drivers likely to have a significant impact on the spectrum demand for fixed wireless links? If not, please provide further detail and evidence to support your answer.

Do you have other comments to make/points to raise with us on these issues?

Question 2:

Do you agree with our conclusions on spectrum implications and our proposed strategy/next steps for each band?

Are there any other considerations of significance that you feel we should have included or do you have other comments to make/points to raise with us on these issues?

Please provide as much detail as possible to support your answer.

Question 3:

Do you agree with the items we've identified for further consideration? Are there any other significant areas that you believe should be included? If so, please include all necessary evidence to support your view.

Question 4:

Do you agree with our proposal to change the authorisation regime in the 64 – 66 GHz band to licence exempt to create a common authorisation approach across the 57 – 66 GHz band for fixed outdoor installation use and that this would be a benefit to UK citizens and consumers?

Question 5:

a) Do you agree with the proposed new technical conditions in Table 6 to facilitate equipment intended for fixed outdoor installation in the 57 – 66 GHz band? Please provide evidenced views /alternatives if you disagree with our proposal. Do you consider any additional conditions should be mandated as part of a licence exemption to manage the interference environment?

b) Do you agree with our assessment that the proposed changes in technical conditions will have minimal impact on existing use and are appropriate to manage the future outdoor interference environment?

c) Are there likely to be any fixed outdoor installation use cases that will require operation at eirp levels above 55 dBm? If so, please provide evidence of how the coexistence with the different outdoor users could be ensured?

Question 6:

a) What are the use cases and technical parameters envisaged for the 66 - 71 GHz band? Are they likely to be similar to those in the 57 – 66 GHz band? If so, what are your views on extending the same or similar technical conditions as described above for the 57 - 66 GHz band (both existing wideband data transmission (SRD) and new fixed outdoor technical conditions) to the 66 – 71 GHz band to facilitate both fixed and mobile use cases.

b) Please provide your view on whether the technical parameters of wideband data transmission (SRD) as shown in Figure 4 are suitable to facilitate mobile/portable equipment including use outdoor? If you do not consider they are suitable, what alternative technical parameters do you think should be considered?

Please provide as much detail to your answer as possible and your considerations on the co-existence aspects.

Question 7:

Do you agree that there is a continued need for future low capacity fixed link applications?

If so, please provide information to support your view and what alternatives you would consider appropriate should the upper 1.4 GHz band no longer be available.

Please provide clear evidence to support the reasons for your views.

Question 8:

Do you consider there is merit in considering making the bands 52 GHz and 55 GHz available under alternative authorisation approach(es) such as block assignment? If so, what would you consider to be the best approach(es)? Please provide detailed views to support your response.

Question 9:

Do you think we should review our authorisation approach to any other band used for fixed wireless links?

Question 10:

a) How do you envisage W band and D band will be used for mobile backhaul provision and the likely timescales? Please provide as much detail as possible on deployment scenarios and whether this would include indoor use. Are there any other types of applications (other than mobile backhaul) that could be suited for these bands?

b) What are your views on the most appropriate authorisation approach for the W and D bands? Please provide as much detail and technical evidence as possible in your answer.

Question 11:

Which capacity enhancing technique(s) are you using or planning to use? Please provide detail / evidence and clearly explain why and how each technique is planned to be used and if you consider there are any other aspects that should be considered.