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## Enabling mmWave spectrum for new uses

Making the 26 GHz and 40 GHz bands available for  
mobile technology

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[Enabling mmWave spectrum for new uses – Welsh overview](#)

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### **STATEMENT AND CONSULTATION:**

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# 1. Overview

Ofcom is responsible for managing the UK's radio spectrum, which is the range of radio frequencies essential for all wireless communications.

We have decided to make over 6 GHz of millimetre wave (“**mmWave**”) spectrum available across the 26 GHz (24.25-27.5 GHz) and 40 GHz (40.5 GHz-43.5 GHz) bands for mobile technology, including 5G. This spectrum has the potential to deliver significant benefits by enabling large increases in wireless data capacity and speeds, and we want to provide industry with certainty of access to this spectrum to enable timely investment and innovation.

We are taking a proactive approach to making mmWave spectrum available, to enable investment in faster, better quality services and innovation. We consider that making the 26 GHz and 40 GHz bands available for new uses at the same time will maximise this spectrum's potential to benefit for people and businesses.

## What we have decided – in brief

We are enabling opportunities to access mmWave spectrum across the country for a variety of new uses. In this document, we set out how we will allocate mmWave spectrum to best support new uses:

- In the major towns and cities, where we expect the highest volume of mmWave deployment (“**high density areas**”), we will assign **local licences on a first come, first served basis**, using our Shared Access licensing framework; and **award city/townwide licences by auction**.
- Elsewhere in the UK (“**low density areas**”), we expect deployments to be sparser, and so we will assign **local licences on a first come, first served basis** for mmWave spectrum, using our Shared Access licensing framework.

To do this, we first need to clear the incumbent fixed wireless links which will not be able to coexist with mobile technology in this spectrum. We have therefore decided to **start the statutory process to revoke**:

- licences authorising fixed links in the 26 GHz band which are likely to receive harmful interference from new uses;<sup>1</sup> and
- all of the existing block assigned licences in the 40 GHz band.

We note that the decisions and proposals set out in this document are subject to the outcome of these statutory processes for revoking existing licences.

We are now consulting on proposals for the design of the auction for citywide licences, the licence conditions for citywide and local mmWave licences and how we will coordinate users of this spectrum.

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<sup>1</sup> We will begin this process later this year, once we have determined which fixed links are likely to receive interference from new users.

## Our decisions

### Authorisation of mmWave spectrum for new uses

- 1.1 We expect that new uses of mmWave spectrum will be mostly concentrated in areas with high data traffic such as towns and cities. Frequencies in the mmWave range can carry large amounts of data, but their propagation is typically limited to short distances as it is easily blocked by buildings and trees. This part of the spectrum is therefore better suited to providing high capacity and speeds than coverage over a wide area. We refer to the towns and cities where we expect the most widespread deployment of mmWave spectrum for new uses to occur as “**high density areas**”.
- 1.2 In deciding how to authorise new uses of the spectrum, we aim to:
  - a) facilitate investment and network planning by mobile network operators (“**MNOs**”) and by wide area operators more generally in areas where we expect most widespread deployment of mmWave spectrum for new uses; we have defined 68 such high density areas in and around cities, major towns and some transport hubs;
  - b) enable more localised investments throughout the UK (both within and outside high density areas) by a wide range of operators; and
  - c) safeguard the needs of the Ministry of Defence (“**MOD**”).
- 1.3 In the 26 GHz band we have decided to:
  - a) award wide area licences (“**award licences**”) by auction in the top 2.4 GHz of the band (25.10-27.5 GHz) in high density areas;
  - a) make local access licences available on a first come, first served basis, using our Shared Access licensing framework, in the 24.45-25.10 GHz range in high density areas, and in the 24.45-27.5 GHz range everywhere else; and
  - b) safeguard exclusive nationwide access for the MOD to the bottom 200 MHz of the band (24.25-24.45 GHz).
- 1.4 **In the 40 GHz band**, we are minded to make the whole of the band available for auctioned citywide licences in high density areas, and to make the whole band available for local first come, first served licences, using our Shared Access licensing framework, in the rest of the country.
- 1.5 We set out more detail on our approach to authorisation of this spectrum in section 3, and on how we have identified high density areas in section 4.

### Our approach to existing users of the 26 GHz band

- 1.6 We will need to clear many of the fixed links currently operating in the 26 GHz band because our coexistence studies indicate that they could suffer harmful interference from the new uses we have decided to authorise in the band. We expect that operators of these links could replace them with wireless links using other spectrum bands or with fibre links.

We are consulting on how we will identify which fixed links around high density areas will need to be cleared. Once we have identified these links, we will start the statutory process for revoking such links and those in high density areas. In other areas of the UK, we will allow fixed links to remain in the band. We will begin this revocation process later this year, when we publish our next document. As part of the revocation process, licensees will have the opportunity to make representations to Ofcom regarding the proposed revocations, and any licensee who receives a notice of revocation will have five years' notice before it takes effect.

- 1.7 There are no current PMSE licensees in the 26 GHz band, and we are therefore giving five years' notice that we will close the band to future PMSE licences.
- 1.8 Should the MOD need access to spectrum in addition to its safeguarded 200 MHz at the bottom of the band, we will manage its future access requirements by coordinating them with other uses on a first come, first served basis.
- 1.9 Other current uses of the 26 GHz band include one satellite earth station, level crossing radar used by Network Rail, ultra-wideband radar, and a range of different licence-exempt short-range devices. We have decided that these can remain in the band, as we believe that managing their coexistence with new services would be straightforward.
- 1.10 We set out our decisions on existing users of the 26 GHz band in full in sections 5 and 6.

### **Our approach to existing users of the 40 GHz band**

- 1.11 We have decided to enable the 40 GHz band for new uses on the same timescale as the 26 GHz band. We consider that this is most likely to deliver the best outcomes for people and businesses, ensuring that spectrum availability is not a barrier to innovation and investment in new uses of mmWave spectrum.
- 1.12 There are three existing licensees in the band - H3G, MBNL, and MLL - which hold block assigned national licences. These licences were allocated by auction in 2008. At the time of the 2008 auction, there was no general expectation that the 40 GHz band would be used for future mobile services. The terms of the current licences mean that in practice they can only be used to provide fixed services, and do not permit mobile use. Currently, fixed links are the only use of the 40 GHz licences.
- 1.13 We have decided to start the statutory process to revoke all the existing licences in the 40 GHz band. This is because we consider that the optimal use of the 40 GHz band is for mobile rather than fixed services, and that our re-allocating the whole band at the same time as the 26 GHz band will ensure an efficient allocation of the combined bands in high density areas. As part of the statutory revocation process, licensees will have the opportunity to make representations to Ofcom regarding the proposed revocation, and any licensee who receives a notice of revocation will have five years' notice before it takes effect. In line with our approach to the 26 GHz band, we will allow any of the existing licensees' fixed links which operate outside high density areas and which are unlikely to receive interference from new mobile services to continue to operate in the band.

1.14 We set out our decisions on existing users of the 40 GHz band in full in section 7.

## Competition measures in the award

1.15 We have considered whether it would be necessary to impose any competition measures, such as spectrum caps, in the award, and in particular whether there is a risk of any MNO or MNOs bidding strategically to prevent a rival from acquiring the spectrum it needed to be a competitive MNO in future. We consider such strategic bidding would be very costly, as it would require the strategic bidder or bidders to acquire a large amount of spectrum which would be surplus to their needs over the term of the licence. As we are making 26 GHz and 40 GHz available at the same time, we expect MNOs to be able to acquire as much mmWave spectrum as they require. We do not wish to impose unnecessary constraints on bidders acquiring spectrum in the auction, and we have decided that we will not impose any competition measures in the award.

1.16 For more information on our competition decisions, please see section 8.

## Our proposals

1.17 We are also seeking stakeholders' feedback on the following proposals.

## Auction design

1.18 Section 9 sets out our auction design proposals. In summary, we propose:

- a) A principal stage, in which bidding will decide the quantity of spectrum that will be allocated to each bidder in each lot category, and an assignment stage to decide the precise frequencies to be licensed to each bidder.
- b) A clock format for the principal stage and a sealed-bid second-price rule for assignment stage rounds.
- c) Three lot categories:
  - i) 26 GHz lower (25.1-26.5 GHz); 14x100 MHz lots;
  - ii) 26 GHz upper (26.5-27.5 GHz); 10x100 MHz lots;
  - iii) 40 GHz (40.5-43.5 GHz); 30x100 MHz lots.
- d) Lot sizes of 100 MHz in both the 26 and 40 GHz bands.
- e) To combine all high density areas into subnational lots, with the option of disaggregating specific cities if we see likely demand in response to this consultation.
- f) That reserve prices would fall within the range £0.25m to £2m per lot; our current view is that reserve prices of £1m for 26 GHz and £0.5m for 40 GHz would be appropriate.

1.19 As set out above, we've decided not to include competition measures in the award.

1.20 For more detail on our auction design proposals, please see section 9.

## Coexistence and coordination

- 1.21 We are consulting on how to ensure coexistence without harmful interference between all licensed users of the 26 GHz and 40 GHz bands once new uses are authorised .
- 1.22 **In the 26 GHz band**, we propose to coordinate deployment of Shared Access licensees' medium power base stations (which will only be allowed outside high density areas), and to require minimum separation distances between their low power base stations. We also propose a field strength limit, at the boundary of any high density areas, on transmissions from all new licensees; and a minimum separation distance between any low power base station and the boundary of any high density area.
- 1.23 We are considering how to protect fixed links in and around high density areas, during their revocation periods, from undue interference from award winners' deployments. We currently favour coordinating deployment of medium power base stations ourselves. We also invite views on whether, alternatively, award winners could coordinate their own deployments with fixed links; or whether we should prevent award winners deploying medium power base stations where they will interfere with incumbent fixed links, during the revocation period.
- 1.24 We decided in July 2022 to apply exclusion zones around the six radio astronomy sites that comprise the eMERLIN array, in which we will not allow the deployment of outdoor 26 GHz base stations.<sup>2</sup> At the same time, we decided to limit the density of outdoor base stations in the 24.25-25.05 GHz range, in order to protect the earth exploration satellite service operating below 24 GHz.
- 1.25 **In the 40 GHz band** we propose to make Shared Access licences available in low density areas only after the end of the revocation period of current licences in that band. We propose to protect the Cambridge radio astronomy site by requiring all award licensees in the 40 GHz band to limit their emissions into the 42.5-43.5 GHz range with a 50km coordination zone and a spectrum quality benchmark.
- 1.26 Our detailed coordination proposals are explained in section 10.

## Award licence conditions

- 1.27 We are consulting on proposals for the technical and non-technical licence conditions to be included in award licences for mmWave spectrum. For more detail on our proposals, please see sections 11-13.

## Duration of auction licences

- 1.28 As the potential of mmWave spectrum is still developing, there is a risk that the initial allocation of award licences will not reflect the most efficient allocation of mmWave spectrum in the longer term. We therefore consider our most recent approach of awarding

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<sup>2</sup> Ofcom's statement, [Protecting passive services at 23.6-24 GHz from future 26 GHz uses](#), published July 2022, paragraph 2.20.

indefinite licences with a 20-year initial term could result in an allocation of mmWave spectrum which might not be efficient over time.

- 1.29 Instead, we are minded to award **15-year fixed term** licences for mmWave spectrum, and to consult on our approach to ensuring an efficient allocation of the spectrum at the end of this term.

## Shared Access

- 1.30 We are minded to offer Shared Access licences subject to the non-technical conditions applied to the Shared Access licences that are already available in other bands.
- 1.31 However, given the specific characteristics of mmWave spectrum, we are proposing to make some modifications to the fees and the technical licence conditions which apply to the Shared Access licences that are already available in other bands. For more detail on our approach to Shared Access licensing in mmWave bands, please see section 14.

## Next steps

- 1.32 We invite responses to this consultation by 22 May 2023.
- 1.33 We intend to start the statutory process for revoking the existing 40 GHz spectrum licences shortly. As part of this process, licensees will have the opportunity to make representations, which we will consider before making a final decision.
- 1.34 Following responses to this consultation, we plan to publish a statement in Q3 of FY 2023/24 setting our decisions on: authorisation of the 40 GHz band, auction design, licence conditions for award licences and Shared Access licences, how we will coordinate users of this spectrum, and how we will identify which fixed links in the 26 GHz band are likely to receive interference from new users of the spectrum and will therefore be subject to revocation. We will then begin the statutory process for revoking fixed link licences in the 26 GHz band. As part of this process, licensees will have the opportunity to make representations, which we will consider before making a final decision.
- 1.35 We intend to hold the auction in Q1 of FY 2024/25 and for Shared Access licences in the 26 GHz band to be available at the same time.

The overview section in this document is a simplified high-level summary only. The detailed proposals and decisions and our reasoning are set out in the full document.

## 2. Our approach to mmWave

### Summary

- 2.1 Making mmWave spectrum available for new uses is an important step in delivering on Ofcom's strategic priorities of supporting investment in high-quality and reliable broadband and mobile networks, and enabling wireless services in the broader economy.<sup>3</sup> We aim to promote and facilitate investment, innovation and competition in the development of wireless services to benefit people and businesses, by making this spectrum available in a timely and effective manner.
- 2.2 In May 2022,<sup>4</sup> we consulted on proposals to make mmWave spectrum available in the 26 GHz and 40 GHz bands for mobile technology, including 5G (the "[May 2022 Consultation](#)").<sup>5</sup> We proposed to enable new uses of this spectrum, including mass-market mobile, gigabit fixed broadband and innovative services more generally. For simplicity, throughout this document we use the term "new uses" to refer collectively to all the potential new applications of mmWave spectrum which the decisions and further proposals set out in this document are intended to enable.
- 2.3 The 26 GHz and 40 GHz bands, which comprise 6.25 GHz of spectrum in combination, have both been identified for mobile services globally, and for 5G in Europe. We expect both bands to be functionally substitutable in the long run.
- 2.4 Making mmWave spectrum available for new uses has the potential to deliver significant benefits to UK people and businesses. It can offer operators the opportunity to acquire very large contiguous blocks of spectrum, which can enable services requiring very high capacity and speeds. However, propagation in this part of the spectrum is usually limited to short distances, as it is easily blocked by obstacles such as trees and buildings. In contrast, mobile bands below 6 GHz can enable coverage over a wide area, but have much smaller bandwidths than mmWave bands, and as a result provide less capacity and lower speeds.
- 2.5 As demand for data continues to grow, mmWave spectrum will be an important component in mobile operators' ability to meet future growth in demand for mobile broadband.<sup>6</sup> This spectrum also has strong potential to support the development of innovative services using mobile technology.
- 2.6 Understanding of the commercial potential of mmWave spectrum for new uses is still evolving, though the potential benefits are high. Now that some mmWave spectrum has been harmonised and is being made available for new uses across the world, business

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<sup>3</sup> Ofcom's "[Plan of work 2022/23](#)", published 25 March 2022, paragraphs 2.18, 3.6 and 3.20-3.23.

<sup>4</sup> Ofcom's Consultation "[Enabling mmWave spectrum for new uses](#)", published 9 May 2022.

<sup>5</sup> We refer to the range of spectrum above 24 GHz (but below 100 GHz) as mmWave spectrum.

<sup>6</sup> See Ofcom's discussion document "[Mobile networks and spectrum: Meeting future demand for mobile data](#)", published 9 February 2022, where we set out that mobile operators will need to evolve to meet future demand and deliver the quality of experience needed by consumers and businesses. There are a number of ways in which they might do this, including through densifying networks by deploying new mmWave spectrum using small cells.

cases are developing and gaining momentum. The US is one of the most advanced markets, where mmWave spectrum (including the 28 GHz and 39 GHz bands) has been deployed on a commercial scale by mobile operators such as Verizon and AT&T. In Europe, 26 GHz spectrum has been made available for new uses in a number of countries (including Germany, Italy, Finland and Spain), with more planned for the next few years, though commercial deployments have been limited to date.

- 2.7 We recognise that the commercial development of mmWave spectrum for new uses is still at a relatively early stage worldwide. However, we consider that taking a proactive approach to the management of this spectrum by making around 6 GHz of spectrum across the 26 GHz and 40 GHz bands available for new uses, and providing industry with certainty of access to this spectrum in a defined timeframe, will enable timely investment and innovation.
- 2.8 In the remainder of this section, we explain some factual background about the 26 GHz and 40 GHz bands and set out our policy objectives for enabling them for new uses, which derive from our statutory duties. We then explain our understanding of the potential use cases and demand for this spectrum, in light of the responses we received to our May 2022 Consultation. Finally, we set out why we have reached the view that awarding both bands at the same time, in 2024, is likely to give rise to greater benefits for citizens and consumers than alternative approaches.

## Background

### The 26 GHz band (24.25 GHz to 27.5 GHz)

- 2.9 We have been indicating our intention to make the 26 GHz band available for mobile technology, including 5G, since February 2017.<sup>7</sup>
- 2.10 There have been a number of developments since 2017 supporting the availability of the band for use of mobile technology, including 5G. In particular, the 26 GHz band was identified on a global basis for International Mobile Telecommunications (“**IMT**”) at the 2019 World Radiocommunication Conference (“**WRC-19**”) by amendments to the Radio Regulations of the International Telecommunications Union. The 26 GHz band was also

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<sup>7</sup> In [February 2017](#), we highlighted our support for the 26 GHz band as the priority mmWave band for global harmonisation, and initiated a programme of work to review how the 26 GHz band could be made available for 5G in the UK. In [July 2017](#), we published a call for input, seeking feedback from stakeholders on making the 26 GHz band available for 5G. In our discussion document of [March 2018](#) about ‘Enabling 5G in the UK’, we noted that while responses to our 26 GHz call for input indicated that the band was likely to become important for 5G, many suggested that it was too early to say how the band will be used, and for what purposes. In our July 2018 "[Review of spectrum used by fixed wireless services](#)", we said that Ofcom was working towards making the 26 GHz band available for 5G.

adopted as a pioneer band for 5G in Europe with harmonised technical conditions set out in the “**26 GHz Decision**”,<sup>8</sup> which are now part of UK law.<sup>9</sup>

- 2.11 Equipment manufacturers already offer products which support new uses of the 26 GHz band, with some equipment capable of tuning across the entire 24.25-27.5 GHz range. The 26 GHz band is also supported in US models of mainstream consumer devices such as the Apple iPhone 13 and 14,<sup>10</sup> and Google Pixel 6.
- 2.12 Current uses of the 26 GHz band include fixed point-to-point links, one satellite earth station, level crossing radar used by Network Rail, licence-exempt short-range devices (SRDs) and an allocation for programme making and special events (PMSE) equipment. The Ministry of Defence (MOD) also currently has access to the top 1 GHz of the band (26.5-27.5 GHz). The most widespread use of the 26 GHz band is fixed links, which we license and coordinate on a per-link basis between 24.5 and 26.5 GHz. In January 2022, we announced that the band will close to new applications for fixed link licences and technical variations with effect from 18 July 2022, in preparation for our upcoming authorisation of the band for new uses.<sup>11</sup>
- 2.13 In 2019, following the 26 GHz Decision, we made part of the band (24.25-26.5 GHz) available for Shared Access licences for low power indoor deployments only.<sup>12</sup> Licences are available on a first come, first served basis, and provide access to spectrum for indoor 5G applications. Currently there is one such Shared Access licence in the band.
- 2.14 For more detail on our approach to existing users of the 26 GHz band, see sections 5 and 6 of this document.

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<sup>8</sup> Commission Implementing Decision (EU) 2019/784 of 14 May 2019 on harmonisation of the 24,25-27,5 GHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services in the Union. See [consolidated text](#). This decision has been developed on the basis of studies conducted by CEPT in [ECC Decision \(18\)06](#) on the harmonised technical conditions for Mobile/Fixed Communications Networks (MFCN) in the band 24.25-27.5 GHz, as amended on 20 November 2020.

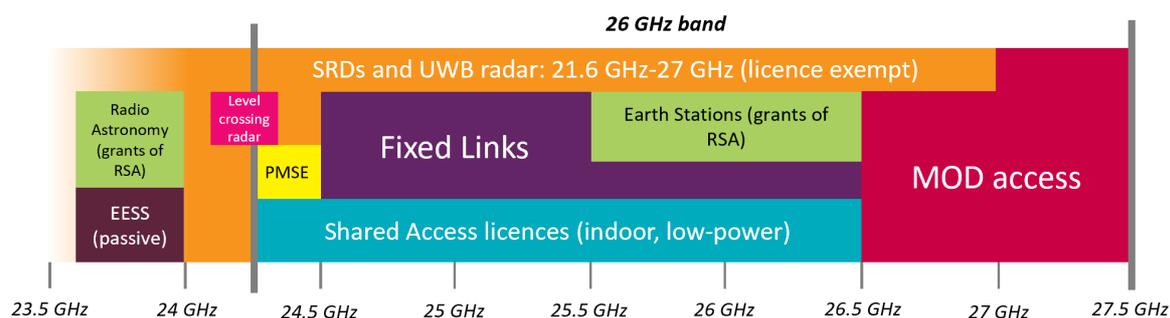
<sup>9</sup> Decision [2019/784](#) and Decision [2020/590](#) continue to be part of UK law, following Brexit, by virtue of section 3 of the EU Withdrawal Act 2018.

<sup>10</sup> See “[5G and LTE. Find the iPhone that’s right for your country or region](#)” on Apple’s website

<sup>11</sup> Ofcom’s notification to stakeholders “[Closure of 26 GHz band to new fixed link licence applications and technical variations](#)”, published 18 January 2022.

<sup>12</sup> Ofcom’s Statement “[Enabling wireless innovation through local licensing](#)”, published 25 July 2019, section 5. In light of Ofcom’s decision to make the lower 26 GHz band available for indoor use, Government decided not to specify requirements for any part of the 26 GHz band to be made available for mobile services through transposition of the European Electronic Communications Code (see “[Government response to the public consultation on implementing the European Electronic Communications Code](#)”, published 22 July 2020, pp. 35-36).

Figure 2.1: 26 GHz band current use



## The 40 GHz band (40.5 GHz to 43.5 GHz)

- 2.15 The wider 37-43.5 GHz band was identified globally for IMT at WRC-19, with Europe identifying 40.5-43.5 GHz as a priority band for 5G. In April 2020, the European Commission issued a mandate to the European Conference of Postal and Telecommunications Administrations (“CEPT”), asking CEPT to develop harmonised technical conditions for use of the 40 GHz band for wireless communications services.<sup>13</sup> On 18 November 2022, CEPT published a report in response to that mandate (“CEPT Report 82”)<sup>14</sup> and the Electronic Communications Committee (“ECC”) published a decision (“ECC Decision (22)06”)<sup>15</sup> reflecting CEPT’s harmonised conditions.
- 2.16 CEPT Report 82 will form the basis of a harmonising Commission Decision, which is currently in draft form.<sup>16</sup> It is currently expected that a final Commission Decision will be published later this year.<sup>17</sup> For the avoidance of doubt, any such decision will not be part of UK law. However, as discussed in more detail in other sections of this document (in particular, section 13), we consider it appropriate to authorise spectrum use of the relevant frequencies on the basis of technical conditions reflecting the CEPT harmonisation (to which the UK has contributed) because the adoption of harmonised conditions is likely to facilitate spectrum use.
- 2.17 New mmWave chipsets and antenna modules support both 26 and 40 GHz.<sup>18</sup> However, the equipment ecosystem for the 40 GHz band is behind that of the 26 GHz band, and there are currently no consumer devices available on the market for new uses of the 40 GHz band.<sup>19</sup>
- 2.18 In order for consumer devices to be usable with 40 GHz spectrum, they would need to (i) have the relevant chipset and antenna module installed (this is often the same as the chipsets which support use of 26 GHz), and (ii) the handsets with those mmWave

<sup>13</sup> [CEPT Report 78, annex 1.](#)

<sup>14</sup> [CEPT Report 82.](#)

<sup>15</sup> [ECC Decision \(22\)06.](#)

<sup>16</sup> CEPT Report 82 will form the basis of a harmonising Commission Decision, which is currently in draft form. A draft of the Commission Implementing Decision, dated 7 December 2022, is available [here](#).

<sup>17</sup> See the [European Commission’s mandate to CEPT](#), which is annexed to CEPT Report 78.

<sup>18</sup> For example, the [new Qualcomm chipsets and mmWave antenna modules support both 26 and 40 GHz](#) (accessed 11 January 2023).

<sup>19</sup> There are [two n259 modules listed on GAMBoD](#) but no consumer devices (accessed 11 January 2023).

chipsets/antenna modules would need to have undergone compliance testing and type approval for their use with the 40 GHz band. This means that some handsets whose hardware could support use of both the 26 GHz and 40 GHz bands, will not be usable in practice with the 40 GHz band until this testing has been completed. Once this testing is completed, handsets already in the UK market could be upgraded to support the 40 GHz band by firmware download, provided that they are equipped with the relevant chipsets.

- 2.19 We understand that in order for handset vendors to undertake this testing, they require (a) demand from network operators, and (b) sufficient network roll out for compliance and interoperability testing from mobile operators.
- 2.20 We consider that making this internationally harmonised spectrum available in the UK is likely to drive mobile operators' demand for this spectrum.<sup>20</sup> In addition, we expect harmonisation of this band within Europe to contribute to international demand for consumer equipment from mobile operators.
- 2.21 Making both bands available in the UK may help to bring forward deployment timelines, by providing additional incentives for manufacturers to develop equipment and also potentially encouraging other administrations to consider authorising 40 GHz for new uses earlier. As a result we consider that once the 40 GHz band has been made available for new uses in the UK, there should be no significant barriers to operators deploying in this spectrum.

### Current use of the band

- 2.22 There are three existing licensees in the band, H3G, MBNL, and MLL, which hold block assigned national licences.<sup>21</sup> The band is arranged with a duplex split: H3G is authorised to use 2 GHz (2x1 GHz), and MBNL and MLL are each authorised to use 500 MHz (2x250 MHz). These licences were assigned by auction in 2008 on a service and technology neutral basis.<sup>22</sup> H3G and MBNL currently use their 40 GHz spectrum for fixed links, while MLL does not currently use its spectrum.
- 2.23 At the time of the 2008 award, there was no general expectation that the 40 GHz band would be used for future mobile services.<sup>23</sup> The existing 40 GHz licences require operators to register the address of radio equipment including terminals using the spectrum, as well as their antenna height and antenna bearing.<sup>24</sup> This requirement prevents licensees from using the spectrum for mobile services, as a mobile terminal (i.e. a user handset) inevitably

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<sup>20</sup> [CONFIDENTIAL <], and similarly [CONFIDENTIAL <]

<sup>21</sup> The licences were originally won by UK Broadband (UKB), MBNL and MLL. H3G, one of the four national MNOs, acquired UKB in 2017. MBNL is a network sharing joint venture, and is owned by BT/EE and H3G. MLL is a provider of managed network services. These [40 GHz licences](#) are published on Ofcom's website.

<sup>22</sup> See the [10 GHz, 28 GHz, 32 GHz and 40 GHz Award](#) page on Ofcom's website.

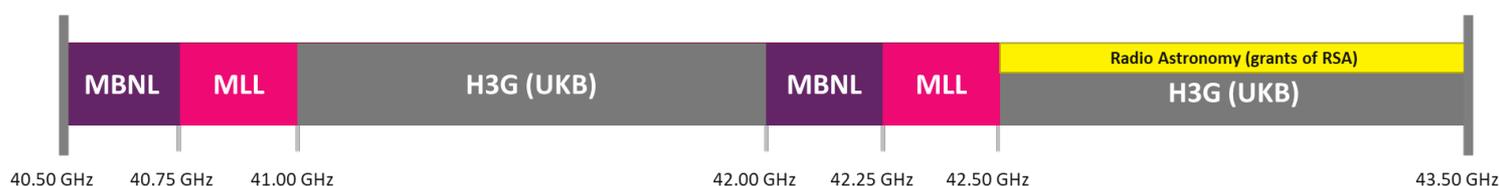
<sup>23</sup> The ERC in June 1999 designated this Band for multimedia wireless systems (MWS), which it defined as terrestrial multipoint systems that provide FWA to the end user for multimedia services (ERC/DEC(99)15)8. However, we noted at the time of the award that there had been no use of the band for MWS, and so did not limit the band to MWS operation. In 2016, the RSPG published an opinion, "[Strategic roadmap towards 5G for Europe](#)", that 40.5-43.5 GHz was a viable option for 5G in the longer term.

<sup>24</sup> See paragraph 3(a) of Schedule 1 of the 40 GHz licences, available on the "[Mobile and wireless broadband above 5 GHz](#)" page of Ofcom's website.

changes location, antenna height and bearing very frequently.<sup>25</sup> The current technical licence conditions are also not optimal for 5G.<sup>26</sup>

- 2.24 These licences have an indefinite duration, with an initial term of 15 years (which expired in February 2023) during which time Ofcom’s powers to revoke the licences were limited.<sup>27</sup> Since February 2018, Ofcom has had the power to revoke these licences (if objectively justified and proportionate), with five years’ notice, for spectrum management reasons.<sup>28</sup>
- 2.25 There is also one grant of Recognised Spectrum Access (“RSA”) for radio astronomy at 42.5-43.5 GHz.<sup>29</sup> A 50km exclusion zone applies around the radioastronomy site at Cambridge for these specific frequencies.
- 2.26 For more detail on our approach to existing users of the 40 GHz band, see section 7 of this document.

**Figure 2.2: 40 GHz band existing users**



### mmWave bands not in scope – 28 GHz and 66-71 GHz

- 2.27 In the May 2022 Consultation,<sup>30</sup> we said that we did not consider the 28 GHz band (27.5-29.5 GHz) to be a future mobile band in the UK. While the 28 GHz band has been identified for 5G and made available for mobile services in the US and other administrations, the UK has adopted the 26 GHz band as the pioneer mmWave band for 5G alongside the rest of Europe. The 28 GHz band is currently used for satellite services, in addition to fixed terrestrial services. The 28 GHz band is a core band for satellite services, and we expect satellite use of this band to continue to grow in the UK. The 28 GHz is therefore unlikely to be suitable for mobile services in the future.
- 2.28 We said that the 66-71 GHz band had been identified as a potential band for 5G at WRC-19, and is already available in the UK on a licence-exempt and light-licensed basis. Ofcom originally made this band available in November 2018 for short range wideband data transmission systems and fixed wireless systems on a licence-exempt basis. In April 2021,

<sup>25</sup> We note that in addition to varying Schedule 1 of the 40 GHz licences, we would also need to make regulations under s8 WT Act 2006 to exempt relevant 40 GHz handsets from the requirement to hold a wireless telegraphy licence, to allow licensees to use the spectrum for mobile services.

<sup>26</sup> As explained above, harmonised technical conditions have been developed at CEPT for new 40 GHz wireless communications services.

<sup>27</sup> Under Condition 3(h) of the 40 GHz licences, as initially awarded in 2008, Ofcom five year’s notice of revocation for spectrum management reasons could not expire before February 2023 (i.e. 15 years from the date of issue of the licences). A draft licence was annexed to the [Information Memorandum](#), published 3 December 2007.

<sup>28</sup> See Condition 3(f) of the 40 GHz licences.

<sup>29</sup> See Ofcom’s frequency allocation table, “[Space science and meteorology spectrum allocations in the UK](#)”, published 19 August 2022, p. 8.

<sup>30</sup> May 2022 Consultation, paragraphs 2.21-2.23.

we subsequently introduced the requirement for higher power wideband data transmission systems to be licensed to ensure compliance with our electromagnetic fields (“EMF”) usage conditions.

- 2.29 Satellite operators (e.g. GSOA and Amazon)<sup>31</sup> supported our approach to the 28 GHz band, and no respondents to our consultation commented on our approach to the 66-71 GHz band. As a result, we have not included the 28 GHz or 66-71 GHz bands within the scope of the decisions and proposals set out in this document.

## Our policy approach and objectives for mmWave

- 2.30 Our approach and objectives for this project derive from our statutory duties, which we have applied to the specific circumstances of the frequency bands we have decided to authorise for new uses.
- 2.31 As explained in more detail in annex 5, our principal duty under the [Communications Act 2003](#) (the “2003 Act”) includes to further the interests of citizens and consumers in relation to communications matters.<sup>32</sup> As part of this, we must ensure that a wide range of electronic communications services are available across the United Kingdom and that optimal use is made of the radio spectrum.<sup>33</sup> We consider that, in general, the optimal use of spectrum means that spectrum is used in a way that maximises the benefits that people, businesses and other organisations derive from its use, including the wider social value of spectrum use.<sup>34</sup>
- 2.32 Our principal duty also includes furthering the interests of consumers in relevant markets, where appropriate by promoting competition,<sup>35</sup> and we must have regard to the desirability of promoting competition in the provision of electronic communications services in carrying out our spectrum management functions.<sup>36</sup>
- 2.33 In carrying out our functions, we also have regard to such factors as appear relevant to us in the circumstances. In light of the specific characteristics of the 26 GHz and 40 GHz bands (which are discussed above), we consider these relevant factors include, in particular, the desirability of encouraging (i) investment and innovation in relevant markets,<sup>37</sup> (ii) the development of innovative services<sup>38</sup> and (iii) the availability of highspeed data transfer services throughout the United Kingdom.<sup>39</sup>
- 2.34 Thus our main policy objectives for enabling mmWave spectrum for new uses are:

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<sup>31</sup> [GSOA response to the May 2022 Consultation](#), p.2; [Amazon response to the May 2022 Consultation](#), pp. 3-4, response to Q.2.

<sup>32</sup> Section 3(1)(a) of the [Communications Act 2003](#).

<sup>33</sup> Section 3(2)(a)-(b) of the 2003 Act.

<sup>34</sup> Ofcom’s spectrum management strategy “[Supporting the UK’s wireless future: Our spectrum management strategy for the 2020s](#)”, published 19 July 2021, paragraph 2.5.

<sup>35</sup> Section 3(1)(b) of the 2003 Act.

<sup>36</sup> Section 3(2)(d) of the [Wireless Telegraphy Act 2006](#).

<sup>37</sup> Section 3(4)(d) of the 2003 Act.

<sup>38</sup> Section 3(2)(c) of the Wireless Telegraphy Act 2006.

<sup>39</sup> Section 3(4)(e) of the 2003 Act.

- a) achieve an efficient allocation of spectrum;
- b) sustain strong competition in mobile markets;
- c) encourage investment and innovation in new uses; and
- d) ensure timely availability of spectrum.

2.35 We explain how we apply these objectives in the context of mmWave spectrum below.

### **Achieve efficient allocation of spectrum**

2.36 Achieving an efficient allocation of spectrum is a key element of securing optimal use of spectrum. In an efficient allocation of spectrum, the spectrum is allocated to operators which will use the spectrum to provide the most value to society.

2.37 In the case of new uses of mmWave spectrum, we believe that the users which would deliver the highest value to society are likely to be a combination of wide area, citywide operators and more localised operators. Due to its technical characteristics, mmWave spectrum is more suited to providing localised services requiring very high capacities and/or speeds, than to providing national coverage. This spectrum is therefore likely to be targeted at areas with high data capacity needs in existing wide area networks, as well as for bespoke local applications.

2.38 In addition to authorising new uses in the 26 GHz band, we also aim to support coexistence with existing uses where reasonable, including fixed links, radioastronomy, and short-range devices. Where we are minded to clear existing uses, we expect that these uses could be accommodated in alternative spectrum bands, or these services could be provided using alternative technologies, e.g. fibre. We note that the MOD also requires access to a portion of the 26 GHz band, and we set out in section 3 how we have decided to support this.

### **Sustain strong competition in mobile markets**

2.39 The mobile sector has delivered good outcomes to date, with competition among MNOs driving investment and improvements in quality.<sup>40</sup> In authorising mmWave spectrum for new uses, we seek to ensure people and business continue to benefit from strong competition in the provision of mobile services.<sup>41</sup>

### **Encouraging investment and innovation in new uses**

2.40 We consider that higher levels of investment in deploying new uses of mmWave spectrum will likely lead to more effective utilisation of the spectrum, and therefore deliver more value from the spectrum to society. Similarly, innovation will support the development of

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<sup>40</sup> Ofcom's discussion paper "[Ofcom's future approach to mobile markets](#)", published 9 February 2022, paragraphs 1.8-1.10.

<sup>41</sup> While we do not expect the use of 26 GHz and 40 GHz spectrum to be limited to mobile operators, we have not identified any potential impact on competition in other markets (see section 8).

new services to the benefit of people and businesses, and lead to ongoing benefits from the spectrum in the future.

- 2.41 There is particular potential for investment and innovation in new uses of mmWave spectrum for a variety of different purposes by a broad range of users with diverse business models. This spectrum is likely to be important to support continued growth in existing mobile services, gigabit fixed broadband, as well as the development of new and innovative services. We consider that supporting opportunities for innovation and investment in new mmWave services by a diverse set of users will be important to ensure ongoing optimal use of the spectrum and maximise benefits from the spectrum to society.

### Ensure timely availability of spectrum

- 2.42 We consider it important to make spectrum available for new services to develop, even if sometimes the spectrum is not immediately useable for providing such services. This is in line with our [July 2021 Spectrum Strategy](#), which includes supporting wireless innovation by making spectrum available before its long-term use is certain.
- 2.43 We believe that mmWave spectrum should be made available in a timely manner for new uses. Both the 26 GHz and 40 GHz bands have been globally identified for mobile, with harmonised technical standards either in place or in draft form, and have high potential to support innovation. We also consider that making the 26 GHz and 40 GHz bands available for new uses on a similar timeframe, and as part of the same award, is most likely to deliver positive outcomes for people and businesses, given that we expect the two bands will become functionally substitutable. We further explain the rationale for this from paragraph 2.68 below.

### mmWave use cases and deployment scenarios

- 2.44 Below, we set out our understanding of mmWave use cases and deployment scenarios, as well as our understanding of the level of demand for this spectrum, in light of responses to the May 2022 Consultation.

#### mmWave use cases

- 2.45 In the May 2022 Consultation,<sup>42</sup> we said that we expected the bulk of mmWave spectrum deployments for new uses, and therefore demand for mmWave spectrum, to be concentrated in densely populated and built-up areas with high demand for data. Frequencies at these higher ranges can carry large amounts of data but are easily blocked by obstacles such as buildings and trees.
- 2.46 We also said that current known applications of mmWave spectrum include mobile hotspots, fixed wireless access (FWA) services providing speeds/throughput of over 1 Gbit/s, integrated access and backhaul (IAB), and mobile private networks. We said we

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<sup>42</sup> May 2022 Consultation, paragraphs 2.39-2.40.

expected new use cases to develop over time, and that we expected a range of potential users of mmWave spectrum, including nationwide players such as the MNOs, regional FWA providers, and highly localised industrial users.

2.47 In summary, consultation respondents provided further evidence of the wide range of potential uses for mmWave spectrum, with some respondents supporting all of the use cases we referred to in the May 2022 Consultation as potential uses of mmWave spectrum, as well as other uses including augmented reality, automotive use cases and satellite services. More specifically:

- a) BT/EE said the large bandwidths available in mmWave bands would be used to enable:  
(i) new use cases where traffic might be localised, e.g. sport stadiums, industrial settings, and smart cities, (ii) augmented reality and the Metaverse, (iii) FWA as an alternative to fibre in rural areas, and (iv) automotive use cases.<sup>43</sup> BT/EE also pointed out that “while support for IAB varies considerably between equipment vendors, we are keen to ensure that any future spectrum regulations enable this use case. To facilitate this, it will be necessary to allow above the horizon transmissions in the same manner as that implemented today for point to point links in the 26 GHz and 40 GHz bands.”<sup>44</sup>
- b) H3G set out plans to use its current 40 GHz spectrum holdings for 5G services using small cells, including self-backhauling; FWA; neutral host models and private networks.<sup>45</sup>
- c) Vodafone agreed that use cases would likely be fulfilling demand for high speed data in high footfall areas, FWA, and localized industrial/ Mobile Private Network applications. It said that while there is a case for mmWave usage, it is not to the degree that Ofcom envisage, and disagreed with our proposal that MNOs could use mmWave to densify their networks using small cells.<sup>46</sup>
- d) VMO2 said that the spectrum will be “deployed selectively in locations with a high density of users to provide significant increases in capacity and exceptional data speeds”. It said that the business case for deployment will be constrained by developments in the broader European ecosystem for handsets.<sup>47</sup>
- e) A number of stakeholders<sup>48</sup> said that FWA would be a key use case for this spectrum.
- f) Airspan said that mmWave opens up new use cases for private networks, which industry is keen to trial.<sup>49</sup> Cellnex considered network densification and indoor and

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<sup>43</sup> [BT/EE response to the May 2022 Consultation](#), p. 4-5.

<sup>44</sup> BT/EE, p. 7; Please see section 13 for our proposed technical licence conditions, including those relating to transmissions above the horizon (paragraphs 13.36-13.46).

<sup>45</sup> [H3G response to the May 2022 Consultation](#), p. 31.

<sup>46</sup> [Vodafone response to the May 2022 Consultation](#), p. 2.

<sup>47</sup> [VMO2 response to the May 2022 Consultation](#), p. 4.

<sup>48</sup> E.g. [INCA response to the May 2022 Consultation](#); [Luminet response to the May 2022 Consultation](#); [Intracom response to the May 2022 Consultation](#); [MLL response to the May 2022 Consultation](#).

<sup>49</sup> [Airspan response to the May 2022 Consultation](#), p. 1, response to Q.1

campus based Private Network applications to be the primary use case for mmWave spectrum.<sup>50</sup>

- g) Amazon and Eutelsat said that the 40 GHz band will be important for FSS satellite services.<sup>51</sup> SpaceX said we should protect satellite services in the 28 GHz band.<sup>52</sup> GSOA supported the use of mmWave spectrum for terrestrial mobile systems in the UK, subject to both bands also being available for use by satellite services, with appropriate interference mitigation measures.

- 2.48 We note that future satellite access to the 26 GHz and 40 GHz bands is out of scope for the proposals set out in this document. However, we remain open to considering future satellite access in low density areas when demand arises, where this could coexist with terrestrial spectrum use (for further detail, please refer to sections 5, 6 and 7 which set out how we intend to treat incumbent users of both bands).

## Network deployment scenarios for new uses of mmWave spectrum

- 2.49 We explained in the May 2022 Consultation<sup>53</sup> that the technical characteristics of mmWave spectrum mean it is particularly well-suited to small cell deployment. In particular, we expect deployments of mmWave spectrum for mobile hotspots will generally be low power, below rooftop deployments on small cells. We also anticipate that densification of mobile networks, including with potentially significant numbers of small cells, will be important to meeting anticipated growth in demand for data in the medium to long term, and to optimise the use of mmWave spectrum in capacity constrained locations.<sup>54</sup>
- 2.50 While we expect that in the longer term the majority of mmWave deployments are likely to be low power, below rooftop small cell deployments, we think that operators could also credibly deploy mmWave spectrum on macro cells at a higher power and above rooftops. For example, integrated access and backhaul (“IAB”) could be deployed on a combination of small cells and macro cells. In addition, FWA operators may look to deploy mmWave spectrum on some of their base stations at medium power and above rooftop to be able to provide coverage to a wider area (e.g. approximately a few hundreds of meters radius in urban areas and several kilometres in rural areas).<sup>55</sup>
- 2.51 In the initial stages of mmWave deployment, we understand MNOs may look to first leverage their existing macrocell infrastructure under some circumstances, while in parallel densifying their networks.
- 2.52 While most respondents broadly agreed with our analysis of how mmWave spectrum may be deployed, Vodafone said: “Ofcom puts forward a model whereby mobile network

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<sup>50</sup> [Cellnex response to the May 2022 Consultation](#), p. 3, paragraph 1.1.

<sup>51</sup> Amazon, pp. 1-3, response to Q.1-2; [Eutelsat response to the May 2022 Consultation](#), p. 2, response to Q.1.

<sup>52</sup> [SpaceX response to the May 2022 Consultation](#), p. 3, response to Q.11.

<sup>53</sup> May 2022 Consultation, paragraphs 2.42-2.44.

<sup>54</sup> Ofcom’s discussion document “[Mobile networks and spectrum: Meeting future demand for mobile data](#)”, published 9 February 2022, paragraph 1.4.

<sup>55</sup> Some prospective users of mmWave spectrum have also told us through pre-consultation engagement that they envisage deploying mmWave spectrum on macrocells and/or at higher powers under certain scenarios.

operators will densify networks to the extent of tens of thousands of small cells utilizing mm-wave spectrum. Mobile stakeholders have universally rejected this thesis as not reflecting commercial investment reality”.<sup>56</sup> We acknowledge that there is still uncertainty about future potential business cases for mmWave. We nevertheless consider that making this spectrum available on a technology neutral basis, at both medium and low power, is appropriate, since it will allow industry to decide on the best use of this spectrum.

## Potential demand for mmWave spectrum

2.53 In summary, in our May 2022 Consultation,<sup>57</sup> we said that we treated early indications of levels of demand from industry with caution because the landscape for new uses of mmWave spectrum is still in a relatively early stage of development. We noted that initial evidence from industry and early engagement with prospective users suggested operators may want to use somewhere between 200 MHz to over 1 GHz in the longer term. We also considered it likely that operators would be interested in acquiring larger amounts if the price of that mmWave spectrum was sufficiently low.

2.54 Having taken account of consultation responses, we still consider the exact level of industry demand for mmWave spectrum to be uncertain, particularly in the short term, as the development of use cases for mmWave spectrum is still in its early stages. Below, we set out the indications of demand for mmWave which we have considered for our analysis, which take account of consultation responses, indications of demand published by industry bodies and vendors, and international indicators.

### Consultation responses and industry demand indications

2.55 Almost all the responses we received to our consultation agreed that the 26 GHz and 40 GHz bands should be made available for mobile use.<sup>58</sup> Stakeholders’ responses to our consultation provide evidence of the range of demand for mmWave spectrum, although there was no clear consensus as to the amount of spectrum that would be required per operator:

- a) BT/EE said that it sees “demand for mmWave in the near term and potentially sooner than Ofcom may envisage”,<sup>59</sup> and that “availability of mmWave spectrum is essential for the UK to benefit from the full range of capabilities that public mobile networks can deliver”.<sup>60</sup> BT/EE also thought “there is a long-term requirement for at least 4 GHz of mmWave spectrum in the UK.” [CONFIDENTIAL ✂]<sup>61</sup>
- b) VMO2 said that “the 26 GHz and 40 GHz bands promise capacity which cannot be matched at lower frequencies... Every mobile operator may therefore be expected to

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<sup>56</sup> Vodafone, p. 4.

<sup>57</sup> May 2022 Consultation, paragraphs 2.38-2.41 and 2.45.

<sup>58</sup> As noted above, some satellite stakeholders said that the band should only be made available for mobile use if sharing with satellite could be facilitated.

<sup>59</sup> BT/EE, p. 10.

<sup>60</sup> BT/EE, p. 3.

<sup>61</sup> BT/EE, p. 10

want access to mmWave spectrum... in the medium to long term.” It said that operators should have the option to bid for large contiguous blocks of up to 1 GHz of spectrum. However, VMO2 said that the uncertainty around the business case and equipment ecosystem for deploying mmWave spectrum at this stage means we should delay the auction until 2026-7, although we should proceed with revoking incumbent users’ licences.<sup>62</sup>

- c) Vodafone said it disagreed with the view put forward by Ofcom in its discussion paper on mobile spectrum demand<sup>63</sup> that network operators would densify their networks with tens of thousands of small cells utilizing mmWave spectrum. It said there is a case for “selective usage” of mmWave spectrum, but not to the degree envisaged by Ofcom. [CONFIDENTIAL ✂].<sup>64</sup>
- d) H3G said that the size of its current holdings in the 40 GHz band – 2 x 1 GHz – would enable it to overcome fibre availability issues using self-backhauling technology (also known as Integrated Access and Backhaul, or IAB). It explained that it could allocate 1 GHz for 5G access and 1 GHz for backhaul to transmit wirelessly from multiple small cells through a series of hops to a hub site with fibre backhaul.<sup>65</sup>
- e) FWA providers (e.g. INCA and Luminet)<sup>66</sup> said that 26 GHz spectrum is ideal for the provision of FWA services, and that we should reserve 400-600 MHz of spectrum for FWA providers.<sup>67</sup>
- f) Ericsson said that “Operators will need a minimum of 800 MHz contiguous mmWave spectrum to support optimum 5G services requiring higher speeds, low latency and larger amounts of traffic.”<sup>68</sup> Qualcomm said that “It is critical for mobile operators to get access to a sufficient amount of spectrum... [A]pproximately 800 MHz of contiguous spectrum per operator/network should be assigned”.<sup>69</sup>

2.56 We have also considered the indications of the amount of mmWave spectrum operators will require that have been published by industry bodies and vendors, for example:

- a) The GSMA carried out a study based on highly populated 10 cities, through which it estimated that on average 5 GHz per market will be needed by 2030 on average to satisfy expected demand for different use cases.<sup>70</sup>

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<sup>62</sup> VMO2, p. 5.

<sup>63</sup> Ofcom discussion paper “[Mobile networks and spectrum, Meeting future demand for mobile data](#)”, published 9 February 2022.

<sup>64</sup> Vodafone, pp. 4-5.

<sup>65</sup> H3G, pp. 32-33.

<sup>66</sup> INCA, p. 4; Luminet, p2.

<sup>67</sup> Intracom said 200 MHz would be enough for a FWA provider (Intracom, p. 3, response to Q.5). INCA said 400 MHz of low power spectrum and 400-600 MHz of medium power spectrum could be reserved for FWA (INCA response, p. 7, paragraph 15). INCA and Luminet both suggested mobile and FWA should be able to share use of the same frequencies, if they operated at different heights. (INCA response, p. 5, paragraph 14; Luminet p. 4-5).

<sup>68</sup> [Ericsson response to the May Consultation](#), p. 3.

<sup>69</sup> [Qualcomm response to the May Consultation](#), p. 1.

<sup>70</sup> GSMA, “[Vision 2030: mmWave Spectrum Needs](#)”, published June 2022.

- b) Ericsson estimates that in the longer term about 6 GHz of total bandwidth is expected per country across two to three different bands.<sup>71</sup>

### International indicators

- 2.57 The 26 GHz band has been harmonised for mobile use across the EU,<sup>72</sup> and has been allocated in many European countries. We expect to see increasing deployment of this spectrum across Europe over the next few years. As noted above, we also expect the 40 GHz band to be harmonised for mobile in Europe later this year. We consider that once the 40 GHz band has been harmonised across Europe, equipment will become more readily available and innovative use cases will materialise, resulting in increased demand for this spectrum.
- 2.58 We note that some operators have won 1 GHz or more in mmWave spectrum auctions in other countries, e.g. in Denmark TDC won 1.25 GHz and Hi3G 1 GHz,<sup>73</sup> while in Australia Telstra won 1 GHz.<sup>74</sup> However, we also note that there is a fair amount of variance in the amount operators have won in international auctions. For example, in Denmark TTN won 600 MHz in contrast to the larger amounts won by TDC and Hi3G, and in the December 2022 Spanish auction, although Telefonica acquired 1 GHz of spectrum (which was the maximum it was allowed to bid for), two other operators only acquired 400 MHz each.

### Demand for mobile data is increasing

- 2.59 We also note that we continue to see exponential growth in demand for mobile data. In our recently published paper on "[Mobile Spectrum Demand](#)",<sup>75</sup> we set out three potential growth scenarios for growth in mobile traffic up to 2035:
- a) low growth: 25% increase per year to 2030, 20% increase per year from 2030–2035;
  - b) medium growth: 40% sustained increase per year to 2035; and
  - c) high growth: 55% increase per year to 2030, 60% increase per year from 2030–2035.
- 2.60 We set out our view that network densification (including greater use of small cells and mmWave spectrum) is likely to be necessary to meet demand for data,<sup>76</sup> and could represent a step change in the way MNOs deliver more capacity to meet growth in demand.

### Conclusions on potential demand for mmWave spectrum

- 2.61 In light of the above, there is clear evidence of demand for mmWave spectrum from some operators (and in some cases demand for 1 GHz or more of spectrum per operator). We

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<sup>71</sup> Ericsson, "[Leveraging the potential of 5G millimeter wave](#)".

<sup>72</sup> See the [consolidated version of the 26 GHz Decision](#).

<sup>73</sup> European 5G observatory, "[5G auction in Denmark raised 2.1 billion DKK \(279.1 million EUR\)](#)", published 23 April 2021.

<sup>74</sup> ACMA, "[26 GHz band auction results](#)", last updated 23 April 2021.

<sup>75</sup> Ofcom's Conclusions Paper "[Ofcom's future approach to mobile markets and spectrum](#)", published 6 December 2022, paragraph 4.5.

<sup>76</sup> December 2022 Consulsions Paper, paragraph 1.6.

have reflected on stakeholders' submissions in considering how to enable the industry to realise the potential which mmWave spectrum offers for investment and innovation. Although we remain uncertain about the precise levels of demand, to enable industry to realise the potential which mmWave spectrum offers for investment and innovation, we consider it appropriate both to make mmWave spectrum available to a range of different users and to provide the opportunity for operators to access 1 GHz or more each.

- 2.62 We explain below why we consider making all of the relevant mmWave spectrum available at this stage, even in light of some uncertainty about the precise levels of demand, is likely to result in better outcomes for citizens and consumers than alternative approaches.

## Timeframe for making mmWave spectrum available for new uses

### Timing to make award licences available

- 2.63 In the May 2022 Consultation,<sup>77</sup> we said we expected there could be deployment of mmWave spectrum in 2024 and sought stakeholders' comments on our proposed overall approach to mmWave spectrum. This included our proposed aim to make the 26 GHz and 40 GHz bands available (through auctioned licences and local, Shared Access licences) on the same or a similar timeframe.
- 2.64 Stakeholders' views on the appropriate timing for the auction were mixed:
- a) On one hand, Qualcomm,<sup>78</sup> Intracom<sup>79</sup> and techUK<sup>80</sup> were all in favour of us making at least the 26 GHz band available in 2023, and BT/EE urged us to push ahead and make mmWave spectrum available by 2024. BT/EE said "we see demand for mmWave in the near term and potentially sooner than Ofcom may envisage. We have already seen trends for high data use cases that suggest mmWave will be required, but agree that for practical reasons Ofcom should aim to have the authorisation process completed for the 26 GHz band by 2024."<sup>81</sup>
  - b) On the other hand, VMO2 said that an award in 2024 would be "premature" and would "oblige operators to bid for spectrum that they anticipate deploying in the long term, but do not yet need".<sup>82</sup> Its preference was "to delay the award until 2026-27, with exclusive licences commencing by 2028", although it suggested we make Shared Access licences available now.<sup>83</sup> VMO2 also urged us to begin clearing both bands of incumbent users as soon as practically possible.<sup>84</sup>

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<sup>77</sup> May 2022 Consultation, paragraph 2.46.

<sup>78</sup> Qualcomm, p. 2, response to Q.2: "Qualcomm would like to highlight on the fact that making 26 GHz band available as soon as possible and not later than 1H 2023 needs to be the main priority"

<sup>79</sup> Intracom, p. 2, response to Q.2.

<sup>80</sup> [techUK response to the May 2022 Consultation](#), p. 1, response to Q.2: "techUK welcomes Ofcom's aim to authorise mobile in both 26 GHz and 40 GHz so that such deployments are from 2023. In particular, the 26 GHz band should be released as soon as possible and not later than 1H 2023".

<sup>81</sup> BT/EE, p. 10.

<sup>82</sup> VMO2, p. 8.

<sup>83</sup> VMO2, p. 2.

<sup>84</sup> VMO2, p. 17.

- 2.65 As set out above, we consider it important to make spectrum available for new services to develop, even if sometimes the spectrum is not immediately useable for providing such services. As a result, given that many respondents have urged us to make at least the 26 GHz band available in 2023 or 2024, we remain of the view that it is appropriate to aim to make the spectrum available as soon as possible. This will provide industry with the certainty of spectrum access to enable innovation and realise the full benefits of mmWave spectrum for new uses.
- 2.66 In addition, we note that we are required to give at least 5 years' notice to clear incumbent users of the spectrum.<sup>85</sup> Given the length of this notice period, we need to begin the necessary statutory revocation processes as soon as possible to reduce the period during which new users will have to coexist with incumbent users.

### Timing to make Shared Access licences available

- 2.67 As set out above, we consider that making this spectrum available as soon as possible is likely to promote innovation and investment, giving rise to benefits for citizens and consumers. We therefore aim to make Shared Access licences available in early 2024. For more detail on our approach to Shared Access licensing in these bands, please see section 14.

### Making 26 GHz and 40 GHz available on the same timeframe

- 2.68 In the May 2022 Consultation,<sup>86</sup> we said that we considered that making the 26 GHz and 40 GHz bands available for new uses on the same or a similar timeframe is most likely to deliver good outcomes for people and businesses, given that we expect the two bands will become functionally substitutable. Most respondents to the May 2022 Consultation were supportive of making the two bands available for mobile on the same timeframe,<sup>87</sup> although some users preferred us to delay making 40 GHz available (see paragraph 2.70 below).<sup>88</sup>
- 2.69 In particular, VMO2, BT/EE and Vodafone agreed that both bands should be made available on the same timeframe.<sup>89</sup> Although, as set out above, VMO2's preference was that the award of both bands should be delayed until 2026-7, and BT/EE and Vodafone noted that there was a difference in the maturity of the equipment ecosystem in the two bands.<sup>90</sup>
- 2.70 However, some stakeholders objected to making the band available on the same timescale.

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<sup>85</sup> See e.g. paragraph 3(f) of [MBNL's 40 GHz licence](#).

<sup>86</sup> May 2022 Consultation, paragraph 2.47.

<sup>87</sup> BT/EE, Dense Air (response to Q.2), Airspan, Luminet, VMO2, Vodafone, and Wildanet.

<sup>88</sup> Eutelsat recommended "making available only the 26 GHz band at this stage [...] And only at a later stage reconsider if the demand is sufficient enough to justify the opening of the 40 GHz band for new mobile uses." Intracom thought we should make 26 GHz available before 2024, as waiting until 2024 "might lead to a loss of opportunities for operators that wish to invest now." (Eutelsat, p. 3, response to Q.2).

<sup>89</sup> [CONFIDENTIAL ><]

<sup>90</sup> VMO2, pp. 31-2; BT/EE, p. 10; Vodafone, p. 6.

- a) MLL said that auctioning the bands together may increase uncertainty, because the lack of incentive to deploy services during the revocation period will hold back the development of 40 GHz equipment, against a background where the focus of most manufacturers will be already on 26 GHz and 28 GHz, as the 'pioneer' bands for mmWave development. MLL also argued that auctioning 26 and 40 GHz together could be inefficient as Ofcom will need to make decisions regarding spectrum band allocations and technology with a lack of information.<sup>91</sup>
- b) Eutelsat argued that the 26 GHz band should be largely sufficient to accommodate current and future demand for new mobile uses, and recommended making only the 26 GHz band available at this stage. Eutelsat said Ofcom should wait for the auction outcome and deployment and use of the 26 GHz band before considering whether demand is sufficient to justify opening the 40 GHz band for new mobile uses.<sup>92</sup>
- c) Intracom thought that we should make 26 GHz available before 2024, as waiting until 2024 "might lead to a loss of opportunities for operators that wish to invest now."<sup>93</sup>

2.71 In line with our initial view,<sup>94</sup> we think making around 6 GHz of mmWave spectrum available across the two bands around the same time will best ensure spectrum availability is not a barrier to innovation and investment in new uses of mmWave spectrum, by maximising opportunities for operators to obtain large contiguous blocks of spectrum. We also consider that making this spectrum available as soon as possible may provide an incentive for mobile operators to accelerate their network densification plans, to maximise the benefits of this spectrum.

2.72 We consider that providing certainty to industry now on the future availability of both bands will support the development of the mmWave market and ecosystem for new uses both within the UK and more widely. We recognise that the ecosystem for the 40 GHz band is behind that of the 26 GHz band, and that 40 GHz has yet to be made available for mobile services in any country in Europe. However, once this spectrum has been made available for new uses in the UK, we do not consider that there should be significant barriers to operators deploying 40 GHz.<sup>95</sup> Making both bands available in the UK in 2024 may help to bring forward deployment timelines by providing additional incentives for manufacturers to develop equipment and also potentially encouraging other administrations to consider authorising 40 GHz for new uses earlier.<sup>96</sup>

2.73 We have considered whether there is a case for delaying making the 40 GHz band available for new uses until after the 26 GHz band, as some stakeholders suggested. It is possible that operators may have greater certainty of their longer-term mmWave spectrum

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<sup>91</sup> MLL, p. 6, response to Q.2.

<sup>92</sup> Eutelsat, p. 3, response to Q.2.

<sup>93</sup> Intracom, p. 2, response to Q.2.

<sup>94</sup> May 2022 Consultation, paragraphs 2.47-2.54.

<sup>95</sup> Harmonised technical conditions for 5G in the 40.5-43.5 GHz band have been agreed at CEPT, and an EC decision on harmonisation is expected in this year. See paragraphs 2.17-2.21 above in relation to equipment availability in the 40 GHz band.

<sup>96</sup> [CONFIDENTIAL ✕], and similarly [CONFIDENTIAL ✕]

requirements in the next few years, as the commercial potential for this spectrum crystallises. If this is the case, staggering the availability of mmWave spectrum may reduce the risk of operators acquiring more spectrum than they need on a speculative basis. It would also increase opportunities for future prospective mmWave users to acquire spectrum.

2.74 However, we continue to think the high potential benefits of authorising both bands together for new uses on the same or similar timeframe outweigh the potential downsides.

- a) In particular, delaying the availability of the 40 GHz band runs the risk of unnecessarily constraining industry's access to mmWave spectrum for new uses at an early stage. This constraint on spectrum availability could potentially hinder the development of new mmWave services, leading to less innovation and investment. The impact of this risk, if realised, would be poorer outcomes for people and businesses.
- b) Furthermore, we consider that making these two bands, which are likely to be functionally substitutable in the long term, available together on the same timeframe is more likely to lead to an efficient allocation of mmWave spectrum as a whole. We consider that an efficient allocation of spectrum could credibly involve operators holding relatively large blocks of spectrum in one of either the 26 GHz or 40 GHz bands, rather than spectrum split across both bands.<sup>97</sup> Making both bands available on the same or similar timeframe would enable operators to consider their mmWave spectrum holdings holistically across the 26 GHz and 40 GHz bands, increasing opportunities for operators to secure large blocks of spectrum in one band or the other.
- c) In addition, if we were to delay making a decision on the 40 GHz band (as suggested by some consultation respondents), we would have to either:
  - i) Delay enabling the 40 GHz band for mobile. This would mean delaying revoking or varying the incumbents' licences, and in light of the 5 year revocation period, would risk delaying the benefits of enabling the band for new uses. This would be inconsistent with our (and industry's) view that the optimal use of the band is mobile, and the stated intention of the two of the existing licensees to use the spectrum to provide mobile services;<sup>98</sup> or
  - ii) Vary the incumbent users' licences to enable them to provide mobile services, and reconsider whether reallocation of the 40 GHz band is necessary at a later date. We consider this approach would reduce opportunities for operators other than H3G to secure large blocks of mmWave spectrum and would carry the risk of not providing the incumbent licensees with enough certainty over their spectrum rights to invest in deployment; or

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<sup>97</sup> We explain in more detail in paragraphs 7.41-7.44.

<sup>98</sup> See paragraph 2.47b) above, and MLL's response, pp. 1-2.

- iii) Revoke the incumbent users' licences and reconsider reallocation of the band at a later date. We consider this approach would be likely to leave the spectrum unused for a significant period of time.

We consider that these alternative options are less likely to result in optimal use of this spectrum, relative to the option of authorising both bands together for new uses on the same or similar timeframe.

- 2.75 We note that all of the MNOs supported our proposals to make the two bands available on a similar timeframe. Even VMO2, which argued that we should delay the award, was in favour of us awarding the two bands together.
- 2.76 By contrast, authorising the two bands separately increases the risk of an inefficient allocation, potentially risking poorer services to people and businesses.<sup>99</sup> For example, uncertainty about the future availability of the 40 GHz band may make it difficult for operators to determine their optimal bidding strategy in an award of 26 GHz, and could incentivise more operators to acquire smaller blocks of mmWave spectrum in the 26 GHz band than would be optimal from their perspective. While operators could acquire supplementary spectrum in the 40 GHz band later on, this would result in split holdings across the 26 GHz and 40 GHz bands. An operator with split holdings would need to deploy additional equipment to make use of both its blocks in the 26 GHz and 40 GHz bands. The resulting additional complexity and cost may lead operators to choose to only deploy radio equipment in one band (rather than both bands) in certain areas. This would lead to under-utilisation of spectrum, and potentially hamper the quality of services.

## Impact assessment

- 2.77 The analysis presented in this document in support of our further consultation proposals (including the analysis in sections 9-14) represents an impact assessment as defined in section 7 of the Communications Act 2003. Impact assessments provide a valuable way of assessing different options for regulation. They form part of best practice policy making.<sup>100</sup> In particular, in addition to their likely impact on citizens and consumers, we have considered the impact of our proposals on existing and future users of the relevant frequencies, including adjacent bands.
- 2.78 We have also given careful consideration to whether our proposals will have a particular impact on persons sharing protected characteristics (including race, age, disability, sex, sexual orientation, gender reassignment, pregnancy and maternity, marriage and civil partnership, and religion or belief in the UK, and in Northern Ireland also dependents and political opinion), and in particular whether they may discriminate against such persons or

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<sup>99</sup> Vodafone agreed with this. It commented: "*Whilst acknowledging that the ecosystem for 40GHz will significantly lag that for 26GHz, we believe that Ofcom is correct to award the two bands as a single exercise. The evidence of the release of the 3.xGHz band shows that whilst the decision to stagger the award of 3.4GHz and 3.6GHz was correct in light of the need to launch 5G in an expedient manner, the constrained supply at each award inevitably led to higher prices for the spectrum: we do not wish this artificial constraint to be repeated in mm-wave.*" (Vodafone, p. 6).

<sup>100</sup> For more information on our approach to impact assessments, see [Ofcom's impact assessment guidelines](#).

impact on equality of opportunity or good relations. This assessment helps us comply with our duties under the Equality Act 2010 and the Northern Ireland Act 1998.<sup>101</sup> We do not consider that our proposals have equality implications under the 2010 Act or the 1998 Act.

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<sup>101</sup> Further detail is given in section 149 of the [Equality Act 2010](#) and section 75 of the [Northern Ireland Act 1998](#).

## 3. Authorisation

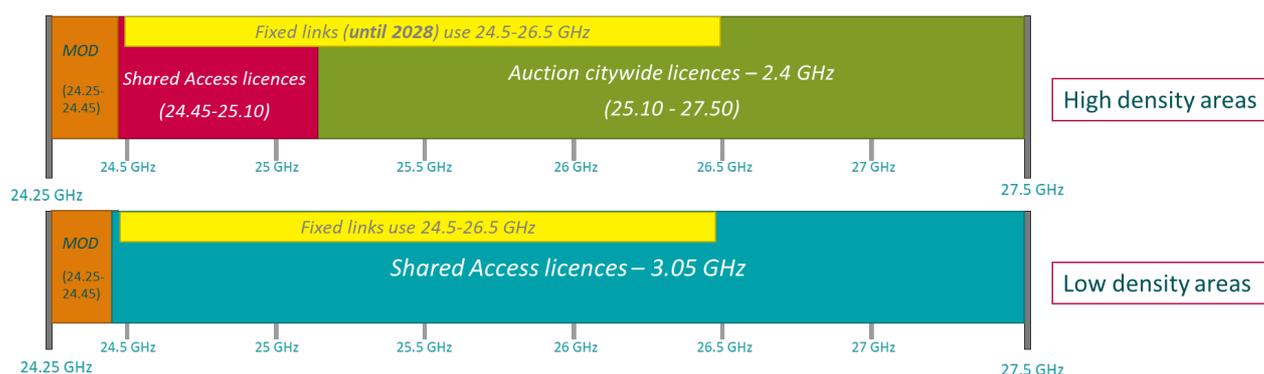
### Summary

3.1 This section sets out our decisions to:

- a) **identify “high” and “low density” areas of the UK**, where:
  - i) “high density” areas are the major towns and cities where we expect the most widespread deployment of mmWave spectrum for new uses to occur; and
  - ii) “low density” areas are the rest of the UK, outside high density areas, where we expect deployments to be sparser and more highly localised;
- b) implement a **nationwide safeguard in the bottom 200 MHz of the 26 GHz band (i.e. 24.25-24.45 GHz) for MOD access**, to support future Defence access to mmWave spectrum;
- c) in **high density areas**, authorise spectrum use in a way which enables both wide area and local operators to access spectrum for new uses, by:
  - i) making local licences available in 650 MHz of spectrum between 24.45-25.10 GHz via our Shared Access licensing framework;<sup>102</sup> and
  - ii) auctioning citywide licences for the top 2.4 GHz of the band (25.10-27.5 GHz).
- d) in **low density areas**, authorise spectrum between 24.45 and 27.5 GHz for use on a local basis via our Shared Access licensing framework, which we will grant on a first come, first served basis.

3.2 The diagram below shows how we have decided to authorise use of the 26 GHz band.

**Figure 3.2: How we will authorise use of the 26 GHz band**



3.3 As set out in section 7 of this document, we have decided to start the process for revoking the 40 GHz licences and to reallocate 40 GHz spectrum alongside 26 GHz spectrum. We are

<sup>102</sup> [Shared Access licences are part of our framework for enabling shared use of spectrum](#). This framework was set up to support innovation and enable new use of spectrum by providing localised access to spectrum bands where consumer equipment was available or becoming available.

now minded to make 40 GHz spectrum available in a similar way to 26 GHz spectrum. Specifically, in this section we set out proposals to:

- a) auction citywide licences for 40 GHz spectrum in **high density** areas; and
- b) in **low density areas**, authorise 40 GHz spectrum using our existing Shared Access licensing framework, granting local licences on a first come, first served basis.

## Introduction

- 3.4 As set out in section 2, we believe it is important to enable both wide area and local access to mmWave spectrum, in order to maximise the benefits of this spectrum. This spectrum will be key to enabling mobile network operators (“**MNOs**”) to increase their network capacity to meet the ongoing exponential growth in demand for mobile data, as well as supporting other wide area applications such as FWA providing high speed services.
- 3.5 We also expect mmWave spectrum to support more highly localised enterprise applications and innovation through the deployment of this spectrum in mobile private networks. As set out in our recently published [paper on Ofcom’s future approach to mobile markets and spectrum](#),<sup>103</sup> we expect to see strong growth in mobile private networks in the future, provided by a range of operators. For example, mmWave mobile private networks could be used to improve surveillance and video streaming/broadcasts, augmented and virtual reality for enhanced online gaming experiences, and the evolution of 5G smart factories.
- 3.6 Our authorisation model is designed to enable both wide area and local users to access mmWave spectrum.

## Nationwide safeguard for MOD in 24.25-24.45 GHz

- 3.7 In the May 2022 Consultation,<sup>104</sup> we proposed to manage the Ministry of Defence’s (“**MOD**”) future access to the 26 GHz band by coordinating their uses on a first come, first served basis, with additional safeguards in place on key MOD sites to ensure access to spectrum in these locations. MOD currently has access to the top 1 GHz of the 26 GHz band, though it is not using this spectrum.
- 3.8 Since we published the May 2022 Consultation, we have worked with MOD to further understand its use cases for 26 GHz spectrum. As a result, we have decided to implement a nationwide safeguard of 200 MHz spectrum for Defence use in 24.25-24.45 GHz (the lowest 200 MHz of the band) because we now understand that:

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<sup>103</sup> Ofcom’s Conclusions Paper “[Ofcom’s future approach to mobile markets and spectrum](#)”, published 6 December 2022.

<sup>104</sup> [May 2022 Consultation](#), paragraphs 6.34-6.35.

- a) some of the potential use cases envisaged by MOD, which include counter terrorism, smart military bases, autonomous vehicles and drones,<sup>105</sup> require “go anywhere, any time” capabilities; and
  - b) certainty of access is important to MOD when developing those operational use cases for mmWave spectrum, and in some cases, development can take several years.
- 3.9 We consider it is appropriate for this safeguard to be in the very bottom of the 26 GHz band because:
- a) As set out in the May 2022 Consultation,<sup>106</sup> the bottom 800 MHz of the band is more suited to users with highly localised deployment requirements (as we understand MOD’s future cases are likely to be), due to the limit on outdoor base stations that applies to protect adjacent EESS services.<sup>107</sup> MOD’s future uses are also likely to be sparsely distributed across the country (although still requiring nationwide certainty of access to spectrum), and therefore likely to improve availability of outdoor base stations for other users within the density limit in the remainder of the 800 MHz for other users; and
  - b) This part of the band is clear from incumbent users, and so reduces the coordination burden on both us and MOD. This is necessary for some use cases where detailed information could not be shared by MOD.
- 3.10 Where Defence capabilities materialise which require access to more spectrum, or spectrum in different parts of the band, MOD will be able to access any parts of the wider 26 GHz band which we are making available for local licences via our existing Shared Access licensing framework.<sup>108</sup>
- 3.11 While this safeguard reduces the amount of spectrum available to other users by 200 MHz, we do not consider this would have a material impact on the development and deployment of mmWave spectrum for civil use cases. This is particularly the case in low density areas, where there would still be up to 3.05 GHz of 26 GHz spectrum available through the Shared Access licensing framework. We discuss the specific impact this has on the availability of 26 GHz spectrum in high density areas below (see paragraphs 3.34-3.45), where this would reduce the amount available for other Shared Access from 850 MHz to 650 MHz.
- 3.12 This nationwide safeguard will be reviewed in 10 years, or sooner if there is significant excess demand for civil or military use cases. Following this review period, the nature and amount of this safeguard for MOD access may be adjusted in light of developments in civil and defence use cases.

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<sup>105</sup> See [“MOD Spectrum Policy Access to 26 GHz: An assessment of the MOD’s requirements for access to the 26 GHz frequency band, December 2022”](#).

<sup>106</sup> May 2022 Consultation, paragraph 3.19.

<sup>107</sup> These restrictions are explained in further detail in Ofcom’s Statement, [“Protecting passive services at 23.6-24 GHz from future 26 GHz uses”](#), published July 2022.

<sup>108</sup> Ofcom’s Statement [“Enabling wireless innovation through local licensing”](#) published July 2019.

## A different approach to authorisation in high density and low density areas

- 3.13 Consultation respondents generally supported our view that the bulk of mmWave spectrum deployments for new uses, and therefore demand for mmWave spectrum, will be concentrated in densely populated and built-up areas with high demand for data. Frequencies at these higher ranges can carry large amounts of data, but are easily blocked by walls or obstacles such as buildings and trees. Therefore, we expect mmWave spectrum to be used to provide ultra-dense and high-capacity services in areas with high mobile data traffic, rather than to provide national coverage. Elsewhere, we expect any mmWave deployments to be sparser.
- 3.14 In the May 2022 Consultation,<sup>109</sup> we proposed to divide the UK landmass into two categories, based on where mmWave deployments for new uses are likely to be most densely packed in the future:
- a) **“High density” areas:** This covers the small proportion of the UK territory, primarily in larger built-up areas, where we expect there to be a greater density of mmWave deployments. In these areas we considered that there would be a benefit to allocating wide area licences, alongside local licences. We think wide area licences would enable operators to use the spectrum more efficiently (as frequency reuse distances are reduced)<sup>110</sup> and facilitate investment by providing certainty of spectrum access for ease of network planning. We proposed that high density areas should be the UK’s major towns and cities. This is because major towns and cities have high populations, and therefore are likely to experience high levels of mobile data traffic.
  - b) **“Low density” areas:** This comprises the majority of the UK landmass, where we expect deployments to be highly localised and far apart. Due to this, we said that demand for new uses of mmWave spectrum in much of the UK could be satisfied through local licences.
- 3.15 We considered national licences would not be suitable for mmWave spectrum, as this approach would likely result in under-utilised spectrum. National licences would create barriers for other potential users of mmWave spectrum, resulting in fewer services for people and businesses, and sub-optimal use of spectrum.

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<sup>109</sup> May 2022 Consultation, paragraph 3.8.

<sup>110</sup> Radio equipment can be closer together if a single operator is managing the coordination and interference risk between its deployments in the same set of frequencies.

## Stakeholders' comments

- 3.16 While 13 respondents<sup>111</sup> supported our proposal to split the country into high and low density areas, five stakeholders (BT/EE, Ericsson, MLL, Qualcomm and Vodafone) preferred that we award national licences for mmWave spectrum:
- a) BT/EE said that its preference would be for us to award the full band on a national basis, which it thought would be more likely to secure optimal use of the spectrum, and would enable it to provide mmWave services anywhere its customers want.<sup>112</sup>
  - b) Qualcomm and Ericsson both said that nationwide licences would be preferable, and that at a minimum we should offer a single licence to cover all urban/suburban areas.<sup>113</sup>
  - c) MLL said that its business case for 40 GHz for broadband fixed wireless access would be severely undermined by creating a high density/low density licensing structure, and that high power use would be "best supported by a national licence".<sup>114</sup>
  - d) Vodafone accepted the proposal to split the country into high and low density areas on the basis that, whilst their preferred release mechanism would be a national auction of spectrum, the likely usage levels of mmWave spectrum in the UK can justify a more nuanced approach.<sup>115</sup>
  - e) BT/EE and Vodafone both noted that our Local Access licensing framework could facilitate new entry.

## Ofcom's response

- 3.17 We continue to consider that offering exclusive, national licences would be unlikely to lead to an efficient allocation of the band. This is because the technical characteristics of mmWave spectrum mean that it is unlikely to be used to provide wide area coverage. Therefore, there is a significant risk that if we offered national licences, a large portion of spectrum would be unused, especially in rural areas.
- 3.18 While Local Access licences would mitigate the risk of spectrum going unused, we note that Local Access licences are for a fixed 3 year term (unless otherwise agreed with the wide-area licensee), which is likely to be a barrier for longer term investment. Shared Access

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<sup>111</sup> [Dense Air response to the May 2022 Consultation](#), p. 1, response to Q.6; [Caleycom response to the May 2022 Consultation](#), p. 1, response to Q.3; [Cellnex response to the May 2022 Consultation](#), p. 6. [Intracom response to the May 2022 Consultation](#), p. 3, response to Q.3; [ITS UK response to the May 2022 Consultation](#), pp. 1-2, response to Q.3; [JRC response to the May 2022 Consultation](#), p. 1, response to Q.3; [Luminet response to the May 2022 Consultation](#), pp. 7-8 ; VM02, [Stephen Temple response to the May 2022 Consultation](#), p. 3, response to Q.3; [techUK response to the May 2022 Consultation](#), p. 2, response to Q.3; [UKWISPA response to the May 2022 Consultation](#), p. 1, response to Q.3; [Wildanet response to the May 2022 Consultation](#), p.6, response to Q.3; [WPD response to the May 2022 Consultation](#), pp. 3-4.

<sup>112</sup> [BT/EE response to the May 2022 Consultation](#), pp. 10-11.

<sup>113</sup> [Ericsson response to the May 2022 Consultation](#), p. 3; [Qualcomm response to the May 2022 Consultation](#), p. 1.

<sup>114</sup> [MLL response to the May 2022 Consultation](#), p. 6, response to Q.3.

<sup>115</sup> [Vodafone response to the May 2022 Consultation](#); p. 6, response to Q.3.

licences provide operators with greater certainty for investment, without the need to reach commercial agreements with an MNO.

- 3.19 We also note that the majority of stakeholders supported our proposals, and we do not consider there is a strong case for an alternative approach.
- 3.20 We have therefore decided to adopt different licensing approaches in high and low density areas, as set out below. We have also decided to award citywide licences, rather than national licences (although, in line with Qualcomm and Ericsson’s suggestion, as explained further in section 9, we are now proposing to combine all high density areas so that each lot awarded would authorise spectrum use in all high density areas).

## Authorisation of the 26 GHz band – our decisions

### Authorisation of 26 GHz in high density areas

#### Consultation proposals

- 3.21 In the May 2022 Consultation, we proposed that in high density areas, we would:
- a) auction medium power, citywide licences for the top 2.4 GHz of the band (25.1-27.5 GHz); and
  - b) allocate low power licences authorising use of the bottom 850 MHz of the band (24.25-25.1 GHz) for local users on a first come first served basis, by extending the Shared Access licensing framework.<sup>116</sup>
- 3.22 We received comments on the balance between Shared Access and award licences, and our proposal to limit Shared Access licences to low power only, which we discuss below. We also received comments in favour of a “club use” model, as a complement or alternative to an auction. We discuss these comments below, from paragraph 3.77.

#### Proposal to offer both Shared Access licences and auctioned citywide licences in high density areas

#### Stakeholders’ comments

- 3.23 Many stakeholders supported our proposal to offer 850 MHz of the 26 GHz band for local licences and the remaining 2.4 GHz for citywide auctioned licences:
- a) Cellnex, ITS, UKWISPA, Qualcomm and Wildanet agreed with our proposed approach.<sup>117</sup>
  - b) VMO2 said that it supported the 850 MHz/2.4 GHz balance between shared use and “exclusive use licences”. It said that its priority is “exclusive licences”, but it recognised “there may be demand for local area licences, and the 850 MHz block is a suitable way to meet this demand”. VMO2 also noted that “the opportunity cost of allocating the lower part of the band to local licences is low, as Ofcom’s proposed measures to

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<sup>116</sup> May 2022 Consultation, paragraphs 3.11-3.21.

<sup>117</sup> Cellnex, p. 7, paragraph 4.1; ITS UK, p. 2, response to Q.4; [UKWISPA response to the May 2022 Consultation](#), p. 1, response to Q.4; Qualcomm, p. 6, response to Q.4; Wildanet, p. 6, response to Q.4.

protect EESS services in this part of the band make the spectrum less attractive for mobile use.”<sup>118</sup>

- c) Vodafone agreed with the proposal, which it thought would facilitate market entry and also allow Ofcom to directly manage use of these frequencies to ensure protection of adjacent users.<sup>119</sup>

3.24 BT/EE, H3G and Intracom thought we should make the entire 26 GHz band available for citywide, auctioned licences:

- a) BT/EE said including the entire 26 GHz band in the auction would be more likely to secure optimal use of the spectrum, and that excluding the bottom 850 MHz of the band from the auction would lead to “higher prices and/or smaller per operator assignments”. BT/EE noted that 60 GHz spectrum was available for low power use.<sup>120</sup>
- b) H3G said we should have spelt out why we proposed to reserve 850 MHz specifically, and a “large spectrum set-aside of 26GHz for local users represents a break from the use of market mechanisms to allocate scarce spectrum.”<sup>121</sup> It said: “Ofcom should not set aside 26GHz for local uses unless it has identified a market failure, has carried out a cost-benefit analysis and discarded other alternatives.”<sup>122</sup> H3G also said the proposal “requires much more evidence and analysis than has been presented in the consultation”.<sup>123</sup> In particular, H3G said that:
  - i) It recognised that there “could be a market failure (a “coordination problem”) if many potential local users had to bid for shared spectrum in competition with wide-area users, and this could prevent local users with a high combined willingness to pay from successfully expressing their joint values at the auction.” However, it did not consider that we had “investigated whether these coordination problems could be addressed by the market, for instance through band managers or market aggregators”.<sup>124</sup>
  - ii) H3G also thought we should have assessed other alternatives to setting aside 26 GHz spectrum for local users, for example the 39-40 GHz band.<sup>125</sup>
- c) Intracom said the proposal would limit the spectrum that can be used for FWA, and preferred the full band to be allocated for wide area use to support mobile and FWA.<sup>126</sup>

3.25 No stakeholders objected to our proposal to make these local licences available through our Shared Access licensing framework, as opposed to an alternative local licensing regime.

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<sup>118</sup> VMO2, p. 9.

<sup>119</sup> Vodafone, p. 6.

<sup>120</sup> BT/EE, p. 12.

<sup>121</sup> [H3G response to the May 2022 Consultation](#), p. 53.

<sup>122</sup> H3G, pp. 52-58.

<sup>123</sup> H3G, p. 53.

<sup>124</sup> H3G, p. 55.

<sup>125</sup> H3G, p. 58.

<sup>126</sup> Intracom, p. 3, response to Q.4.

## Our response

- 3.26 Respondents have shown evidence of demand for mmWave spectrum for a range of different uses, including mobile networks, FWA and mobile private networks. In light of these responses, we consider it appropriate to enable opportunities for a diverse set of users to access the spectrum for investment and innovation across the country, in both urban and rural areas, which we consider important to maximise the benefits from mmWave spectrum. This is consistent with our recently published spectrum strategy<sup>127</sup> and mobile demand strategy.<sup>128</sup>
- 3.27 We have considered H3G and BT/EE's submissions that making spectrum in the 26 GHz band available for local users could create artificial scarcity of spectrum for wide area users.
- 3.28 We are aware that demand from wide area operators may exceed the 2.4 GHz of 26 GHz spectrum that we have decided to make available in the award. To mitigate this risk and to ensure the optimal use of spectrum, we have decided to make the 40 GHz band available on the same timescale as 26 GHz. We also acknowledge that the 26 GHz band is likely to support earlier deployments than 40 GHz due to its more mature ecosystem. However, we expect the 40 GHz band to be substitutable with the 26 GHz band in the long term. Making the 40 GHz band available for mobile will ensure that all operators will have access to the mmWave spectrum they need in the coming years.
- 3.29 We consider it is appropriate to enable both local and wide area users to gain access to 26 GHz spectrum.<sup>129</sup> Noting that we are making a considerable amount of spectrum available for award licences across both bands, we consider making 2.4 GHz of 26 GHz spectrum available for award licences strikes an appropriate balance between enabling both local and wide area users to access this spectrum.
- 3.30 We disagree with H3G's suggestion that making spectrum available for Shared Access signals a move away from our established approach to spectrum management. We note that, as of the date of this document, we have made over 1,600 Shared Access licences available.<sup>130</sup> Auctions and Shared Access licensing on a first come first served basis are both well-established approaches to allocating spectrum, and we have used both methods successfully in other bands.
- 3.31 Given the highly localised deployments by local users and the disparate nature of these operators, we do not consider it appropriate to expect local users to bid in an auction for citywide licences, or to come together and coordinate a band manager to bid on their behalf, as suggested by H3G.<sup>131</sup> We also note that the commercial potential of mmWave is

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<sup>127</sup> See Ofcom's 2021 spectrum strategy document "[Supporting the UK's wireless future](#)", where we set out our goals to support wireless innovation and ensure our licensing is fit for local and national services (see, e.g. p. 16).

<sup>128</sup> See Ofcom's December 2022 statement, "[Ofcom's future approach to mobile markets and spectrum](#)", where we explained that we want to see innovation and investment in new technologies.

<sup>129</sup> As set out in section 2, enabling a wide range of users to access this spectrum is one of our key objectives

<sup>130</sup> We also note that other European administrations are increasingly adopting the UK's shared licensing approach in the 3.8-4.2 GHz range.

<sup>131</sup> H3G, p. 55.

still emerging. It is therefore possible that many local users of the spectrum would only materialise after the auction. Any such operators' access to spectrum, and the associated benefits that they would deliver, would be precluded if we were to auction the entire band.

- 3.32 We also do not agree that other Shared Access bands (e.g. 3.8-4.2 GHz) or other mmWave bands (e.g. 39-40 GHz or 60 GHz) are adequate substitutes for 26 GHz or 40 GHz. Other Shared Access bands do not enable the same high capacity/high speed/low latency services as mmWave, as they are much lower in the frequency range and only comprise smaller bandwidths. The 60 GHz band does not offer operators the same guarantee of service levels as the 26 GHz and 40 GHz bands, because it is only light-licensed (for medium power use) and licence exempt (for low power use). However, Shared Access licences in the 40 GHz and 26 GHz bands would allow operators to offer commercial services with greater certainty and assurance of service quality. These are also European pioneer/high priority bands, and so would offer a more mature ecosystem and market than the 60 GHz band.
- 3.33 We note that we have decided to apply restrictions to use of the bottom 850 MHz of the 26 GHz band to protect passive services in the adjacent 24 GHz band.<sup>132</sup> These restrictions include a limit on the density of outdoor 26 GHz base stations within any 300km<sup>2</sup> area. Given these restrictions, we consider that the bottom 850 MHz of the 26 GHz band is more suited to local users, and/or users with low density of deployments such as the MOD. Authorising the bottom of the band on a Shared Access basis also allows us to ensure compliance with the base station density restrictions, rather than relying on block assigned licensees to ensure compliance with restrictions.

#### **Amount of 26 GHz spectrum available for Shared Access and the auction, in light of the MOD safeguard**

- 3.34 As set out in paragraphs 3.7-3.12 above, we have decided to make the bottom 200 MHz of the 26 GHz band available to MOD on a nationwide basis. This reduces the amount of the 26 GHz band available to other users from 3.25 GHz to 3.05 GHz.
- 3.35 Accordingly, we have considered whether this should reduce the amount of spectrum available for Shared Access, or the auction portions of the 26 GHz band in high density areas.
- 3.36 In the May 2022 Consultation, we said we want to ensure that a reasonable amount of spectrum for new uses is available for local users, and also that wide area users have the opportunity to acquire large blocks of spectrum. As such, our provisional view was that the majority of the band should be allocated to wide area users, and a smaller part of the band should be allocated primarily to local users.<sup>133</sup>
- 3.37 We proposed to make the bottom 850 MHz of the 26 GHz band (24.25-25.1 GHz) available for Shared Access, and the remaining 2.4 GHz (25.1-27.5 GHz) available for auctioned citywide licences. We said we thought that it would be appropriate to offer at least the

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<sup>132</sup> Ofcom's Statement "[Protecting passive services at 23.6-24 GHz from future 26 GHz uses](#)", published July 2022.

<sup>133</sup> May 2022 Consultation, paragraph 3.17.

bottom 800 MHz of the 26 GHz band in high demand areas to local users on a first come, first served basis.<sup>134</sup> There were three reasons for this:

- a) 800 MHz is within the range of early indications for spectrum demand per operator
- b) Ofcom allocating this spectrum on a local basis would mitigate many of the implementation challenges that may otherwise arise as a result of our proposed measures to protect EESS services in the 24 GHz band; and
- c) allocating 800 MHz for local licences would also allow multiple local users to access spectrum in high density areas, while still making the majority of the band available for auctioned citywide licences.

3.38 We also noted that there was a “spare” 50 MHz available in the band, and this could be more straightforwardly used by local users than incorporated into the auction.

3.39 We have now decided to make 650 MHz of 26 GHz spectrum (between 24.45-25.1 GHz) available for Shared Access licences, in light of our decision to provide MOD with a nationwide safeguard at the bottom 200 MHz (24.25-24.45 GHz) of the band.

3.40 We acknowledge that this is less spectrum than we proposed to make available on a shared access basis in the May 2022 Consultation, and the potential downside of this is that a Shared Access user might require more than 650 MHz of contiguous spectrum. However, we consider that 650 MHz is likely to be sufficient to meet the requirements of local users, in particular because 650 MHz is within range of early indications of demand (200 MHz-1 GHz, as set out in the May 2022 Consultation) and the GSMA reports 150-400 MHz will be required for an enterprise network (i.e. mobile private network).<sup>135</sup> We therefore consider that 650 MHz would allow for multiple users to deploy in a particular location and/or a single local user to access larger bandwidths for use cases that require more than 400 MHz.

3.41 We recognise there may be some benefits to maintaining 850 MHz for Shared Access in the 26 GHz band, particularly in the longer term as the mmWave market develops. For example, this would support scenarios where multiple operators want access to 400 MHz in the same 50m area, or to support potential future use cases that require more than 650 MHz of bandwidth. However, we also consider that constraining the amount of 26 GHz spectrum available in the auction would risk impeding wide area deployments. We consider mmWave will be important to the MNOs’ ability to meet ongoing growth in demand for mobile data due to the large bandwidths on offer, and so consider it appropriate to enable their access to large contiguous blocks in both the 26 GHz and 40 GHz bands. We also note that, while the 26 GHz and 40 GHz bands will be substitutable in the longer term, the 26 GHz band is likely to support earlier deployments than 40 GHz due to its more mature ecosystem. Reducing the amount of 26 GHz spectrum available in the auction from 2.4 GHz to 2.2 GHz could pose a risk to the quality or timeliness of MNOs’ deployments.

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<sup>134</sup> [May 2022 Consultation](#), paragraphs 3.20-3.21.

<sup>135</sup> GSMA, “[Vision 2030: mmWave Spectrum Needs](#)”, published June 2022.

- 3.42 We also think that erring on the side of making more spectrum available in the auction will help to support investment from a range of wide area operators. We note that in addition to demand for wide area licences from the MNOs, we saw strong interest in FWA as a use case for mmWave from a range of operators, including the MNOs, INCA, Luminet, and UKWISPA.<sup>136</sup> We consider FWA to be a wide area use case, that would be best delivered using the citywide licences we will auction, with which operators can manage their own deployments and which would have more permissive power limits and no height restrictions.
- 3.43 We also note that, should local users require more than 650 MHz in the longer term, there may be alternative routes for these users to be able to access more spectrum in high density areas. For example, Ofcom’s Local Access licensing framework provides a mechanism to enable local users to access auctioned spectrum where it is unused for a three-year fixed term (unless the user can agree otherwise with the existing licence holder).<sup>137</sup>
- 3.44 In addition, the way the band is allocated could be adjusted in the future following expiry of the fixed term auctioned licences, should we decide to adopt them,<sup>138</sup> and review of MOD’s needs.
- 3.45 Having considered all the factors above, we consider that making 650 MHz of spectrum available for local users, and 2.4 GHz for wide area users will best achieve our objectives of achieving efficient allocation of spectrum and encouraging investment and innovation by a wide range of operators. We consider this split will enable local users to access an appropriate amount of the spectrum, while not risking the benefits that are likely to result from wide area operators having access to large blocks of spectrum.

### Restriction of Shared Access to low power only in high density areas

#### Stakeholders’ comments

- 3.46 In the May 2022 Consultation, we proposed to limit Shared Access licences in high density areas to low power only. This would allow low power small cells to be deployed. We proposed to not allow medium power deployments (suitable for macro cells) with Shared Access licences in high density areas because they could sterilise a large area and deny the opportunity for a number of other users to deploy spectrum in high density areas. Stakeholders interested in deploying medium power equipment in high density areas would therefore need to participate in the proposed auction for citywide licences.<sup>139</sup>

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<sup>136</sup> BT/EE, p. 5; H3G, p. 31; Vodafone, p. 4; [INCA response to the May 2022 Consultation](#), pp. 4-7; Luminet, p. 2; UKWISPA, p.1, response to Q.1.

<sup>137</sup> Ofcom’s Guidance Document “[Local Access Licence](#)”.

<sup>138</sup> As there is a degree of uncertainty on how the mmWave market will develop in the medium-long term, it is possible that Ofcom may want to revisit the balance between wide area and local users at the end of the licence term of auctioned licences.

<sup>139</sup> May 2022 Consultation, paragraph 3.34.

- 3.47 A number of respondents thought we should offer higher power Shared Access licences in high density areas, and allow above rooftop antennas:
- a) Vodafone said that low power would mean that licences would only cover a tiny coverage footprint, and that a constraint that antennas must be below the roofline in urban environments will severely constrain deployment options.<sup>140</sup>
  - b) techUK said that the “lack of high-power access for the shared access licences risks uneconomic deployment in campus and private networks environments.”<sup>141</sup>
  - c) INCA and Luminet both thought that it might be possible for MNO and hotspot providers to share spectrum with FWA/BFWA providers, given they would operate at different heights, but that if not, we should reserve some spectrum for FWA use (INCA suggested 400 MHz of low power spectrum and 400-600 MHz of medium power spectrum).<sup>142</sup>
  - d) Airspan said that for both hotspot and FWA use in high density areas we must not limit effective radiated power (“EIRP”), otherwise coverage will be reduced and the use cases will not be economically viable. Airspan recommended 64dBm of EIRP as an average outdoor power to make these use cases attractive.<sup>143</sup>
  - e) Ericsson thought that all licences should allow medium power. It said that it would be challenging for an operator with a citywide licence to extend coverage via Shared Access licences in dense areas due to the mix of power requirements.<sup>144</sup>

### Ofcom’s response

- 3.48 We consider medium power FWA to be a wide area application, as it would sterilise a relatively large area for other deployments. This could, for example, mean that only one medium power operator could deploy in any particular channel in an entire town centre of a medium sized town, which could include multiple deployment targets for other prospective users. Therefore, allowing medium power Shared Access use in high density areas would significantly reduce the amount of spectrum available for low power use by local operators. This is also why we have limited medium power use to outside urban areas in other Shared Access bands.
- 3.49 We consider it would be more efficient for wide area users, such as the MNOs and other FWA operators, to acquire citywide licences for deployments that would cover a large area. This would enable both FWA use, where efficient, while maintaining availability for low power use. We also note that the large amount of mmWave spectrum we are proposing to make available through the auction (5.4 GHz) should enable multiple wide area operators with sufficient value for the spectrum to acquire licences in the auction.<sup>145</sup>

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<sup>140</sup> Vodafone, p. 7.

<sup>141</sup> techUK, p. 3, response to Q.4.

<sup>142</sup> INCA, pp. 5-6, sections 3.1-3.2; Luminet, pp. 5-6, section 4.2.

<sup>143</sup> Airspan, p. 2, response to Q.3.

<sup>144</sup> Ericsson, p. 3.

<sup>145</sup> i.e. 2.4 GHz that we have decided to make available by auction in the 26 GHz band, alongside the 3 GHz we are minded to make available by auction in the 40 GHz band (see paragraphs 3.64-3.70 below).

- 3.50 Given FWA operators have the opportunity to acquire auction licences, we do not see strong benefits in further facilitating FWA operators access to the Shared Access spectrum, at the expense of risking availability for low power users. Ensuring sufficient spectrum for low power use will support innovation through mobile private network providers, whereas enabling medium power shared access use risks impeding these developments.
- 3.51 We also do not think it would be appropriate to reserve spectrum specifically for FWA, as suggested by Luminet and INCA. We have not identified any competition concerns in relation to FWA provision that would justify such a reservation. We also have not identified any reason why FWA operators would not be able to participate in the auction and win licences if they are the most efficient user of that spectrum, noting that we will be making a large amount available in the auction and that we are consulting on reserve prices of £0.25m to £2m per lot.<sup>146</sup>
- 3.52 For the reasons set out above, we have decided to limit Shared Access licences available in high density areas to low power.

### Options for awarding citywide licences

- 3.53 In the May 2022 Consultation, we set out three options for making citywide licences available: (i) an auction, (ii) a comparative selection process, and (iii) a first come, first served process. We proposed to make citywide licences available by auction, which we said was the allocation method most likely to achieve an efficient allocation of the spectrum.<sup>147</sup>
- 3.54 BT/EE, VMO2 and H3G all supported authorising citywide licences through an auction. However, Vodafone did not think an auction was merited for mmWave spectrum, and instead proposed use of a “club model” (see paragraphs 3.77-3.81 below).<sup>148</sup>
- 3.55 We continue to believe an auction is the best way to allocate this spectrum. In an auction, the spectrum is awarded to the participant who bids the highest for it, which is likely to be the user who can obtain the most value from using the spectrum and provide the most value to society. This would not necessarily be the case if we made the spectrum available through Vodafone’s proposed “club model”, which does not include a mechanism to ensure the highest value users of the spectrum have access to it at any given time.<sup>149</sup> In addition, an auction process is transparent to stakeholders, and clear auction rules allow stakeholders to check the auction results after it has taken place.
- 3.56 As set out in section 7 of this document, we have decided to start the statutory process to revoke licences in the 40 GHz band. Subject to the outcome of this process, we are minded

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<sup>146</sup> See section 9 for further detail.

<sup>147</sup> May 2022 Consultation, paragraph 3.22.

<sup>148</sup> Vodafone, p. 7.

<sup>149</sup> In Vodafone’s proposed club model, the amount of spectrum available for each user at any given time would depend only on the number of users requesting access to it (Vodafone proposes spectrum would be divided equally amongst club members), without regard to the value of their use for the relevant spectrum. Instead, in an auction, bidders’ bids would be based on expected value, thereby ensuring the spectrum is allocated to the users with the highest value for it. In addition, if there were lots of club members, their individual allocations of spectrum could be less than they each need to provide a good quality service.

to include the 40 GHz spectrum in the same auction as the 26 GHz spectrum, which will enable bidders to consider both bands during the auction. Our proposed auction design is described in section 9.

### Allowing citywide licence holders to hold Shared Access licences in high density areas

- 3.57 In the May 2022 Consultation, we said that holders of award licences<sup>150</sup> may also want to acquire Shared Access licences in high density areas (for example in order to access more spectrum than they won in the auction to deliver a specific service in a particular area). We noted that allowing this would give rise to a risk of award licensees ‘hoarding’ Shared Access licences, and potentially preventing local users from accessing the spectrum. However, we said the risk of spectrum hoarding by award licensees was probably low because: (i) we were proposing to include a “use it or lose it” condition in Shared Access licences, and (ii) we expected that award licensees would prefer to deploy spectrum in the same frequencies across a city.<sup>151</sup>
- 3.58 For the reasons set out above, we have decided to allow award winners to access Shared Access spectrum in high density areas, noting that stakeholders were generally supportive of this approach.

### Summary of Ofcom’s decisions on authorisation of the 26 GHz band in high density areas

- 3.59 Having taken account of stakeholder responses and in light of our decision to safeguard the bottom 200 MHz of the 26 GHz band on a nationwide basis for Defence use, we have decided to:
- a) make 650 MHz of spectrum (24.45 - 25.10 GHz) available for local, low power licences, using our existing Shared Access framework, and
  - b) make 2.4 GHz of spectrum (25.10 - 27.50 GHz) available for citywide, medium power licences, available by auction.

## Authorisation of 26 GHz in low density areas

### Consultation proposals

- 3.60 We proposed to make all of the 26 GHz band (24.25 - 27.5 GHz) available via our Shared Access licensing framework in low density areas.<sup>152</sup> We proposed that 26 GHz Shared Access licences in low density areas would allow both indoor and outdoor deployments, and both medium power and low power uses.

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<sup>150</sup> We note that in the May 2022 Consultation, we proposed to auction each citywide licences for each high density area as a separate lot category. As explained in section 9, we are now proposing instead to auction sub-national licences for all high density areas.

<sup>151</sup> May 2022 Consultation, paragraphs 3.35-3.38.

<sup>152</sup> May 2022 Consultation, paragraphs 3.44-3.46.

### Stakeholders' comments

- 3.61 Most stakeholders agreed with our proposals to make available first come, first served licences in low density areas.<sup>153</sup> However, BT/EE said it would prefer national licences.<sup>154</sup> We explain at paragraph 3.17-3.20 above why we do not consider it is appropriate to offer national licences for mmWave spectrum.
- 3.62 A number of stakeholders<sup>155</sup> also commented on the detail of the technical licence conditions and process for obtaining a Shared Access licence. Our response to these comments is covered in sections 13 and 14 of this document.

### Ofcom's decisions

- 3.63 As explained above, we have decided to implement a nationwide safeguard for MOD in 24.25-24.45 GHz. As a result, we have now decided to make 24.45-27.5 GHz spectrum available in low density areas using our existing Shared Access licensing framework. Our detailed decisions and proposals in relation to these licences are set out in section 14.

## Authorisation of the 40 GHz band – our proposals

- 3.64 In the May 2022 Consultation, we set out our initial view that we would authorise the 40 GHz spectrum in a similar way to 26 GHz, if we were to revoke 40 GHz licences.<sup>156</sup> Specifically, we said that:
- a) we would allocate 40 GHz spectrum in low density areas on a first come, first served basis, in the same way as the 26 GHz band, via our Shared Access licensing scheme; and
  - b) we would only allocate citywide licences in high density areas.
- 3.65 We said that if we decided to revoke and reallocate the 40 GHz spectrum, we would consult on our detailed approach to authorising the spectrum.<sup>157</sup>

### Stakeholders' comments

- 3.66 Wildanet, UKWISPA, Cellnex, techUK, Professor Stephen Temple, VMO2 and Vodafone agreed with this approach.<sup>158</sup> However, Dense Air commented that if we decide to reallocate the band, it would be beneficial to provide a local access mechanism in densely populated areas,<sup>159</sup> Caleycom said we should not auction the spectrum at a national

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<sup>153</sup> Caleycom, p. 1, response to Q.5; Cellnex, p.8; Dense Air, pp. 1-2, response to Q.5; Qualcomm, p. 7, response to Q.5; [Professor Stephen Temple response to the May 2022 Consultation](#), p. 4, response to Q.5; tech UK, p. 4, response to Q.5; UKWISPA, p. 1, response to Q.5; Wildanet, p. 7, response to Q.5; Vodafone, p. 9.

<sup>154</sup> BT/EE, p.10.

<sup>155</sup> Wildnet, Vodafone, Intracom, ITS UK and Dense Air.

<sup>156</sup> May 2022 Consultation, paragraphs 3.47-3.51.

<sup>157</sup> May 2022 Consultation, paragraph 3.51.

<sup>158</sup> Wildanet; p. 7, response to Q.6; UK WISPA, p. 1, response to Q6. Cellnex, p. 9, response to Q.6; techUK, p.4, response to Q.6; Professor Stephen Temple, p. 4, response to Q.6; VMO2 response, p. 10; Vodafone, p. 10.

<sup>159</sup> Dense Air, p. 2, response to Q.6.

level,<sup>160</sup> and MLL said its business case relies on nationwide access to 40 GHz spectrum.<sup>161</sup> While we acknowledge that certain potential users of 40 GHz spectrum would prefer national licences, we do not consider that allocating nationwide licences for mmWave spectrum would be likely to secure an efficient allocation of this spectrum, as set out in paragraphs 3.17-3.20.

## High density areas

- 3.67 As set out above, in the May 2022 Consultation<sup>162</sup> we set out our initial view that we would make only award licences available in high density areas (i.e. that we would not authorise any spectrum in high density areas on a Shared Access basis to support local users). As suggested by some respondents, we have reconsidered whether we should make 40 GHz spectrum available for Shared Access licences in high density areas, particularly as the MOD nationwide safeguard will reduce the amount of shared access spectrum available in high density areas in the 26 GHz band by 200 MHz.<sup>163</sup>
- 3.68 However, we are not convinced of the benefits of making spectrum available in high density areas in the 40 GHz band for Shared Access licensees. We consider that 650 MHz of contiguous spectrum in the 26 GHz band is likely to be sufficient to meet the requirements of local users, for the reasons set out in paragraph 3.39-3.43, and that making a single block of contiguous spectrum available for shared access use is likely to be better than making two smaller blocks available, should any users require larger contiguous blocks of spectrum.
- 3.69 We are therefore minded to make all the 40 GHz spectrum available via auctioned citywide licences in high density areas.
- 3.70 As set out in section 2, and section 7, we have decided to make the 40 GHz and 26 GHz bands available at the same time. This will best enable efficient use of the spectrum and maximise opportunities for operators to obtain large contiguous blocks of spectrum in either the 26 GHz or 40 GHz band. We note that we received strong support for our proposal to authorise the 26 GHz and 40 GHz bands at the same time.<sup>164</sup>

## Protection of Radio Astronomy

- 3.71 As explained in more detail in section 7, we have decided to protect the radio astronomy site (“RAS”) in Cambridge, which uses 42.5-43.5 GHz.
- 3.72 Nevertheless, we propose to authorise 40 GHz spectrum in Cambridge in the same way we have decided to authorise the band elsewhere. However, as explained in more detail in

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<sup>160</sup> Caleycom, p. 2, response to Q.12.

<sup>161</sup> MLL, p. 7, response to Q.6.

<sup>162</sup> May 2022 Consultation, paragraphs 3.49-3.50.

<sup>163</sup> E.g., Dense Air, p. 2, response to Q.6.

<sup>164</sup> See section 2, paragraph 2.68.

section 10, we propose to require the new licensees of 40 GHz spectrum to ensure they do not cause interference to the RAS.<sup>165</sup> In particular:

- a) In the award licences for the high density areas within 50km of the Cambridge radio astronomy site, we propose to require users of all 40 GHz spectrum to comply with a spectrum quality benchmark (“SQB”) limit to protect the RAS. In 40.5-43.5 GHz, we expect that in order to comply with our proposed power limits, licensees will only be able to operate at low power in most locations in Cambridge but that there should be little constraint on low or medium power deployments in high density areas further from the Cambridge radio astronomy site including Peterborough, Luton and Stansted Airport.
- b) As explained in section 10 (paragraph 10.71), we will consult on how to protect the RAS at Cambridge from Shared Access licensees before we make the 40 GHz band available for Shared Access.

3.73 Our coordination proposals are explained in further detail in section 10.

## Low density areas

3.74 In low density areas, we are minded to make all of the spectrum in the 40 GHz band available for Shared Access users. As per our 26 GHz authorisation model, we propose that both low and medium power licences would be available.

3.75 However, noting that the 26 GHz band is the more immediately useable band, and that we do not expect there to be excess demand in low density areas in the 26 GHz band in the short to medium term, we intend to prioritise making 26 GHz available for Shared Access by early 2024.

3.76 In the 40 GHz band, as H3G, MLL and MBNL’s licences are subject to a 5-year notice period, our current intention is to make Shared Access licences available after the end of the revocation period. This will reduce the coordination burden on H3G, MLL and MBNL during the 5 year revocation period, and help manage Ofcom’s internal resource. See section 10 for more detail on our approach to coordination.

## Club model

3.77 In the May 2022 Consultation, we said that some stakeholders had expressed interest in a “club model”, which would enable licensees to access spectrum specifically assigned to them, as well as to temporarily access spectrum in the same band which has been licensed to another operator, but which that operator is not currently using in a particular area. We noted that a club use model was used in the 2018 Italian auction of the 26 GHz band.

3.78 We said that we recognised a club model approach could be used for citywide licences in the 26 GHz band, and would be likely to enable efficient use of spectrum by increasing the likelihood that all available spectrum is used, while still providing licensees with certainty

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<sup>165</sup> Paragraphs 10.101-10.104.

that they can deploy in the specific areas licensed to them. However, our provisional view was that a club model would be difficult to implement, and we said it was unclear whether it would provide significant additional benefits compared with those available under the Local Access licensing framework or the mobile spectrum trading scheme.<sup>166</sup>

## Stakeholders' comments

3.79 Vodafone, VMO2, Professor Stephen Temple and TechUK all commented on the potential use of a club model:

- a) Vodafone said it would prefer a club use model to an auction, which it said would ensure more efficient use of the spectrum. Vodafone proposed a model in which club members would pay a membership fee, for which they would be awarded a citywide licence, and club members would agree to a Code of Practice to mutually coordinate their usage. Where only one member deploys infrastructure, that member would be free to utilise all of the spectrum until other club members wished to deploy, at which point the first mover would constrain their usage so members could use the spectrum equitably.<sup>167</sup>
- b) VMO2 said that a club model could work after an auction. VMO2's proposal was that licensees subject to the club regime would be free to use each other's spectrum provided it is otherwise unused. It would be the responsibility of club members to manage these arrangements, for example by sharing database information regarding their deployments, with appropriate 'black box' information sharing safeguards in place. Licensees would retain exclusive rights to their own spectrum and may invoke these rights if necessary.<sup>168</sup>
- c) Professor Stephen Temple also thought a club model would be an alternative to an auction. He suggested that we allocate the spectrum on an equal basis to the MNOs involved in the club, and that we include a requirement on members of the club to cover a specified number of very high traffic density locations with 26 GHz 5G cells. Professor Temple said this would speed up the spectrum release, have a low administrative cost and deliver superior local technical spectrum efficiency.<sup>169</sup>
- d) TechUK said that some of its members would prefer the spectrum to be allocated by auction, while others would prefer use of the club model proposed by UK SPF, which may result in more efficient spectrum usage.<sup>170</sup>

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<sup>166</sup> May 2022 Consultation, paragraphs 3.39-3.43.

<sup>167</sup> Vodafone, pp. 7-9.

<sup>168</sup> VMO2, p. 10.

<sup>169</sup> Professor Stephen Temple, p. 1, response to Q.2.

<sup>170</sup> techUK, p. 3, response to Q.4.

## Ofcom's response

- 3.80 We are making over 6 GHz of mmWave spectrum available. We therefore do not expect spectrum sharing to be necessary for operators to access as much mmWave spectrum as they might need.
- 3.81 We do not consider that the club model would give rise to significant additional benefits compared with those available under the Local Access licensing framework or the mobile spectrum trading scheme, which are already available. As a result, we have decided not to implement a club model. However, should operators continue to see significant benefits from a club model, they should be able to achieve similar benefits using Ofcom's Local Access licensing framework.

## Consultation question

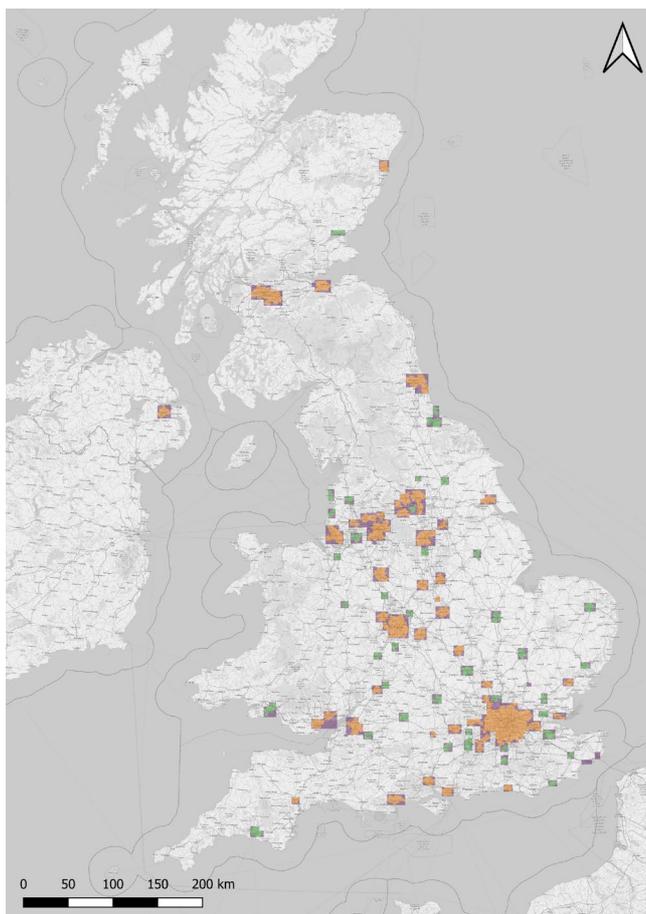
**Question 1:** Do you have any further comments on the approach we are minded to take to authorising the 40 GHz band?

## 4. High density areas

### Summary

- 4.1 We have decided to designate 68 high density areas, in which we will award wide area licences for mmWave spectrum. These areas include the cities and major towns in the top 80 high density areas that we set out in our May 2022 Consultation,<sup>171</sup> 17 major airports, the Port of Dover and the Eurotunnel terminal at Folkestone.
- 4.2 In designating these areas, we have used the overall approach we proposed in our May 2022 Consultation with some adjustments reflecting stakeholders' comments. The resulting high density areas will cover a larger part of the UK territory (6.4%) and population (52.5%), and have simpler boundaries. Figure 4.1 provides an overview of the proposals we set out in the May 2022 Consultation and of the final outcome.

**Figure 4.1: Map showing coverage of the top 40 (amber) and top 80 (green) high density areas proposed in the May 2022 Consultation, and final high density areas (purple)**



Source: Ofcom, base map © [OpenStreetMap contributors](#) N.B. Orkney and Shetland not shown as no areas there have been designated as high density areas.

<sup>171</sup> [May 2022 Consultation](#), p. 42, Table 4.2.

## Consultation proposals

- 4.3 In section 4 of the May 2022 Consultation, we proposed to identify high density areas of the UK using the following method:
- we first identified towns and cities which have either:
    - a population of 75,000 or more; or
    - notably high peak hour mobile traffic; and
  - we then ranked these areas based on both the level of mobile traffic they experience at peak hours and the greatest density of mobile base stations within the area.
- 4.4 Using this method, we developed a ranked list of potential high density areas. We consulted on defining high density areas as either the top 20, 40 or 80 towns and cities in this list, and said we were minded towards adopting 40 high density areas. We noted that identifying too few high density areas would run the risk of reducing wide area operators' economies of scale and incentives to invest, but that including areas where deployments are likely to be fewer in number would risk underutilising spectrum and revoking more fixed links than necessary.
- 4.5 To identify the boundaries of high density areas, we proposed to use as a starting point the boundaries that have already been established by the UK's statistics agencies for the corresponding towns and cities. We then proposed to apply an overlay of 1km grid squares to simplify and standardise the boundaries.
- 4.6 We considered whether we should also designate as high density areas some potential additional hotspots of demand, such as airports, train stations or sports stadia not already captured within the high density areas, and provisionally concluded that this would not be necessary.<sup>172</sup>

## High-level summary of consultation responses

- 4.7 Fifteen stakeholders commented on our proposals for defining high density areas.<sup>173</sup> Most, including those who preferred that we award national licences, agreed broadly with the method we proposed for defining high density areas.<sup>174</sup> Some respondents disagreed with certain aspects of the method and suggested changes.

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<sup>172</sup> We based our provisional conclusion on two reasons. Firstly, we said that most major sports stadia and train stations, and a significant number of major airports, would be within our proposed high density areas. Secondly, we said that users looking to deploy mmWave spectrum for new uses in any location that falls outside a high density area will be able to apply for a Shared Access licence (May 2022 Consultation, paragraphs 4.38-4.41).

<sup>173</sup> They were: Airspan, Airwave, BT/EE, Cellnex, Dense Air, H3G, ITS, JRC, VMO2, Qualcomm, Professor Stephen Temple, techUK, UKWISPA, Vodafone and Wildanet.

<sup>174</sup> We address comments on some stakeholders' preference for national licences in 3.

- 4.8 BT/EE, Cellnex, H3G, JRC, VMO2 and Vodafone thought that the high density areas definition we proposed did not include enough of the locations most likely to attract future deployment of mmWave technology.<sup>175</sup>
- 4.9 Additionally, BT/EE suggested that the boundaries we had proposed for the high density areas were unduly complicated;<sup>176</sup> and BT/EE, VMO2 and Vodafone all suggested that we should amalgamate high density areas which are close to each other.<sup>177</sup>
- 4.10 VMO2 said that, while it had put forward ideas to improve our definition of high density areas, the best solution to the uncertainty in the still nascent understanding of where and when mobile operators will deploy mmWave spectrum would be to delay the award, to give Ofcom and the industry the time and information needed to define sensible boundaries for high density areas.<sup>178</sup>

## Discussion of stakeholders' comments

### Overview of our decisions

- 4.11 We have considered stakeholders' comments and have decided to make some adjustments to the method we proposed for defining the high density areas. In particular, we have decided to:
- a) simplify the borders of high density areas; in most cases, we did this by drawing a rectangle, aligned to the Ordnance Survey 1km grid, around the boundary of each area, rather than following the 1km grid squares around the boundary;
  - b) increase the number of high density areas, to include all of the top 80 areas on which we consulted;
  - c) combine some neighbouring high density areas which are very close to each other; and
  - d) include some additional high-footfall locations, including Gatwick, Stansted, Manchester and Bristol airports, as well as the towns of Dover and Folkestone.
- 4.12 We have defined the high density areas, of which there are now a total of 68, using the adjusted method.
- 4.13 The revised definition of high density areas results in: (i) an increase in the total area available for award licensees, (ii) a corresponding decrease in the total area available for Shared Access medium power licences and (iii) an increased number of fixed links that will need to be cleared.<sup>179</sup> We discuss the impact on fixed links in sections 5 and 7, and annex 7.

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<sup>175</sup> Paragraphs 4.22-4.24.

<sup>176</sup> Paragraph 4.14.

<sup>177</sup> Paragraph 4.15.

<sup>178</sup> [VMO2 response to the May 2022 Consultation](#), p. 2; We discuss VMO2's suggestion that we should delay the award in section 2.

<sup>179</sup> In the May 2022 Consultation, we estimated that if we were to define 40 high density areas then 4,289 links would need to be cleared from the 26 GHz and 40 GHz bands (see Tables A8.6-8 in the May 2022 Consultation). Using our revised definition of high density areas, together with our detailed method for identifying fixed links outside high density areas

In our view, this revised split between high density areas and low density areas strikes a reasonable balance. We consider that it will increase investment opportunities and certainty for wide area operators, while still enabling local users to invest in low power applications anywhere in the UK and in medium power applications in low density areas, which include 93.6% of the landmass and 47.5% of the population.

## Simplifying boundaries

### Stakeholders' comments

- 4.14 BT/EE thought that our methodology results in irregular boundaries around high density areas, and that this would complicate managing interference across those boundaries, both for operators and for Ofcom.<sup>180</sup> It suggested adopting a more regular shape for boundaries, such as rectangles.<sup>181</sup>
- 4.15 BT/EE and Vodafone suggested that we should combine clusters of high density areas which were close to each other.<sup>182</sup> BT/EE argued that this could enable more efficient use of spectrum than leaving narrow gaps between distinct high density areas, because the need to protect deployment within high density areas from interference would prevent issue of Shared Access licences in those gaps. VMO2 made similar comments, and suggested that we might, for example, combine Greater Manchester, Wigan and Rochdale, or the Leeds & Bradford Area and Huddersfield.<sup>183</sup>
- 4.16 VMO2 did not think it essential that all parts of a defined high density area should be contiguous, as long as they made sense as an economic unit. It suggested, for example, combining densely populated areas and a local airport, but excluding the rural areas between them.<sup>184</sup>
- 4.17 UKWISPA, while considering our general approach reasonable, was nevertheless concerned that our proposals encompass within high density areas some rural/less dense locations, which could be neglected by urban operators while being inaccessible to rural operators.<sup>185</sup>

### Ofcom's response

- 4.18 We have considered stakeholders' comments and concluded that it is appropriate to use our judgement to adjust the boundaries, to promote efficient use of the spectrum while limiting the issues licensees and we will face in managing interference at the boundaries of high density areas.

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that may not coexist with deployments of new uses of mmWave spectrum set out in annex 16, we now expect that 4,015 links will need to be cleared across both the 26 GHz and 40 GHz bands.

<sup>180</sup> [BT/EE response to the May 2022 Consultation](#), p. 15.

<sup>181</sup> BT/EE, p. 17.

<sup>182</sup> BT/EE, p. 16; [Vodafone response to the May 2022 Consultation](#), p. 10.

<sup>183</sup> [VMO2 response to the May 2022 Consultation](#), p. 15.

<sup>184</sup> VMO2, p. 15.

<sup>185</sup> [UKWISPA response to the May 2022 Consultation](#), p. 2, response to Q.7.

- 4.19 We agree that drawing less granular boundaries could facilitate the management of interference at boundaries for licensees and for us. We also agree with BT/EE that narrow gaps between high density areas which are close together could result in “dead” zones in which spectrum could lie fallow. We have therefore instead drawn rectangles around individual high density areas, aligning with the 1km square grid we used to construct the areas that we initially proposed. Where the rectangles overlap (as is particularly the case around the largest urban areas and conurbations), we combined the areas into a single high density area (for example, Wigan is now included in Greater Manchester, Slough & Maidenhead is now included in Greater London, and Bristol and Bath are now combined together).
- 4.20 In order to reduce the likelihood that spectrum will lie fallow, we have subsequently adjusted the resulting boundaries to avoid capturing large tracts of open countryside, or areas which we did not consider to be high density areas in the May 2022 Consultation. We have made such adjustments particularly around Greater London, Greater Manchester and Greater Glasgow but we have made similar changes across a range of areas to balance our initial identification of high density areas of the UK with the need to simplify their boundaries. In addition, to further facilitate management of interference, we have ensured that the resulting high density areas are at least 4km in size in each dimension.
- 4.21 We have also discussed our changes to the boundaries of high density areas with the Ministry of Defence (“**MOD**”), to understand any impact on the MOD’s access to spectrum on its sites. Having considered the MOD’s views,<sup>186</sup> we have decided to remove RAF Waddington airbase from the Lincoln high density area and Royal Military Academy Sandhurst from the Farnborough & Aldershot high density area.

## Locations included

### Stakeholders’ comments

- 4.22 All four MNOs argued that we should include additional important locations. Their combined suggested additions included York and Oxford, some airports, stations, stadia, shopping centres, business parks, university campuses, and exhibition centres.<sup>187</sup> BT/EE, H3G, VMO2, Cellnex and JRC thought that we should include more cities and towns than the top 40 in our ranked list of potential high density areas.<sup>188</sup> BT/EE thought it preferable to include as many high traffic locations as possible in the auction licence.<sup>189</sup> Vodafone, while broadly agreeing with our methodology and with a cut-off point of 40 high density areas, thought that it would be better to over-designate high density areas rather than to

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<sup>186</sup> [CONFIDENTIAL ✕].

<sup>187</sup> See for example BT/EE, annex A, p. 46 et seq.

<sup>188</sup> BT/EE, p. 17; H3G, p. 63; VMO2, p. 14; [Cellnex response to the May 2022 Consultation](#), p. 11; [JRC response to the May 2022 Consultation](#), p. 4.

<sup>189</sup> BT/EE added that if the licences we award would not be national, then we would need to issue shared access licences very rapidly on demand and cater for bulk requirements (BT/EE, p. 19). We discuss our Shared Access licence process in section 14.

under-designate them.<sup>190</sup> H3G argued similarly, that the impact of over-estimating the number of high density areas is likely to be materially smaller than under-estimating.<sup>191</sup> It also argued that we should future-proof our approach by erring on the side of categorising more and wider areas as high density.<sup>192</sup>

- 4.23 BT/EE and [CONFIDENTIAL ✂] said that they forecast congestion at some sites in their respective networks outside the areas which we had identified.<sup>193</sup>
- 4.24 BT/EE said we should include all UK motorways,<sup>194</sup> and Vodafone said that we should include motorways in the vicinity of high-density areas,<sup>195</sup> while ITS UK noted that we had not mentioned the roads network.<sup>196</sup> BT/EE also recommended including A roads.<sup>197</sup>

### Ofcom's response

- 4.25 As set out in the May 2022 Consultation,<sup>198</sup> we need to strike a reasonable balance between identifying too few versus too many high density areas. Identifying too few high density areas runs the risk of reducing citywide operators' economies of scale and incentives to invest in other areas. However, identifying areas where fewer deployments are likely as high density areas would risk underutilisation of spectrum and unnecessary revocation of fixed links.
- 4.26 In light of stakeholders' comments, we have decided to expand the set of high density areas that we initially proposed by (i) opting for the top 80 areas discussed in the May 2022 Consultation, rather than the top 40, and (ii) ensuring that some specific high-footfall locations are included in full. In particular, we have adjusted the boundaries of Greater Manchester, Edinburgh, Tyne & Wear, Crawley and Bristol & Bath to include the major airports (Manchester, Edinburgh, Newcastle, Gatwick and Bristol) on the edges of these high density areas. We have also defined a separate high density area to cover Stansted airport, as well as high density areas around the towns of Dover and Folkestone (driven principally by high footfall at the Port of Dover and Eurotunnel terminal respectively).
- 4.27 We have decided not to add individual sports stadia, exhibition centres, university campuses, business parks, specific sites where certain operators forecast congestion and shopping centres, or motorways and A roads which fall outside the newly defined areas. We consider that supporting investment in these locations with shared access licences is likely to drive outcomes which strike an appropriate balance between risks to wide area operators' incentives to invest on the one hand against risks of underutilisation of spectrum and unnecessary revocation of fixed links on the other.

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<sup>190</sup> Vodafone, p. 10.

<sup>191</sup> H3G, p. 60.

<sup>192</sup> H3G, p. 61.

<sup>193</sup> BT/EE, pp. 51-54; [CONFIDENTIAL ✂].

<sup>194</sup> BT/EE, annex A, p. 48.

<sup>195</sup> Vodafone, p. 11.

<sup>196</sup> [ITS UK response to the May 2022 Consultation](#), p. 2, response to Q.7.

<sup>197</sup> BT/EE, p. 16.

<sup>198</sup> May 2022 Consultation, paragraph 4.37.

- 4.28 Combined with the adjustments described above, these further adjustments result in a total of 68 high density areas, covering 6.4% of the UK territory and 52.5% of the population.

## Other points raised

### Stakeholders' comments

- 4.29 VMO2 said that operators have no plans to deploy mmWave spectrum everywhere and that all deployments in the current decade are likely to be localised.<sup>199</sup> It elaborated that operators will be selective, deploying only to the busiest locations, starting within the larger cities, and may return later to different parts of the same cities to build out new locations that will then have met criteria for deployment. It argued that, rather than defining high density areas by city boundaries, we should define them as locations where there could be significant deployments of mmWave spectrum on a 5–15 year time horizon, where operators may require exclusive licences to support efficient deployment.
- 4.30 H3G said that many of the metrics we had used may change by the time mmWave spectrum is widely deployed in the mid-late 2020s.<sup>200</sup> VMO2 recommended refreshing the analysis with 2021 census data, when released in H2 2022.<sup>201</sup>
- 4.31 BT/EE commented that our approach puts most weight on population density, and that the busiest sites are not always correlated with the highest population density.<sup>202</sup> H3G and Cellnex thought deployment of mmWave spectrum would not be limited to areas in which macro base stations are densely deployed at present.<sup>203</sup> Professor Stephen Temple thought that it is wrong to equate high traffic density areas with density of dwellings.<sup>204</sup> He thought that very high performance connectivity was required first and foremost where people do not live.
- 4.32 Vodafone said that we should repeat our analysis with data from various times of year, to reflect seasonality, in order not to miss holiday hotspots.<sup>205</sup>

### Ofcom's response

- 4.33 We agree with VMO2 that the initial deployments of mmWave are likely to be relatively localised even within towns and cities. Nevertheless, we consider that a wide area licence in a city or town will offer the licensee better incentives to invest in such deployments than more localised licences. The right to use a block of frequencies anywhere in a wide area during the licence term will:
- a) enable certainty and economies of scale;

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<sup>199</sup> VMO2, pp. 11-12.

<sup>200</sup> H3G, p. 61.

<sup>201</sup> VMO2, p. 16.

<sup>202</sup> BT/EE, p. 14.

<sup>203</sup> H3G, p. 61; Cellnex, p. 10, paragraph 7.1.

<sup>204</sup> Professor Stephen Temple response, p. 1.

<sup>205</sup> Vodafone, p. 10.

- b) reduce the risk of error that would be inherent if we were to attempt to define precisely, several years in advance, a large number of small areas in which significant deployment could occur; and
  - c) facilitate the management of interference across boundaries.
- 4.34 Our method allows for the fact that the busiest sites are not always correlated with highest population density. We consider our approach is appropriate because:
- a) It allows us to use a nationally recognised database of ‘major towns and cities’ produced for England and Wales by the Office of National Statistics, and to apply broadly the same methodological approach for Scotland and Northern Ireland.
  - b) We have taken the additional step of using data traffic information from 2021 to capture areas of potentially high demand not captured in the initial major towns and cities list. This step has allowed us to capture several towns which, while smaller, have high peak data traffic. Examples include Newbury, Stafford, and Tamworth (included in the Greater Birmingham high density area).
  - c) While we accept that the census data we have used is from 2011 and therefore relatively old, we have not used it to determine the ranking of high density areas from which we have taken the top 80. Rather, we have used two equally weighted metrics of data traffic and base station density. Both metrics are derived from our 2021 Connected Nations data.
- 4.35 In our view, the recent Connected Nations data provide a reasonable basis for identifying the major high density areas, recognising that this exercise entails a degree of approximation. Stakeholders have also not suggested that any specific towns and cities should be designated as high density areas that were not already on our longlist of potential high density areas. We also note that the increases in area and population covered by the high density areas, resulting from the adjustments we have made, reduce the likelihood that we will have missed areas where significant deployments of mmWave will occur.
- 4.36 We have checked our process for identifying high density areas using the most recent Connected Nations data from 2022. This did not result in material changes or identify further potential high density areas that have not previously been considered. In essence, our analysis showed that, while the detailed ranking of most candidate areas differed when using 2021 and 2022 data, 73 of those areas were nevertheless in the top 80 using either of the two datasets. The remaining seven areas, which were ranked towards the bottom of both lists, differed between the two datasets. We consider that no ranking will remain completely stable over time, and that the changes our analysis identified are not material because such relatively small changes are likely to occur again if we were to repeat the analysis using future data. We have decided to make no changes to the list on which we consulted, to provide greater certainty to stakeholders and on the basis that our initial list appears to us reasonably stable.

- 4.37 We also recognise that there may be locations outside the high density areas where localised mmWave deployment may be attractive. However, such cases are more likely to be geographically isolated one-off investments, where spectrum is less likely to be scarce. In addition, we do not consider that the benefits of issuing a wide area licence in this context would outweigh the benefits of providing greater access to the spectrum via local licences and the costs that could arise from revoking existing users' licences.
- 4.38 We have also considered whether repeating our analysis using seasonal data (as suggested by Vodafone) would be appropriate. We consider it unlikely that the seasonality of data would have a material impact on our designation of high density areas. Firstly, it would have little to no impact on the base station density metric that provides 50% of the weighting for our ranking. Secondly, a significant portion of seasonal changes are likely to be similar across the relatively large geographies of the candidate areas. We therefore expect that seasonal variations would have minimal impact on our ranking.
- 4.39 We received no specific evidence from stakeholders that seasonality effects are likely to substantially change the outcome of our analysis. To understand any remaining impact from seasonality, we would have to obtain traffic data from the MNOs across the whole year. We consider that this would be disproportionate given the expected small impact on our analysis.

## Conclusions

- 4.40 Having considered stakeholders' comments and reviewed our initial proposals against the most recent Connection Nations data from 2022, we have decided to designate 68 high density areas using the following method, which is described in more detail in annex 6:

### Identifying towns and cities with potentially high data demands

- a) Identify towns and cities which have either:
  - i) a population of 75,000 or more (using the UK statistics agencies' definitions);<sup>206</sup> or
  - ii) notably high peak hour mobile traffic (using data obtained through Ofcom's Connected Nations report 2021).
- b) Make the boundaries of high density areas less granular by applying an overlay of 1km grid squares over the pre-defined boundaries established by the UK's statistics agencies (as proposed in the May 2022 Consultation).
- c) This gave us a list of 107 potential high density areas.

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<sup>206</sup> Specifically, the Major Towns and Cities Dataset from the ONS for England & Wales, Locality boundaries from the Scottish Government, and Settlement Development Limits from the Northern Ireland Statistics and Research Agency.

## Ranking the areas identified and selecting a cut-off point

- d) Rank the 107 potential high density areas based on the level of mobile traffic they experience at peak hours and the greatest density of mobile base stations within the area
  - i) Use the data from the Connected Nations 2022 report to review both step a)(ii) and step c)
- e) Select the top 80 cities and towns (instead of the top 40, as we initially proposed).

## Adjusting the boundaries of high density areas to be simpler to use and to include major airports

- f) Make the following adjustments to simplify the boundaries:
  - i) in general, draw rectangles around those boundaries and combine overlapping rectangles; and
  - ii) where high density areas are close together,<sup>207</sup> combine them into a single contiguous area;<sup>208</sup>
- g) Adjust the boundaries of Aberdeen, Greater Manchester, Edinburgh, Tyne & Wear, Crawley and Bristol & Bath to include the major airports on the edges of those high density areas;

## Adding three further high density areas to cover Stansted airport, Dover and Folkestone

- h) Add in selected additional high-footfall locations as new high density areas: Stansted airport, Dover and Folkestone (giving 68 discrete high density areas in total);

## Adjusting the boundaries of high density areas to exclude some locations

- i) Adjust the resulting boundaries in some high density areas, in particular Greater London, Greater Manchester, Greater Glasgow, Tyne & Wear and the Leeds & Bradford Area to avoid unintentionally capturing large tracts of land, in order to reduce the likelihood that spectrum will lie fallow;
- j) Ensure the resulting areas are no smaller than 4km in size in each dimension;
- k) Remove RAF Waddington from the Lincoln high density area, and Royal Military Academy Sandhurst from the Farnborough & Aldershot high density area.

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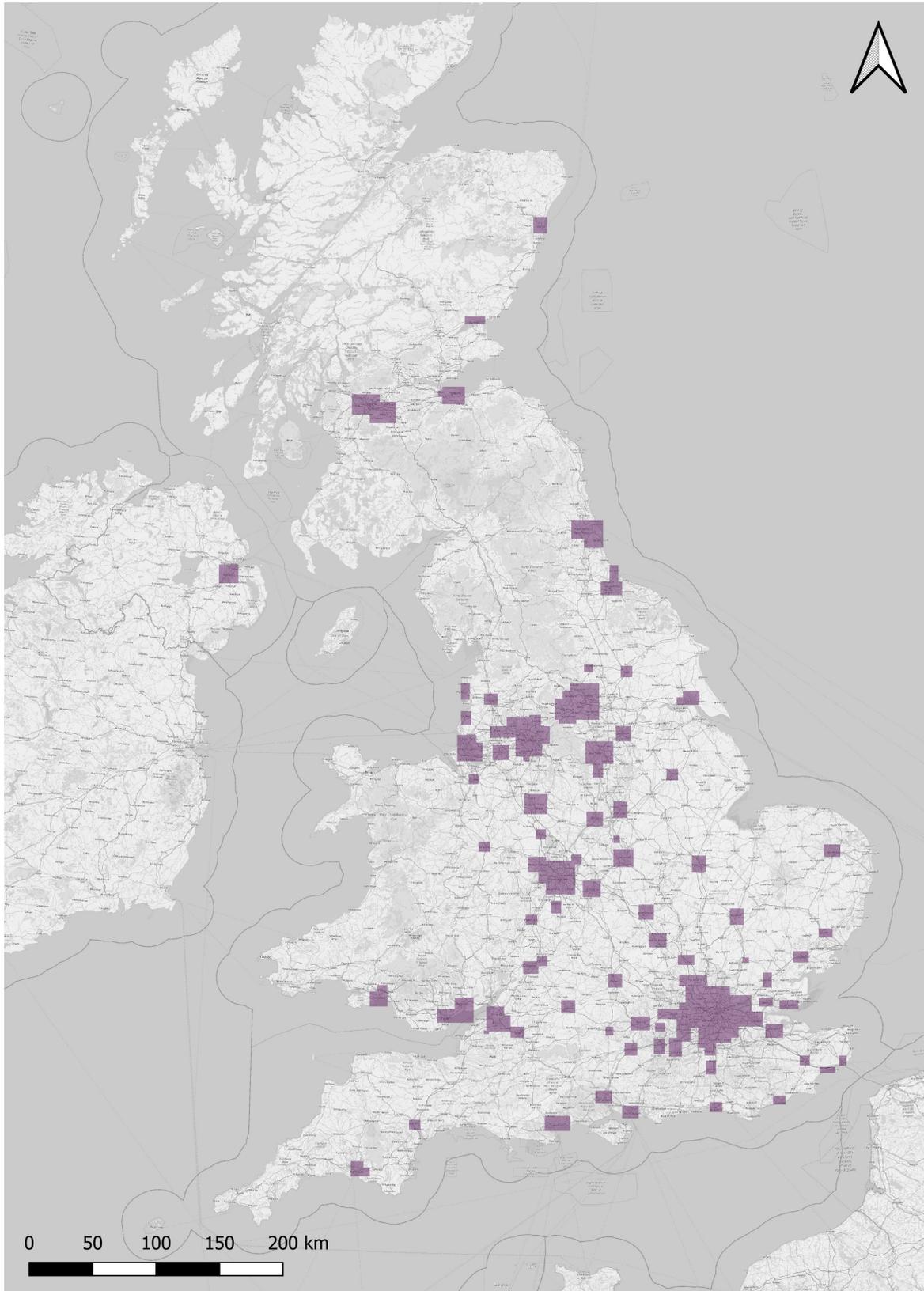
<sup>207</sup> Specifically, where separate areas were within 4-5km of each other, and not separated by any significant terrain features such as ridges or hills.

<sup>208</sup> We have combined together (i) Middlesbrough and Hartlepool, (ii) Sheffield and Chesterfield and (iii) Bristol and Bath.

## Minor practical amendments

- l) Make some minor practical amendments, including: (i) convert the high density area shapefiles so that each one is a single, separate polygon, rather than a collection of many individual 1km squares; (ii) manually edit the Tyne & Wear and Bournemouth high density areas where the extent of the 1km grid has cut off the corners of these areas; (iii) align the Belfast high density area with the British National Grid system used for all other high density areas; (iv) simplify vectors to reduce the number of vertices.
- 4.41 The resulting high density areas, shown below in Figure 4.2, are listed in annex 6 where we have outlined the full details of our methodology. Shapefiles for the high density areas are available on our website.

Figure 4.2: Map showing the final high density areas (purple)



Source: Ofcom, base map [@ OpenStreetMap contributors](#); N.B. Orkney and Shetland not shown as no areas there have been designated as high density areas

## 5. Approach to fixed links in the 26 GHz band

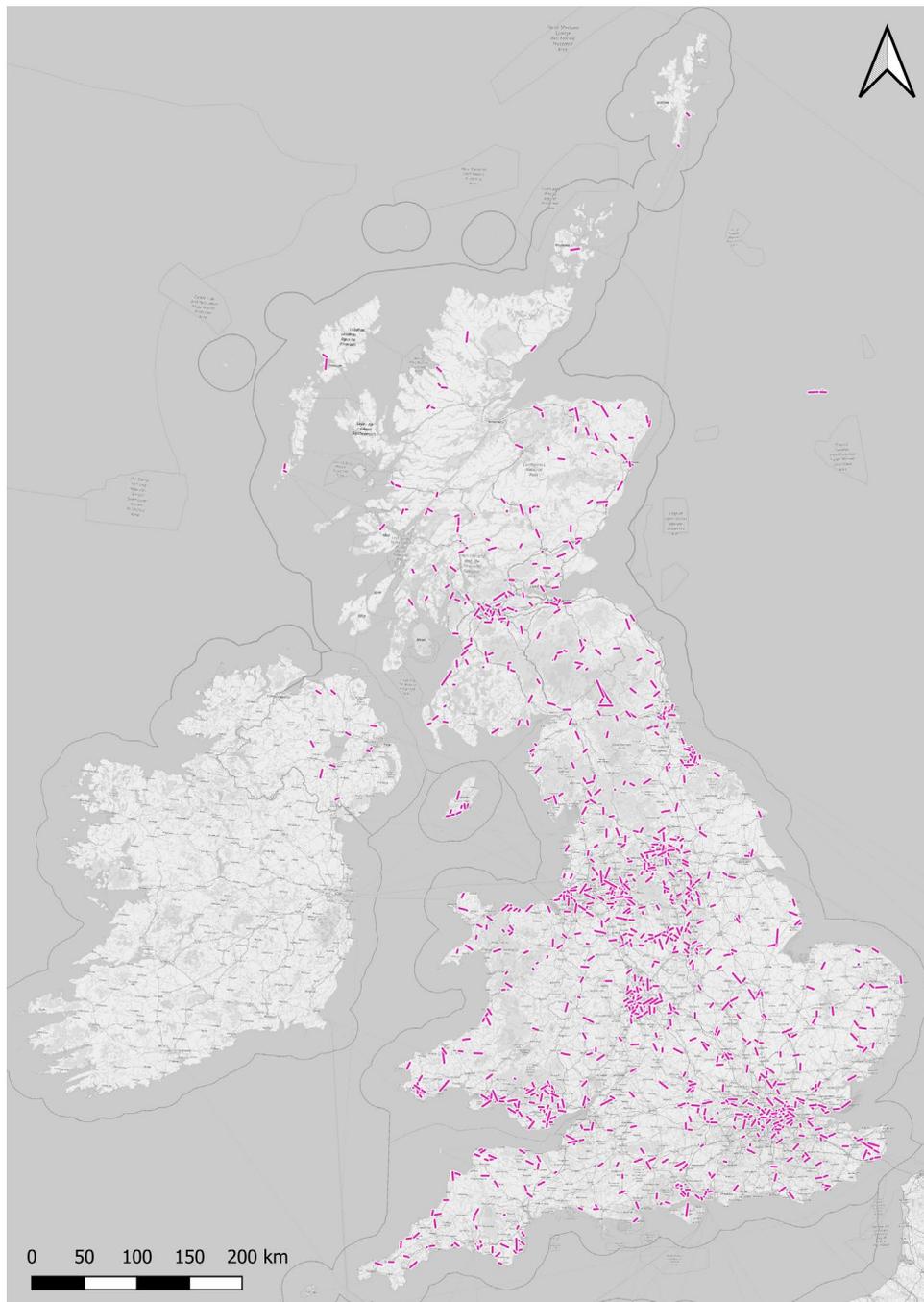
### Summary

- 5.1 The 26 GHz band is currently predominantly used for fixed point-to-point links. Fixed links in this band have access to the frequency range 24.5-26.5 GHz and are licensed on a location-by-location basis, with each licence authorising a single wireless link between two fixed points.
- 5.2 We have decided to start the process for revoking the licences of 26 GHz fixed links in and around high density areas, and to allow any other links in the band to remain.
- 5.3 Having considered the feedback we received from stakeholders on our proposal in the May 2022 Consultation, we remain of the view that our proposed approach is the most likely to meet our objectives for authorising mmWave spectrum, which are derived from our statutory duties. We believe that the costs imposed on existing users are proportionate when considered with respect to the value of new uses to citizens and consumers.
- 5.4 In annex 16 of this document we outline how we propose to identify which links around high density areas to clear from the 26 GHz band. We will consider any comments on our proposals for identifying such links before beginning the statutory process for revoking the relevant licences. Our current proposals would mean that licences authorising use of 691 of the 1,124 fixed links currently using the 26 GHz band would be subject to revocation.

### Current state of the 26 GHz band

- 5.5 The 26 GHz band is currently predominantly used for fixed point-to-point links. Fixed links in this band have access to the frequency range 24.5-26.5 GHz and are licensed on a location-by-location basis, with each licence authorising a single wireless link between two points.
- 5.6 The 26 GHz band is an “Ofcom-managed” band, meaning Ofcom individually licenses and coordinates each fixed link that operates in the band. As of 5 January 2023, there are 1,124 fixed links in the 26 GHz band, across the frequency range 24.5-26.5 GHz. There is no spectrum available used by fixed links between 24.25-24.5 GHz, or from 26.5-27.5 GHz.
- 5.7 The links in this band are located all over the UK, but are more densely concentrated around the country’s largest cities, as shown below. These links are used for a range of applications, including mobile network backhaul, utilities, high frequency trading and as part of the emergency services communications network.

Figure 5.1: Map showing fixed links in the 26 GHz band



Source: Ofcom; base map [@ OpenStreetMap contributors](#)

- 5.8 The 26 GHz fixed links are operated by 38 different licensees, but a small number of licensees operate the majority of the links in the band. Airwave, which provides the current emergency services communications network, holds more than half of the licences issued in the band and the top 9 users account for 90% of all links in the band, as outlined in Table 5.1 below.

**Table 5.1: Top fixed link licensees in the 26 GHz band, by number of links**

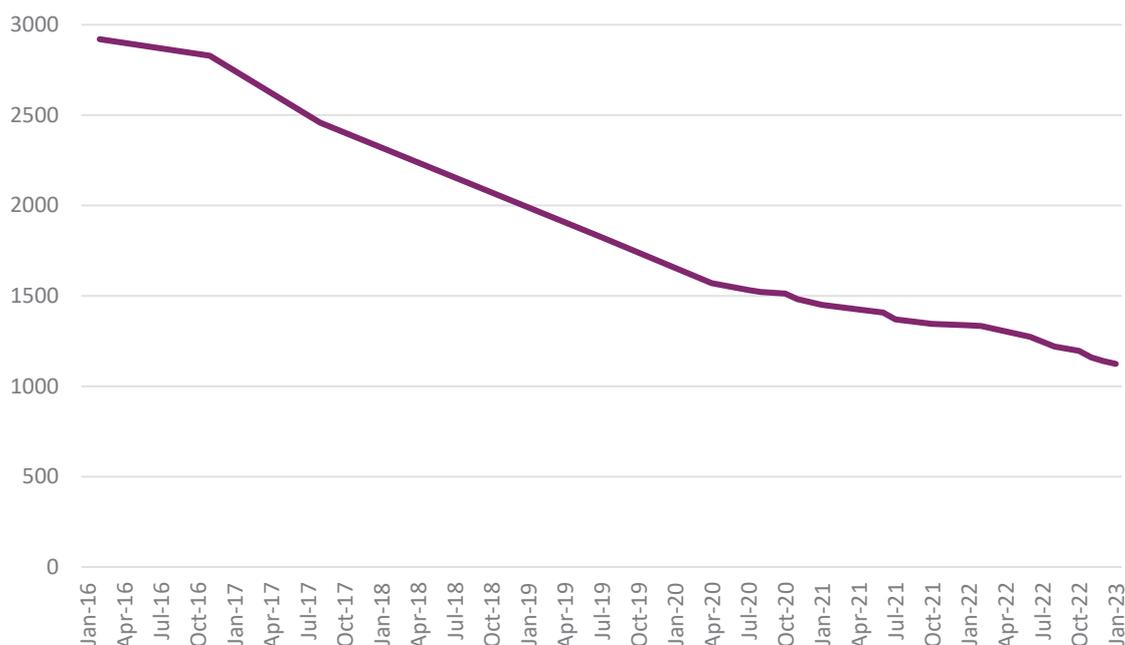
Licensee	Number of links
<b>Airwave</b>	643
<b>MBNL</b>	93
<b>Vodafone</b>	91
<b>National Grid Telecoms*</b>	67
<b>BT</b>	43
<b>M247 UK</b>	42
<b>New Line Networks</b>	14
<b>Aquila Air Traffic Management Services</b>	13
<b>Mckay Brothers International</b>	10

Source: Ofcom; \* National Grid Telecoms was formerly known as WPD Telecoms, which is how this licensee appears in Table 5.1 in the May 2022 Consultation.

5.9 Use of the band has been falling consistently for some time, and since 2016 the number of fixed links in this band has dropped by more than half, as shown in Figure 5.2 below. Since 2017 Ofcom has indicated its intention to open up the 26 GHz band for the use of mobile technologies, including 5G.

5.10 As of 18 July 2022, the band has been closed to new applications for fixed link licences and technical variations; we [announced this closure](#) on 18 January 2022.

**Figure 5.2: Number of fixed links in the 26 GHz band over time, 2016–present**



Source: Ofcom.

## Consultation proposals

- 5.11 In our May 2022 Consultation,<sup>209</sup> we explained that keeping existing fixed links in the 26 GHz band could impose a material constraint on spectrum availability for new uses, as the need to protect fixed links from interference from new users would lead to limited spectrum availability.
- 5.12 We therefore considered how to ensure that new users will be able to access the spectrum they need while allowing the continued operation of fixed links where possible. In particular, we consulted on the following three options:
- a) **Option 1: No Ofcom-led clearance of fixed links; overlay licences for award winners** – award winners would coordinate with existing users to negotiate access to spectrum when needed.
  - b) **Option 2: Clear all fixed links in the 26 GHz band** – this would involve clearing links indiscriminately in both high and low density areas.
  - c) **Option 3: Clear links in and around high density areas only** – this would involve clearing links only in and around the high density areas where Ofcom would award access to spectrum by auction, and allowing the remaining links to stay in the band.
- 5.13 We proposed that option 3 would be most likely to meet our objectives without imposing disproportionate costs on existing users, and explained that we expected other fixed link bands to be able to accommodate the fixed links cleared from the 26 GHz band.

## High-level summary of consultation responses

- 5.14 We received consultation responses from 18 stakeholders discussing this topic.
- 5.15 Twelve stakeholders broadly agreed with our proposed approach (Airspan,<sup>210</sup> BT/EE,<sup>211</sup> H3G,<sup>212</sup> Intracom,<sup>213</sup> Luminet,<sup>214</sup> MLL,<sup>215</sup> Qualcomm,<sup>216</sup> Professor Stephen Temple,<sup>217</sup> UKWISPA,<sup>218</sup> VMO2,<sup>219</sup> Vodafone,<sup>220</sup> and Wildanet).<sup>221</sup>

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<sup>209</sup> [May 2022 Consultation](#), paragraphs 5.11-5.18 and annex 6.

<sup>210</sup> [Airspan response to the May 2022 Consultation](#), pp. 1-2.

<sup>211</sup> [BT/EE response to the May 2022 Consultation](#), p. 4.

<sup>212</sup> [H3G response to the May 2022 Consultation](#), p. 8.

<sup>213</sup> [Intracom Telecom response to the May 2022 Consultation](#), p. 1.

<sup>214</sup> [Luminet response to the May 2022 Consultation](#), p. 2.

<sup>215</sup> [MLL response to the May 2022 Consultation](#), p. 8.

<sup>216</sup> [Qualcomm response to the May 2022 Consultation](#), p. 7.

<sup>217</sup> [Professor Stephen Temple response to the May 2022 Consultation](#), p.4.

<sup>218</sup> [UKWISPA response to the May 2022 Consultation](#), p. 2.

<sup>219</sup> [VMO2 response to the May 2022 Consultation](#), p. 34.

<sup>220</sup> [Vodafone response to the May 2022 Consultation](#), p. 11; While Vodafone did have comments on the flexibility of the five-year revocation notice period, it did agree in principle with the approach we outlined in the consultation.

<sup>221</sup> [Wildanet response to the May 2022 Consultation](#), p. 8.

- 5.16 Six stakeholders objected to our proposed approach or aspects of it (Airwave,<sup>222</sup> Caleycom,<sup>223</sup> the JRC,<sup>224</sup> techUK,<sup>225</sup> Viasat,<sup>226</sup> and WPD Telecoms).<sup>227</sup>

## Keeping fixed links in the 26 GHz band

- 5.17 Airwave<sup>228</sup> and Viasat<sup>229</sup> said that existing fixed links should continue to be accommodated in the 26 GHz band. Airwave specifically proposed that all current links should be condensed down into a 2x200 MHz portion of the band.<sup>230</sup> It suggested this would avoid interference to Airwave's fixed links and avoid the issues associated with forced migration from the band altogether. Viasat suggested there was enough spectrum in the 26 GHz band to accommodate both fixed links and new users.

### Ofcom's response

- 5.18 We do not agree with Airwave and Viasat's suggestion that we should continue to accommodate existing 26 GHz links in the band in and around high density areas. Given the level of protection needed to prevent harmful interference to fixed links, as outlined in the May 2022 Consultation, we do not expect fixed links to be able to coexist with 5G and other new users in the areas where these users are most likely to deploy extensively since they could impose a material constraint on spectrum availability for new uses.
- 5.19 Additionally, we do not agree that Airwave's suggestion to retain fixed links within part of the band would be a suitable approach, as it would result in fragmentation of the band and limit the availability of large, contiguous blocks of spectrum for new users. In reaching this view we have taken into account that this would cost Airwave less than moving to another band, however we do not consider that this outweighs the downside of fragmentation in the 26 GHz band.

## Allowing new fixed links in low density areas

- 5.20 The JRC,<sup>231</sup> WPD Telecoms<sup>232</sup> and techUK<sup>233</sup> suggested that we should continue to allow new fixed links to be deployed in low density areas, as we are proposing to do for satellite earth stations. The JRC and WPD Telecoms both said that in low density areas demand for 5G service deployment is likely to be low and fixed links will be a relevant alternative use, particularly for the energy sector where fixed links function as part of critical national infrastructure. Similarly, techUK argued that since the 26 GHz band will most likely be

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<sup>222</sup> [Airwave response to the May 2022 Consultation](#), p. 5.

<sup>223</sup> [Caleycom response to the May 2022 Consultation](#), p. 2.

<sup>224</sup> [JRC response to the May 2022 Consultation](#), p. 3.

<sup>225</sup> [techUK response to the May 2022 Consultation](#), p. 5.

<sup>226</sup> [Viasat response to the May 2022 Consultation](#), p. 3.

<sup>227</sup> [WPD Telecoms response to the May 2022 Consultation](#), p. 3.

<sup>228</sup> Airwave, pp. 1, 3-6.

<sup>229</sup> Viasat, p. 3.

<sup>230</sup> Specifically, Airwave suggested this be done in the range 25557 to 26005 MHz, paired with 24549 to 24997 MHz.

<sup>231</sup> JRC, pp. 3-4.

<sup>232</sup> WPD Telecoms, pp. 3-4.

<sup>233</sup> techUK, p. 5.

deployed for mobile in high traffic locations, additional fixed link deployments may still be possible in other parts of the UK.

### Ofcom's response

- 5.21 We have been clear for several years now about the band's future as a pioneer mmWave 5G band. We also note that having frequency division duplex ("FDD") technologies such as fixed point-to-point links and time division duplex ("TDD") technologies such as 5G sharing the same spectrum is generally not an efficient use of spectrum because the two types of systems would need to be far away from each other to avoid interference. We also note that the number of fixed links in this band has been in steady decline since at least 2016. For these reasons, [we closed the band to all new users effective 18 July 2022](#), as announced in January 2022.
- 5.22 As we have made clear in section 3, our priority in the authorisation of this band is to make spectrum available for new users, while minimising disruption to existing users wherever possible. We do not consider the example of satellite earth stations to be relevant to whether new fixed links should be allowed in the band. The band is used for a small number of satellite earth stations which communicate with satellites which cannot operate in other bands. In contrast, there are other Ofcom-managed fixed link bands (in addition to block-assigned bands) where users can deploy without causing or receiving interference with mobile.

### Clearing fixed links from all potential high density areas

- 5.23 VMO2 suggested that it was not sufficient for Ofcom to only revoke the licences of fixed links in and around the top 40 high density areas, as we had proposed. Instead, it argued that that mobile demand will evolve over time, justifying a longer list of high density areas,<sup>234</sup> and as a result it would be better for Ofcom to take action now to clear fixed links from in and around all of the 107 potential high density areas we identified in our May 2022 Consultation. It requested that Ofcom regularly review the status of the remaining fixed link licences, so that it is ready to issue further revocation notices well in advance of mobile industry need.<sup>235</sup>

### Ofcom's response

- 5.24 We maintain that the most appropriate approach in this situation is to clear fixed links only in and around the final high density areas we designate. In the rest of this section, we explain why we think this is the best approach, providing the best balance between meeting our objectives for authorising mmWave spectrum for new users and not causing undue disruption to incumbent users.
- 5.25 In response to VMO2's request to keep the status of the remaining fixed links under review, we note that the licences authorising fixed links in the band contain a clause to

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<sup>234</sup> We address VMO2's comments on the number of high density areas in section 4.

<sup>235</sup> VMO2, p. 18.

allow for revocation for spectrum management reasons. Should there be a significant change in demand in future, Ofcom will consider any appropriate measures that could be required, including revocation.

## Allowing Airwave to keep its links, and to make changes

5.26 Airwave<sup>236</sup> suggested that its links should be exempt from any changes due to the nature of the service it operates and argued that the proposal to require fixed services to vacate the band could result in interruptions to a vital service. It also argued that the introduction of new users into the band would likely result in degradation of service for incumbent users due to interference. Airwave also argued that Ofcom should extend the deadline of 18 July 2022 for new licence applications and further technical licence variations pending the outcome of the May 2022 Consultation. It highlighted that historically it has had to adjust 2-5% of its links per year due to changes in the environment (such as new construction blocking line of sight). In addition, Airwave said that [CONFIDENTIAL ⌘], migration of its links out of the 26 GHz band within 12 months “represents a significant risk to public safety”.<sup>237</sup> It noted that global supply chain challenges would also make migration of links to alternative bands difficult [CONFIDENTIAL ⌘].

### Ofcom’s response

5.27 We do not think that it would be appropriate to exempt Airwave from any changes to links in this band. While we understand that the current emergency services network (“ESN”) which Airwave supports is an important service, other Ofcom-managed fixed links bands are available to all current 26 GHz licensees, as are fixed wired solutions such as leased lines, which are used by many networks. Therefore, Airwave could continue to provide its services using other bands or fixed wired solutions. We also note that the revocation of Airwave’s fixed link licences with a five-year notice period should not affect its ability to provide the emergency services network for the remainder of its existing contract with the Home Office, which is due to expire in December 2026.

5.28 We have considered Airwave’s suggestion that we should delay closure of the 26 GHz band. However, as explained in paragraph 5.21 above, we have been clear for several years that the future of the 26 GHz band would be for mmWave 5G and other new wireless services, in line with European and international harmonisation decisions relating to the band. We set out in paragraph 5.21 above why we do not consider that fixed links, which use FDD technology, can efficiently share spectrum with mobile using TDD technology. In light of this, we remain of the view that it is appropriate to limit the entry of new links in the band.

5.29 We have also considered Airwave’s point that [CONFIDENTIAL ⌘]. However, as explained above, we consider that if this were the case, Airwave should be able to provide its service

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<sup>236</sup> Airwave, p. 2.

<sup>237</sup> [CONFIDENTIAL ⌘].

using alternative bands, or fixed wired solutions, and it will have had five years in which to put in place alternative arrangements.

## Longer notice periods and requirement for leasing

5.30 Airwave<sup>238</sup> and Vodafone<sup>239</sup> suggested that Ofcom should be more flexible with revocation. Airwave suggested 8-10 years' notice to clear the busier parts of the band but a shorter 3-4 years' notice to clear less heavily used channels. Vodafone suggested that after the five-year revocation notice period award winners should be required to lease the spectrum back to incumbent fixed link operators and provide 6-9 months' notice when they know where they want to deploy.

### Ofcom's response

5.31 Under the terms set out in the fixed link licences, Ofcom is required to give licensees five years' notice if we revoke these licences for spectrum management reasons. We do not agree with Airwave's suggestion that we should give a longer revocation notice period for the most used parts of the band (i.e., longer than five years), because it would mean a longer period of reduced spectrum availability for new users.

5.32 Regarding Vodafone's suggestion, we do not propose to allow leasing in this band, as explained in detail in section 11 (paragraphs 11.11-11.19). However, there is a route for licensees to agree access to the auctioned spectrum on a commercial basis with the new licensee, facilitated by the Local Access licensing framework. We do not consider that leasing would allow any benefits beyond what could be enabled through the Local Access framework.

## Grants for users having their licences revoked

5.33 BT/EE<sup>240</sup> and techUK<sup>241</sup> suggested that Ofcom should consider grants for users who have their fixed link licences revoked, to facilitate early migration of existing links and achieve the most efficient use of spectrum. Similarly, the JRC suggested we could set a budget and then compensate licensees for the actual costs they incur.<sup>242</sup>

### Ofcom's response

5.34 In the past, we have used our power to make grants under s1(5) of the [Wireless Telegraphy Act 2006](#) (the "**WT Act 2006**"), which specifically requires HM Treasury's approval, sparingly and in very specific circumstances. For example, when funding was provided for the clearance of PMSE users as part of the 800 MHz clearance programme, we noted that "funding is only likely to be appropriate where we have not provided adequate notice to

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<sup>238</sup> Airwave, p. 2.

<sup>239</sup> Vodafone, p. 12.

<sup>240</sup> BT/EE, pp. 3 and 19-21.

<sup>241</sup> techUK, p. 5.

<sup>242</sup> JRC, p. 5.

cover a licensee's reasonable expectation of continuous access to particular spectrum".<sup>243</sup> We do not consider that the circumstances of the 26 GHz band make compensation appropriate in this case, as we will give licensees reasonable periods of notice in accordance with the terms and conditions of their licences, and we have been indicating our intention to make the 26 GHz band available for mobile technology, including 5G, since February 2017.

- 5.35 Similarly, we did not make any grants for the clearance of fixed links from the 3.6-3.8 GHz band, and we do not consider that compensation for the clearance of users from the 40 GHz band would be appropriate. If a new user particularly values access to cleared spectrum in a given location, early migration might be achieved by means of commercial agreements between new and existing users.

## Costs of clearance

- 5.36 The JRC<sup>244</sup> and a confidential respondent [CONFIDENTIAL ⚡]<sup>245</sup> suggested that Ofcom's analysis of the cost of migrating fixed links into an alternative band was applicable to large organisations which could take advantage of economies of scale, such as MNOs, but did not accurately reflect the costs incurred by smaller operators who do not have the same benefits.

### Ofcom's response

- 5.37 We have revised our estimates of the costs of clearing fixed links in light of stakeholders' feedback (see annex 7). We consider that our revised estimates provide a fair assessment of the incremental costs likely to be incurred by fixed link operators as a result of a requirement to clear links from the 26 GHz band, when compared to operators' normal costs in replacing equipment at the end of its usual lifespan.
- 5.38 We discuss in more detail the comments we received regarding the cost of clearing fixed links, considering our proposals for both 26 GHz and 40 GHz, in annex 7.

## Our decision

- 5.39 In conclusion, having considered consultation responses, we have decided to proceed with option 3, which is to revoke the licences of all links in and around high density areas while allowing the remaining links in low density areas to remain in the band. We are now consulting on how we will identify which links which are close to high density areas will likely be subject to interference from mobile services, such that we would start the process to revoke them. Our current proposals would mean that licences authorising use of 691 of the 1,124 links currently using the 26 GHz band would be subject to revocation.

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<sup>243</sup> Ofcom's Statement "[Clearing the 800 MHz band: Funding for moving programme-making and special events from channel 69](#)", published 5 August 2010, paragraph 4.13.

<sup>244</sup> JRC, p. 5.

<sup>245</sup> [CONFIDENTIAL ⚡]

- 5.40 As set out in annex 5 (paragraph A5.19), Ofcom has a statutory power to revoke spectrum licences, where this is objectively justifiable. We also have a general duty not to discriminate unduly between operators, and to ensure that our interventions are proportionate, consistent and targeted only at cases in which action is needed.
- 5.41 The factors we have taken into account in reaching our decision are:
- a) our objective of securing optimal use of spectrum, which encompasses our objectives of:
    - i) encouraging investment and innovation in services; and
    - ii) ensuring timely availability of spectrum;
    - iii) our objective of promoting competition, which encompasses our objective of sustaining strong competition in mobile markets;
  - b) achieving an efficient allocation of spectrum,
  - c) our objective of securing benefits for consumers and citizens; and
  - d) the impact on existing users, and the need to meet our objectives for mmWave without imposing disproportionate costs on existing users.
- 5.42 Our final assessment of the options against this analytical framework, which is set out below, has focused primarily on securing optimal use of spectrum (factor a) and the impact on existing users (factor d). This is because, as set out in the May 2022 Consultation:<sup>246</sup>
- a) while we consider options 2 and 3 may promote competition, we do not expect any of the options would have a material detrimental impact on competition because under all options operators would be able to acquire licences (factor b); and
  - b) whichever option is most likely to secure optimal use of mmWave spectrum is also likely to secure the greatest benefits to people and businesses by enabling the delivery of new wireless services using mmWave spectrum (factor c).

## Securing optimal use of spectrum

- 5.43 In this sub-section, as in the May 2022 Consultation, we set out our assessment of each option against our statutory duty to secure optimal use of spectrum. This assessment focuses primarily on which option is most likely to achieve an efficient allocation of spectrum. This is because the option that delivers the most efficient allocation should, in this case, maximise opportunities for investment and innovation in services.

### Achieving an efficient allocation

- 5.44 Achieving an efficient allocation of spectrum is a key element of securing optimal use of spectrum. In an efficient allocation of spectrum, the spectrum is:

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<sup>246</sup> May 2022 Consultation, paragraphs 5.58-5.62.

- a) authorised in a way that allows for efficient use of the band, i.e. which enables its effective use by the service that will provide the most benefits (or value) for society;
- b) allocated to operators that will use the spectrum to provide the most benefits (or value) to society (we refer to these as 'efficient users' throughout this section).

5.45 We consider that an efficient allocation of the 26 GHz band would make this spectrum available for mobile use in high density areas, but would allow fixed links to remain where they may be a relevant alternative use case, and where they are unlikely to receive interference from new users. As explained below, option 3 is the option most likely to achieve this outcome.

#### **Option 1: No Ofcom-led clearance of fixed links; overlay licences for award winners**

5.46 Under this option, new users would drive the clearance of existing fixed links, rather than Ofcom. This market-led approach would mean that fixed links should only be cleared if new users' valuations of the spectrum are higher than those for existing fixed links, incentivising efficient use of the band. As a result, this option offers the lowest risk of overclearance of the band.

5.47 However, this approach is the most likely of all three options to lead to an inefficient outcome in the form of under-clearance of the band. This could occur if new users, especially smaller ones, have difficulty in setting up and concluding any necessary negotiations with existing users. H3G agreed with this view in its consultation response. Inefficiency could also arise if existing fixed links operators were unwilling to trade with rivals, or attempted to hold onto existing links to limit competitors' access to spectrum.

#### **Option 2: Clear all links**

5.48 Clearing all links from the band to make as much spectrum as possible available for new users would lead to the most efficient outcome if we assumed that new users were likely to deploy extensively using this band all over the country.

5.49 However, given that this is not what we expect to see from new users of mmWave spectrum bands, this option poses a significant risk of inefficient allocation of spectrum due to over-clearance.

#### **Option 3: Clear links in and around high density areas only**

5.50 Clearing links in and around high density areas would make the entire band available, after the five-year revocation notice period ends, in the areas where we anticipate the most deployments by new users (i.e. the high density areas). While links in low density areas would remain, we would not expect this to materially reduce access to spectrum for new users. This is because we expect new mmWave deployments to be sparse in low density areas.

5.51 This would help to ensure efficient use of spectrum by allowing both fixed links and new users to coexist in the band through spectrum sharing, which is in line with Ofcom's vision

for future spectrum management. This option reduces the risk of over-clearance of fixed links compared to option 2.

## Supporting innovation and investment

- 5.52 We consider that higher levels of investment in deploying new uses of mmWave spectrum will likely lead to greater utilisation of the spectrum, and therefore deliver more value from the spectrum to society through the provision of new services. This spectrum has the strong potential to support the development of new and innovative services, as it offers operators the opportunity to acquire large contiguous blocks of spectrum which can deliver services requiring high capacity and speeds.
- 5.53 Two key aspects of supporting investment and innovation in new services in the 26 GHz band are likely to be:
- a) allowing users to access large blocks of contiguous spectrum, that is not fragmented by the need to protect existing users; and
  - b) enabling both larger and smaller users to access spectrum, on both a wide-area basis and a localised basis, depending on use case.

### Option 1: No Ofcom-led clearance of fixed links; overlay licences for award winners

- 5.54 As discussed in the May 2022 Consultation, while our analysis indicates spectrum availability for low power deployments using 200 MHz channels is good, it is unclear whether new users will be able to access large, contiguous blocks of unencumbered spectrum in the areas where this is most required. Our analysis shows that fixed links reduce the availability of larger channels for new deployments, e.g. 400 MHz and 800 MHz. This is partly due to the duplex nature of fixed links in this band, which means the spectrum will be fragmented by existing users in areas where fixed links are densely deployed. For medium power deployments, this problem will be especially pronounced.<sup>247</sup>
- 5.55 As outlined in section 2 and section 7, large, contiguous blocks of spectrum are likely to be valuable to new users in this band to support innovation. Therefore, compared to the alternative options, option 1 is less likely to support innovation and investment.
- 5.56 Additionally, with fixed links remaining in the band in all areas, all new deployments, including those from holders of block assigned spectrum licences, would be subject to coordination to ensure fixed links were not subjected to harmful interference. We consider that this requirement could increase complexity and costs for new users compared to other options we have considered, in particular for holders of award licences, which would have to coordinate new deployments in the long run under this option. This could be particularly burdensome for any prospective bidders users who are unaccustomed to coordinating deployments with other users.

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<sup>247</sup> May 2022 Consultation, paragraphs 5.11–5.18 and annex A6. We consider that the analysis set out in the May 2022 Consultation remains valid as the number of fixed links operating in the 26 GHz band has not reduced by such an extent that it would change our earlier analysis.

- 5.57 This view was supported by Airspan<sup>248</sup> and Luminet<sup>249</sup> in their consultation responses, which supported the removal of fixed links from the band in the interest of simplifying the environment for new users to deploy in, and enabling the allocation of large, contiguous blocks of cleared spectrum.

### Option 2: Clear all links

- 5.58 Clearing the band of all links would provide the most certainty for all new users around access to spectrum of any option under consideration. New users would know that at the end of the five-year revocation notice period the entire band would be available in all areas (subject to coordination with a small number of other existing users in specific locations, such as the satellite earth station at Harwell).
- 5.59 Additionally, after the five-year notice period has run its course, no new user would need to coordinate with fixed links anywhere in the UK. This would apply to both award licensees, and Shared Access licensees in both high and low density areas. However, some coordination would still be required to protect other existing users, and to prevent interference between new users.

### Option 3: Clear links in and around high density areas only

- 5.60 We expect that clearing links only in and around high density areas would provide the same level of certainty of access to spectrum for block assigned licensees in high density areas as clearing all fixed links would. This option would therefore have the same benefits as option 2 in these areas.
- 5.61 In respect of supporting investment and encouraging innovation, the main difference between this option and option 2 would be that coordination between new users and existing fixed links would still be required in low density areas on an ongoing basis. However, we would not expect this to create any additional burden on new users in low density areas, since Shared Access licence applications would, in any case, still be subject to coordination with other new users, as well as other existing users in the 26 GHz band.
- 5.62 Additionally, we consider that the presence of fixed links in low density areas should not limit access to large blocks of spectrum for new users in these areas. This is because fixed links are more sparsely deployed in low density areas, and so a large amount of spectrum would potentially be available even if fixed links were to remain in these areas.

## Timely availability of spectrum

- 5.63 We consider it important to make spectrum available for new services, even if sometimes the spectrum is not immediately useable for providing such services. We therefore believe that mmWave spectrum should be made available in a timely manner for new uses. We are

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<sup>248</sup> Airspan, p. 4.

<sup>249</sup> Luminet, p. 8.

aiming to make mmWave spectrum available in 2024, which is around when we understand mmWave deployments for new uses are likely to begin.

- 5.64 There would therefore be no material difference in the timescales that operators would be able to acquire licences in the 26 GHz band between any of the options.
- 5.65 However, there would be a difference between options in how soon licensees would be guaranteed access to clear spectrum, i.e., spectrum that is not encumbered with fixed links. As noted above, the presence of fixed links could impose a material constraint on spectrum availability for new uses, which could in turn constrain deployments. We explore this in more detail below.

### **Option 1: No Ofcom-led clearance of fixed links; overlay licences for award winners**

- 5.66 Relying on a market-led approach to clear fixed links from the band would risk the timely availability of clear spectrum. While it is possible that existing users who do not value their access to spectrum as much as new users might be cleared in a timely manner, there is no guarantee of this. This approach would provide no firm end date by which new users in high density areas would be able to expect to have access to clear spectrum.
- 5.67 It is possible that negotiations between new and existing users could result in some fixed links vacating the band in advance of the five-year timeline an Ofcom-led clearance programme would guarantee. However, both options 2 and 3 would also allow for new users to negotiate earlier vacation of the band by fixed links.

### **Option 2: Clear all links**

- 5.68 Clearing all links from the band would ensure that as much clear spectrum as possible becomes available following the five-year revocation notice period, in both high and low density areas of the UK. This would allow users in both high and low density areas access to as much clear spectrum as possible.

### **Option 3: Clear links in and around high density areas only**

- 5.69 Clearing links in and around high density areas would ensure that the maximum amount of clear spectrum possible is made available in high density areas following the five-year notice period. Users in some low density areas could also benefit from more spectrum being made available in a timely manner, as links around high density areas would also be cleared to manage the risk of harmful interference from winners of award licences.

## **Promoting competition**

- 5.70 We consider that options 2 and 3 could be more likely than option 1 to promote competition by enabling more operators to access unencumbered spectrum. Option 1 would only guarantee the top 1 GHz and bottom 250 MHz of the band being unencumbered by fixed links. This could lead to a situation where only some holders of award licences have access to clear spectrum, whereas others only have access to

spectrum which is encumbered with fixed links. Options 2 and 3 would both avoid this risk in the longer term (i.e. after the five-year revocation notice period).

- 5.71 Additionally, we consider that it is possible that option 1 could risk existing fixed link licensees, some of which are operators which may bid in an auction for licences covering the high density areas in this band, strategically maintaining their existing links with the intention of limiting access to spectrum for their competitors. This risk would not apply under options 2 and 3.
- 5.72 However, while we consider options 2 and 3 may promote competition, we do not expect any of the options would have a material detrimental impact on competition. This is because, under all options operators would still be able to acquire licences as proposed in section 3.

## Securing benefits for consumers and citizens

- 5.73 Our view is that whichever option is most likely to secure optimal use of mmWave spectrum is also likely to secure the greatest benefits to people and businesses by enabling the delivery of new wireless services using mmWave spectrum.
- 5.74 Therefore, we consider that options 2 and 3 are more likely than option 1 to secure benefits for citizens and consumers, as these options would better enable the introduction of new services in the band, particularly in high density areas where we expect the greatest volume of mmWave deployments. Option 3 has the additional benefit of allowing some fixed links to remain in the band, to support the continued provision of those services in locations where we consider it is less likely that new users will deploy extensively using mmWave spectrum.

## Impact on existing spectrum users

### Cost of moving fixed links

- 5.75 We have modelled what we expect to be the likely costs imposed on current fixed link licensees of having to migrate their current links into another fixed link band due to having their licences revoked.
- 5.76 As noted above, we consider that there is sufficient spectrum available in other Ofcom managed fixed link bands to accommodate fixed links migrating from the 26 GHz band. Based on preliminary analysis, we expect that a combination of the 18, 23 and 38 GHz bands would be the most likely destinations for migrating 26 GHz fixed links. We note that the majority of the current 26 GHz licensees have fixed link licences in other Ofcom-managed bands. Additionally, several licensees, including Arqiva, BT, EE, the JRC, MBNL and Vodafone, also have access to block-assigned spectrum in the 10, 28 and 32 GHz bands, which could be used for fixed links.
- 5.77 In the rest of this sub-section, we give our baseline estimate for the likely costs for fixed link operators associated with each of the three options we have considered. Please note

that the cost per link does not alter based on these three options, only the overall total cost across all licensees. Full details of our cost modelling, and comments that we received from stakeholders regarding this, are set out in annex 7.

**Option 1: No Ofcom-led clearance of fixed links; overlay licences for award winners**

5.78 This option would present the lowest cost to existing users. With existing fixed links either continuing in the band, leaving the band gradually over time of their own accord, or being paid to leave the band by new users, the cost to incumbent users would be close to zero.

**Option 2: Clear all links**

5.79 Clearing all links in the band would incur the highest total costs across all fixed link users. We estimate that this option would impose a total cost of £10.3m on existing fixed link users in the 26 GHz band.

**Option 3: Clear links in and around high density areas only**

5.80 This approach would incur lower costs for incumbent users than clearing all links, as only fixed links in and around high density areas would be required to leave the band. Based on the high density areas we have identified in section 4, we estimate that this approach would impose a total cost of around £7.6m on fixed link users in the band. Table 5.2 below outlines our estimates for the costs of clearance of the band under the high density area definition we have decided to adopt, as well as for clearing all links, as outlined in option 2 above.

**Table 5.2: Cost of clearing fixed links from the 26 GHz band under option 2 and option 3**

	Number of links cleared	Cost (£m)
<b>Option 2</b>	1,124	10.3
<b>Option 3</b>	835 <sup>250</sup>	7.6

Source: Ofcom.

5.81 We acknowledge that our estimates of the costs associated with migrating links out of the 26 GHz band have increased relative to the estimates we set out in the May 2022 Consultation. However, we remain of the view that the estimated costs of clearing fixed links in the 26 GHz band are proportionate in light of the potential benefits of making the band available for mobile use.

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<sup>250</sup> This number is higher than the 691 links we currently estimate would need to be cleared, based on our proposed coordination approach outlined in annex 16. As explained in annex 7, for the purposes of modelling the costs of clearance, we have assumed that all fixed links in the 68 high density areas we have identified, as well as all fixed links with at least one end within 25km of any of these areas, would need to be cleared. This figure is therefore a conservative estimate of the potential cost of clearing fixed links.

## Additional considerations

- 5.82 As noted in the May 2022 Consultation,<sup>251</sup> option 3 would have a differential effect on operators in low and high density areas, as we would revoke only the fixed link licences in and around high density areas. However, we do not consider this differential effect would amount to undue discrimination against any operator. This is a consequence of operators' different factual situations (as regards, for instance, to the geographic distribution of their deployments in the band) and not of any unequal treatment by Ofcom.
- 5.83 We also remain of the view that no fixed link licensees in the 26 GHz band enjoy any legitimate expectation that we would not revoke their licence. In this regard, we note that the existing 26 GHz licences contain a clear clause enabling Ofcom to revoke the licences, and this clause has remained part of these licences since they were issued. Furthermore, since 2017 Ofcom has consistently stated that the future of the 26 GHz band would involve the introduction of new wireless services, including 5G.

## Our proposal for identifying affected fixed links

- 5.84 Two categories of fixed links will be affected by revocation:
- a) links overlapping high density areas themselves; and
  - b) links outside high density areas which could still receive interference from new users in the high density areas.
- 5.85 In order to identify which links fall within category (b), we need to determine which links that are *outside* of high density areas would be likely to receive interference from new mobile services operating *within* high density areas. Our decision on this depends on our coexistence analysis, which is set out in annex 16. In this annex, we set out the analysis we have done in order to reach a view on the level of interference that new services will cause to fixed links. We welcome stakeholders' comments on this analysis, and will take into account stakeholders' views on our analysis before reaching a final view on which links fall within category (b) above. Once we have identified all the links in each category above, we will begin the statutory revocation process for all links in categories (a) and (b).

## Conclusion and next steps

- 5.86 In conclusion, taking into account all the matters set out above, we have decided to start the process for revoking existing licences for fixed links in the 26 GHz band in and around the high density areas we have identified, giving licensees a five-year notice period.
- 5.87 We are now consulting on the method for identifying which fixed links around high density areas will need to be cleared from the 26 GHz band, on the basis that they are likely to be subject to interference from new users.

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<sup>251</sup> May 2022 Consultation, paragraph 5.69.

- 5.88 We currently aim to publish our decision on this method in our next policy statement.
- 5.89 Following that statement, we will start the statutory revocation process by notifying the existing licensees of Ofcom's proposal to revoke their fixed link licences, giving a five-year notice period.<sup>252</sup> Licensees will have a period of at least 30 days within which to make representations on the proposed revocation of their licences. We will then take into account any representations and write to affected licensees to confirm our final decision.<sup>253</sup> If we decide to revoke their licences as proposed in our initial notification, the five-year notice period will begin when we notify the affected licensees of our final decision.

## Consultation question

**Question 2:** Do you agree with the method that we have outlined in annex 16 for identifying which licences authorising the use of fixed links around high density areas will be subject to revocation on the basis that the authorised links would be likely to suffer interference from new users in the high density areas? If not, please give reasons.

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<sup>252</sup> WT Act 2006, Sch. 1, para 7.

<sup>253</sup> We will make our final decision within one month beginning with the end of the period for the making of representations, and notify our final decision to the relevant licensees within one week of making such decision (WT Act 2006, Sch. 1, para 7).

## 6. Approach to incumbent users in the 26 GHz band other than fixed links

### Summary

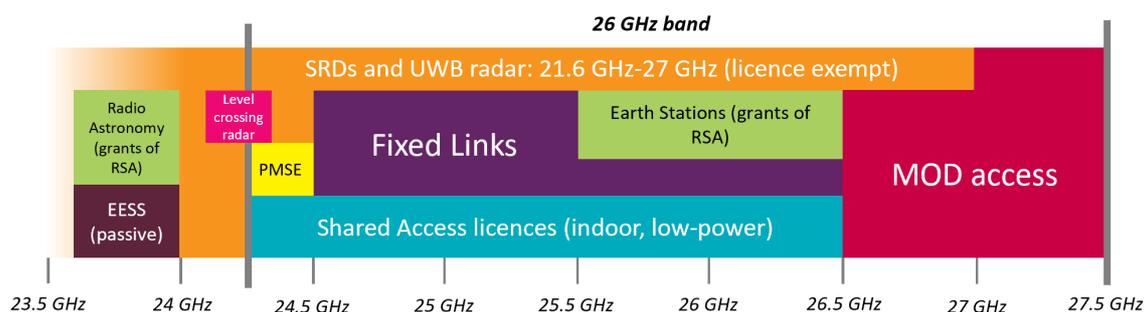
- 6.1 In our May 2022 Consultation, we outlined that a range of incumbent users other than fixed links currently operate in the 26 GHz band, some authorised by specific licence products and others on a licence exempt basis. Since we proposed to make the band available for new uses, we considered whether these existing users would cause interference to, or suffer interference from, new users.
- 6.2 In summary, we proposed that most existing uses would be able to remain in the band, as we believe managing coexistence between new services and existing uses (other than fixed links, as set out in section 5) would be straightforward.
- 6.3 Having considered comments from stakeholders, we have decided to adopt the following measures (where applicable) to manage coexistence between existing users of the 26 GHz band and new uses:
- a) **Satellite earth stations:** we will protect the one existing receive-only satellite earth station which is currently using the band through coordination; we will continue to accept future applications for grants of Recognised Spectrum Access for satellite earth stations in the band, but only in low density areas.
  - b) **Level crossing radar, UWB radar, tank level probing radar and automotive shortrange radar:** we do not expect that these users will cause interference to, or suffer interference from, new users of the band. Therefore, we will continue to authorise these users in the band through licence exemption, and we do not expect any form of coordination to be necessary.
  - c) **PMSE:** there are no current PMSE licensees in the 26 GHz band and no licences have been issued in the band since 2014. We are therefore closing the 26 GHz band to future PMSE licences with effect from 13 March 2028 (i.e. giving five years' notice as of the publication of this statement).
  - d) **Airport security scanners:** we will write to airports which may be using these devices to notify them of potential coexistence challenges if a 26 GHz 5G base station were to be placed nearby.
  - e) **MOD:** we will safeguard 200 MHz of 26 GHz spectrum on a nationwide basis for Defence use. Where MOD needs access to additional spectrum, we will manage future access to the 26 GHz band by the MOD by coordinating their uses on a first come, first served basis.
  - f) **Users in the adjacent 24 GHz band:** our [July 2022 statement](#) on protecting users in the adjacent 23.6–24 GHz band confirmed two additional measures to protect passive

sensors used as part of the Earth Exploration Satellite Service (EESS) and radio telescopes used as part of the Radio Astronomy Service (RAS). These measures are:

- i) To protect EEES, to limit the number (within any 300km<sup>2</sup> area) of outdoor 26 GHz base stations which can be deployed in the lowest 800 MHz of the 26 GHz band (i.e., 24.25–25.05 GHz); and
  - ii) To protect RAS, to impose exclusion zones around the six radio astronomy sites that comprise the e-MERLIN array<sup>254</sup> in which the deployment of 26 GHz base stations would not be permitted.
- g) More information on how we propose to implement these restrictions is set out in section 14.

6.4 In the rest of this section, we outline our consultation proposals, any feedback we received on these proposals from stakeholders, and our decisions and next steps. In summary respondents provided comments only in relation to (i) our proposed approach to satellite earth stations and (ii) the MOD safeguard. Having considered these comments, we have decided to implement our initial proposals and to extend the proposed MOD safeguard so that it will apply across the UK instead of being limited to certain MOD sites (see section 3).

**Figure 6.1: 26 GHz band plan, showing current authorised users**



## Satellite earth stations

### Consultation proposals

6.5 In the May 2022 Consultation, we proposed to protect the one existing receive-only satellite earth station currently operating in this band under a grant of recognised spectrum access for receive-only earth stations (a “grant of RSA”), located at the Harwell science campus in Oxfordshire, through coordination. Due to the relatively rural location of the Harwell earth station, we do not expect that the protections needed to maintain it would impose a material constraint on the ability of operators to deploy new equipment in the 26 GHz band.

<sup>254</sup> These are the radioastronomy sites at Jodrell Bank, Cambridge, Pickmere, Knockin, Defford and Darnhall.

- 6.6 We also proposed that we would continue to accept future applications for grants of RSA for satellite earth stations in the band, but only in low density areas, and subject to coordination. We said we would not accept any future applications for grants of RSA for new earth stations sites in the 26 GHz band if they fall inside our proposed high density areas. Additionally, we said that we would not issue grants where our coordination calculations showed that the earth station would receive interference from existing users (as is currently the case, where the band is shared by fixed links and satellite earth stations on a first come, first served basis).

## Consultation responses and Ofcom's response

- 6.7 In summary, a number of respondents (Airspan,<sup>255</sup> BT/EE,<sup>256</sup> Inacom Telecom,<sup>257</sup> Qualcomm,<sup>258</sup> UKWISPA,<sup>259</sup> VMO2<sup>260</sup> and Vodafone<sup>261</sup>) agreed with our proposed approach to satellite earth stations in the 26 GHz band. As discussed below, other respondents had concerns about our proposals or suggestions to refine them.

### Limit on satellite earth stations in high density areas

- 6.8 The GSOA,<sup>262</sup> SpaceX,<sup>263</sup> techUK<sup>264</sup> and Wildanet<sup>265</sup> all suggested that Ofcom should not limit future satellite earth stations in the 26 GHz band to low density areas only, as it was possible that earth station operators may want to deploy in high density areas in future as well.
- 6.9 Given that the 26 GHz band is used for downlinking scientific data, rather than for satellite communications to consumers or businesses, Ofcom considers that if additional earth stations are needed in this band, sites outside high density areas will be suitable. The majority of existing satellite earth stations and teleports are located outside the high density areas we have designated, due largely to a combination of the lower probability of interference outside large urban areas, and the amount of space needed to install large satellite antennas. In terms of the impact on new users of the 26 GHz band, allowing future earth station deployment in high density areas would create additional complexity, due to the additional coordination that would be needed between award winners and satellite earth stations.
- 6.10 The high density areas we have identified are those areas where we believe mmWave spectrum is most likely to be deployed extensively by award winners. In these areas it will not be possible for new users of mmWave spectrum to share spectrum co-channel with

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<sup>255</sup> [Airspan response to the May 2022 Consultation](#), p. 5.

<sup>256</sup> [BT/EE response to the May 2022 Consultation](#), p. 21.

<sup>257</sup> [Inacom Telecom response to the May 2022 Consultation](#), p. 4.

<sup>258</sup> [Qualcomm response to the May 2022 Consultation](#), p. 8.

<sup>259</sup> [UKWISPA response to the May 2022 Consultation](#), p. 3.

<sup>260</sup> [VMO2 response to the May 2022 Consultation](#), pp. 19 and 34.

<sup>261</sup> [Vodafone response to the May 2022 consultation](#), p. 13.

<sup>262</sup> [GSOA response to the May 2022 Consultation](#), p.2.

<sup>263</sup> [SpaceX response to the May 2022 Consultation](#), p. 3.

<sup>264</sup> [techUK response to the May 2022 Consultation](#), p. 6.

<sup>265</sup> [Wildanet response to the May 2022 Consultation](#), p. 9.

satellite earth stations due to the size of the protection areas generally needed to guard against harmful interference. In low density areas we expect mmWave usage by new users to be localised and more scattered, meaning there will be a higher likelihood of new earth stations being able to find spectrum in these areas.

- 6.11 In line with our recent [Space Spectrum Strategy](#) (paragraph 4.5), users who wish to deploy satellite earth stations within high density areas may be able to do so by agreeing access to the auctioned spectrum on a commercial basis with the new licensee, facilitated by the Local Access licensing framework.<sup>266</sup>

### Approach to licensing satellite earth stations

- 6.12 Dense Air<sup>267</sup> suggested that Ofcom consider a more sophisticated approach to licensing future earth stations, rather than simply limiting future deployments to low density areas only. It argued for an approach which looks at the footprint of the restriction zone required to protect the earth station, taking into account topography and earth station pointing angles, and then looks at the business opportunity within the potentially restricted area before assigning a grant of RSA, suggesting this could allow more optimal use of the band by all parties.
- 6.13 In response to this comment, we would like to clarify that applications for new grants of RSA would be subject to coordination with existing users, taking into account terrain as well as the direction that the earth station is pointing; it would not simply be a case of automatic approval for sites in low density areas. We would coordinate any new application for a grant of RSA with the high density areas, and with existing fixed links, Shared Access licensees and other users. This first come, first served approach is the way in which satellite earth stations and fixed links currently share spectrum in 26 GHz as well as in other bands, rather than taking into account the relative opportunity costs associated with individual applications for grants of RSA or fixed link licences in bands where these or other users share access to spectrum.

### Protection of satellite services operating in the adjacent 28 GHz band

- 6.14 Kuiper Systems, a subsidiary of Amazon (“Amazon”),<sup>268</sup> Eutelsat,<sup>269</sup> SpaceX<sup>270</sup> and Viasat<sup>271</sup> all expressed concern about the possibility of emissions from new users in the 26 GHz band causing interference to the fixed satellite service in the adjacent 28 GHz band.
- 6.15 The 28 GHz band is used by the fixed satellite service for earth to space uplink, including by earth stations uplinking data for satellite broadband connections. We are not intending to impose restrictions on new users of the 26 GHz band to prevent out-of-band interference into the 28 GHz band. This is because coexistence studies between 5G mobile and fixed

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<sup>266</sup> Ofcom’s Guidance Document “[Local Access Licence](#)”.

<sup>267</sup> [Dense Air response to the May 2022 Consultation](#), p. 3.

<sup>268</sup> [Amazon response to the May 2022 Consultation](#), p. 5.

<sup>269</sup> [Eutelsat response to the May 2022 Consultation](#), p. 2.

<sup>270</sup> [SpaceX](#), pp. 1 and 3.

<sup>271</sup> [Viasat response to the May 2022 Consultation](#), p. 3.

satellite service in the 28 GHz band concluded that even co-channel coexistence between mobile and satellite in 28 GHz would be possible with large protection margins for satellites.<sup>272</sup> Therefore, we consider that mobile in 26 GHz can coexist with the fixed satellite service in 28 GHz, because the risk of interference is even lower when the services are not operating in the same band.

- 6.16 Amazon<sup>273</sup> made reference to the fact that Ofcom is putting in place measures to avoid out-of-band interference into the 24 GHz band, and argued that we should take the same approach for the 28 GHz band as well. While Ofcom does not generally coordinate between users in adjacent bands, in the case of the 24 GHz band, used by sensitive radioastronomy telescopes and passive sensors as part of the Earth exploration satellite service (EESS), the European harmonised conditions governing use of the 26 GHz band included limits on out-of-band emissions from future deployments to ensure the protection of EESS sensors in the adjacent 24 GHz band.<sup>274</sup> We set out our reasoning on this topic in detail in our July 2022 statement, [Protecting passive services at 23.6-24 GHz from future 26 GHz uses](#). As explained above, we do not consider similar out-of-band coordination to be necessary for the 28 GHz band, nor do the harmonised conditions for the 26 GHz band require it.

## Our decision

- 6.17 In light of the above, we have decided to proceed with our proposal as set out in the May 2022 Consultation. Therefore, we will continue to protect the existing satellite earth station in the 26 GHz band from interference in line with the terms of its grant of RSA. Additionally, we will continue to accept future applications for grants of RSA for satellite earth stations, but in low density areas only. Applications will be granted on a first come, first served basis and subject to coordination with existing users.
- 6.18 In November 2022, Ofcom published our [Space Spectrum Strategy](#) document. In this, we affirmed our commitment to ensuring that our spectrum management policies support earth observation services (such as those which use the 26 GHz band for Earth-to-space communications) as a priority, because we recognise the importance of this service. At the same time, we said we would take a balanced approach, to ensure that critical applications can be protected without unnecessarily constraining the introduction of new services.<sup>275</sup>
- 6.19 We stated in our May 2022 Consultation,<sup>276</sup> that we would consider extending the availability of grants of RSA in the 26 GHz band by an additional 500 MHz (i.e. to cover the 26.5–27 GHz frequency range), in line with the internationally harmonised allocation for

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<sup>272</sup> [Attachment 3 to Annex 3, Report on the sixth meeting of ITU Task Group 5/1 \(Geneva, Switzerland, 20-29 August 2018\)](#)

<sup>273</sup> Amazon, p. 5.

<sup>274</sup> Commission Implementing Decision (EU) 2019/784 of 14 May 2019 on harmonisation of the 24,25-27,5 GHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services in the Union (as amended by Commission Implementing Decision (EU) 2020/590). See [this unofficial consolidated version of the Decision](#). The UK version of this legislation is set out in [S.I. 784/2019](#) and [S.I. 590/2020](#).

<sup>275</sup> Ofcom's Statement "[Space Spectrum Strategy](#)", published 10 November 2022, paragraph 5.5.

<sup>276</sup> May 2022 Consultation, paragraphs 6.10-6.11.

this use, if there was clear evidence that this would be beneficial. We will keep this under review, subject to evidence on stakeholder needs and the benefits arising from them.

## Level crossing radars

- 6.20 Network Rail operates a number of level crossing radar sensor systems at locations across the UK, which are used to detect objects obstructing level crossings on the rail network, and if necessary stop approaching trains, to prevent accidents or collisions. These systems are deployed in a number of places all over the country, and are authorised under a licence held by Network Rail.
- 6.21 Past technical work has indicated that these radar systems are very robust against interference and based on this we outlined in the May 2022 Consultation that we expected new users in the band would be unlikely to pose a risk of interference to these systems. In the unlikely event of interference these systems would record a false positive, meaning that even in this scenario interference to these radars would not pose any risk to safety on the railway.
- 6.22 Given the low chance of interference as stated above, we proposed in the consultation to allow level crossing radar sensor systems to remain in the band, and said that we did not expect any form of coordination to be necessary to protect these.

### Our decision

- 6.23 We have decided to implement this proposed approach, noting that stakeholders did not comment on it.

## PMSE

- 6.24 The 24.25–24.5 GHz range is currently available to users of PMSE equipment, and we have issued 44 time-limited PMSE licences in this band since 2000. Thirty-eight of these were issued in 2014 for the Commonwealth Games. Since 2014 however, there has been no PMSE usage of this band.
- 6.25 Given the low level of use and the availability of other bands for PMSE users, in the May 2022 Consultation we proposed to close this band for future PMSE licences. We said we would give stakeholders a five-year notice period if we decided to implement this proposal following consultation.

### Our decision

- 6.26 We have received no comments from stakeholders and decided to proceed with our proposal to close the 26 GHz band to PMSE with effect from 13 March 2028 (i.e., giving five years' notice commencing on the publication of this statement). For the avoidance of doubt, this means that PMSE use will not be authorised in the 26 GHz band after that date.

## Licence exempt devices

- 6.27 Licence exempt devices that use this band include:
- a) Ultra-Wideband (“**UWB**”) Radar
  - b) Short Range Devices (“**SRDs**”) including:
    - i) Tank Level Probing Radar (“**TLPR**”)
    - ii) Automotive Short-Range Radar (“**SRR**”)
    - iii) Some types of airport security scanner.
- 6.28 Due to a combination of either limited (or very location-specific) usage of these devices, and the characteristics of these systems making them not very susceptible to either receiving or causing interference, we outlined in the May 2022 Consultation<sup>277</sup> that we expected all of these devices to be able to continue to operate without receiving or causing any interference from or to new users because they operate at a short range and at low power levels.
- 6.29 In the case of airport security scanners, we said that we would write to airports in the UK which offer transatlantic flights (as we understand that the use of these devices is a requirement from the US Transport Security Administration) to urge airport operators to be cautious if allowing 26 GHz mobile base stations to be deployed near to these types of scanner.
- 6.30 We did not receive any comments from stakeholders in response to the May 2022 Consultation regarding our proposals for licence exempt users in this band. We did, however, receive one response to our [Spectrum Roadmap](#) discussion document from Valeport,<sup>278</sup> regarding licence exempt short-range tide height measuring radar systems in the 26 GHz band and whether this would be protected from interference from 5G in the 26 GHz band. In response to this comment, we consider that the nature of these devices (i.e., being pointed down into bodies of water) is likely to be sufficiently different to the deployment patterns of new users to avoid interference between these two use cases.

## Our decision

- 6.31 We have decided to implement the approaches we proposed, noting that stakeholders did not comment on them.

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<sup>277</sup> May 2022 Consultation, paragraphs 6.17-6.33.

<sup>278</sup> [Valeport response Spectrum Roadmap](#) to Ofcom’s Discussion Document “[Spectrum Roadmap](#)”, published 31 March 2022.

## MOD

### Our decision

6.32 As set out in section 3 (paragraph 3.7-3.12) of this document, we have decided to implement a nationwide safeguard in the bottom 200 MHz of the 26 GHz band for Defence use. Should MOD require access to additional spectrum in the 26 GHz band, we will coordinate its use on a first come, first served basis.

### Users in the adjacent 24 GHz band

6.33 In July 2022, Ofcom published a [statement](#) where we set out our measures for protecting users in the adjacent 23.6–24 GHz band from out-of-band emissions of new users in the 26 GHz band. We decided to implement two additional measures to protect passive sensors used as part of the Earth Exploration Satellite Service (“**EESS**”) and radio telescopes used as part of the Radio Astronomy Service (“**RAS**”). These measures are:

- a) To protect EESS, to limit the number (within any 300km<sup>2</sup> area) of outdoor 26 GHz base stations which can be deployed in the lowest 800 MHz of the 26 GHz band (i.e. 24.25–25.05 GHz); and
- b) To protect RAS, to impose exclusion zones around the six radio astronomy sites that comprise the e-MERLIN array<sup>279</sup> in which the deployment of 26 GHz base stations would not be permitted.

6.34 More information on how we propose to implement these restrictions in our authorisation of new users in 26 GHz is set out in section 10.

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<sup>279</sup> These are the radioastronomy sites at Jodrell Bank, Cambridge, Pickmere, Knockin, Defford and Darnhall.

## 7. Approach to existing licensees in the 40 GHz band

### Summary

- 7.1 The 40 GHz band (40.5-43.5 GHz) is currently licensed to H3G, MLL and MBNL.<sup>280</sup> H3G and MBNL use the band to provide point-to-point fixed links. Existing licences do not allow the spectrum to be used for mobile services.
- 7.2 The 40 GHz band has been identified globally for mobile and as a 5G band in Europe, and harmonised technical conditions for 5G use of this band in Europe are set out in ECC Decision (22)06<sup>281</sup> and CEPT Report 82.<sup>282</sup> We consider that long term optimal use of this spectrum is mobile, rather than fixed services.
- 7.3 We consider that the large amount of spectrum in the mmWave bands has the potential to deliver significant benefits for people and businesses by enabling large increases in wireless data capacity and speeds. As set out in section 2, we have decided to make the 26 and 40 GHz bands available for new uses on the same or a similar timescale, as proposed in the May 2022 Consultation.<sup>283</sup>
- 7.4 In section 7 of the May 2022 Consultation we consulted on options to enable the 40 GHz band for new uses including mobile use, either by varying existing licences to allow new uses, revoking them and re-allocating the relevant spectrum, or a combination of both. Our provisional view was that varying the existing licences and relying on trading to deliver an efficient outcome would be unlikely to meet our objectives (which are set out in paragraphs 2.30-2.35 of this document). We said that the more 40 GHz spectrum that is available for re-allocation alongside the 26 GHz band, the greater the likelihood of meeting our objectives, but that it is possible that we could achieve our objectives by revoking part of, but not all, existing licences.<sup>284</sup>
- 7.5 As set out in section 2, we consider it appropriate to take a proactive approach to making mmWave spectrum available for new uses, to enable investment in faster broadband, better quality mobile services, and innovation in services. We also consider it appropriate to ensure that spectrum availability is not a barrier to innovation.
- 7.6 Having considered all responses to the May 2022 Consultation, we have decided the best way to achieve our objectives for this award, which are derived from our statutory duties, is to award the entire 40 GHz band alongside 26 GHz. We consider that this option is more likely than alternative options we have considered to ensure an efficient allocation of this

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<sup>280</sup> MBNL is a joint venture between H3G and BT/EE.

<sup>281</sup> [ECC Decision \(22\)06](#)

<sup>282</sup> [CEPT Report 82](#) will form the basis of a harmonising Commission Decision, which is currently in draft form. A [draft of the Commission Implementing Decision](#), dated 7 December 2022, is available. We expect the 40 GHz and 26 GHz bands to be functionally substitutable in the long run (i.e. that they could be used to provide the same types of services to customers).

<sup>283</sup> [May 2022 Consultation](#), paragraph 2.54.

<sup>284</sup> [May 2022 Consultation](#), paragraph 7.4.

spectrum, which will maximise this spectrum’s potential to deliver benefits for people and businesses in the UK. We expect an efficient allocation is likely to mean creating the opportunity for operators to acquire large, contiguous spectrum blocks. We consider that we cannot rely on trading to achieve an efficient allocation in this band, and that liberalising the incumbents’ licences would be less likely to secure an efficient allocation than an award. A single auction making the large amounts of spectrum in the 26 GHz and 40 GHz bands available at the same time will, in our view, be the most effective way of securing efficient allocation of this spectrum and maximising its value for society in the coming years. Awarding the full band will also ‘reset’ the band for new uses going forwards, removing constraints from coexistence with fixed links that would severely limit the extent of deployment of mobile services, as well as allowing us to authorise the band differently in high and low density areas.

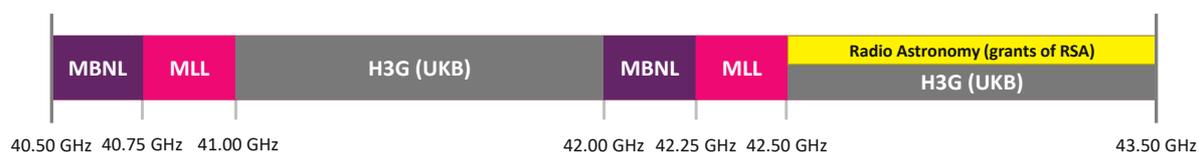
- 7.7 We have therefore decided to start the statutory process for revoking all existing licences in the 40 GHz band in order to reallocate this band alongside the 26 GHz band, as this is most likely to achieve our objectives for this award, which are derived from our statutory duties.
- 7.8 We will shortly start the revocation process by issuing notice of the proposed revocation to H3G, MBNL and MLL with a five-year notice period. We will consider any further representations that these licensees might want to make in response to our notices of proposed revocation before making a final decision. In line with our approach to efficient allocation of mmWave across both bands, if we revoke existing licences, we would offer to grant individual fixed link licences for links already in place at the time of publishing this statement where these are not likely to receive interference from new uses in high density areas.

## Current and potential future use of the 40 GHz band

### Current use of the 40 GHz band

- 7.9 The 40 GHz band is currently used for fixed links, and also has an allocation for satellite and radioastronomy use. We explain these existing uses in more detail below.

Figure 7.1: Existing users of the 40 GHz band



### Block assigned licences currently used for fixed links

- 7.10 There are three existing licensees in the band (H3G, MBNL, and MLL) who hold block assigned national licences.<sup>285</sup> The band is arranged with a duplex split, with H3G holding a licence to use 2 GHz (2x1 GHz), and MBNL and MLL each holding a licence for 500 MHz (2x250 MHz). These licences were allocated by auction in 2008 on a technology and service neutral basis.<sup>286</sup>
- 7.11 At the time of the 2008 auction, there was no general expectation that the 40 GHz band would be used for future mobile or 5G services.<sup>287</sup> The 40 GHz licences require operators to register the address of radio equipment including terminals using the spectrum, as well as their antenna height and antenna bearing.<sup>288</sup> This requirement prevents licensees using the spectrum for mobile services, as a mobile terminal (i.e. a user handset) inevitably changes location, and antenna height and bearing very frequently.<sup>289</sup> The current technical licence conditions are also not optimal for 5G, and harmonised technical conditions have been agreed in CEPT for new 40 GHz wireless communications services.
- 7.12 The 40 GHz licences are currently used for fixed links. MBNL has the largest number of fixed links in the band, totalling 4,338 links.<sup>290</sup> H3G has 63 links.<sup>291</sup> MLL has no deployments in the band.
- 7.13 These licences have an indefinite duration, with an initial term of 15 years (up to February 2023) during which time Ofcom's powers to revoke the licences were limited.<sup>292</sup> Since February 2018, Ofcom has had the power to revoke these licences (if objectively justified and proportionate), with five years' notice, for spectrum management reasons.<sup>293</sup> Since 21

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<sup>285</sup> The licences were originally won by UK Broadband (UKB), MBNL and MLL. H3G, one of the four national MNOs, acquired UK Broadband in 2017. MBNL is a network sharing joint venture and is owned by BT/EE and H3G. MLL is a provider of managed network services. The 40 GHz licences are published on the "[Mobile and wireless broadband above 5 GHz](#)" page of Ofcom's website.

<sup>286</sup> Ofcom's Statement "[Award of available spectrum: 10 GHz, 28 GHz, 32 GHz and 40 GHz: Spectrum packaging and auction design](#)", published August 2007.

<sup>287</sup> The ERC in June 1999 designated this Band for multimedia wireless systems (MWS), which it defined as terrestrial multipoint systems that provide FWA to the end user for multimedia services (ERC/DEC(99)15)8. However, we noted at the time of the award that there had been no use of the band for MWS, and so did not limit the band to MWS operation. The RSPG published an opinion, "[Strategic roadmap towards 5G for Europe](#)", in 2016 that 40.5-43.5 GHz was a viable option for 5G in the longer term.

<sup>288</sup> See paragraph 3(a) of Schedule 1 to the 40 GHz licences.

<sup>289</sup> We note that in addition to varying Schedule 1 of the 40 GHz licences, allowing licensees to use the spectrum for mobile services would also require making regulations under s8 WT Act 2006 to exempt relevant 40 GHz handsets from the requirement to hold a wireless telegraphy licence.

<sup>290</sup> MBNL fixed links statistics taken from data provided by MBNL. MBNL supplied Ofcom with updated figures on its fixed links usage in 40 GHz as of 13 December 2022. The number of fixed links deployed by MBNL in the 40 GHz band has reduced relative to the figures we used in the May 2022 Consultation.

<sup>291</sup> H3G fixed link statistics taken from data provided by H3G response to statutory information request dated 7 February 2022.

<sup>292</sup> Under Condition 3(h) of the 40 GHz licences, as initially awarded in 2008, the five-years' notice of revocation for spectrum management reasons could not expire before February 2023 (i.e. 15 years from the date of issue of the licences). A draft licence was set out in Annex 1 annexed to the [Information Memorandum Update](#) published 3 December 2007.

<sup>293</sup> See Condition 3(f) of the 40 GHz licences.

February 2023, Ofcom has been able to use its powers to impose annual licence fees on existing licences.<sup>294</sup>

### Radioastronomy in 40 GHz

7.14 The 42.5-43.5 GHz block of frequencies has been allocated internationally for radioastronomy. There is currently one grant of Recognised Spectrum Access (“**RSA**”) for radioastronomy use in this part of the band, issued to the Science and Technology Facilities Council (“**STFC**”). To protect radioastronomy use, an exclusion zone of 50km currently applies around the Cambridge radioastronomy site for the relevant frequencies of H3G’s 40 GHz licence.

## Potential future use of the 40 GHz band

### Demand for mobile use of the 40 GHz band is likely to arise in the future

7.15 Section 2 sets out our understanding of the potential use cases and demand for mmWave spectrum. Applications include mobile hotspots, fixed wireless access (“**FWA**”) services, integrated access and backhaul (“**IAB**”) and mobile private networks. Although we are uncertain about the precise levels of demand for mmWave spectrum at this early stage, there is clear evidence of demand for mmWave spectrum from some operators, and in some cases, demand for at least 1 GHz of spectrum per operator (see paragraphs 2.53-2.62).

7.16 The equipment ecosystem for the 40 GHz band is behind that of the 26 GHz band. However, as we set out in section 2 (paragraph 2.21), once the 40 GHz band has been made available for new uses in the UK, we do not consider there should be significant barriers to operators deploying in this spectrum.

### Future demand for satellite services

7.17 In the May 2022 Consultation,<sup>295</sup> we noted that there is an allocation for the Earth to space and space to Earth services in the band.

7.18 As noted in section 2, satellite stakeholders responded that the 40 GHz band will be important for future satellite services. Satellite stakeholders,<sup>296</sup> Amazon, Eutelsat, GSOA and OneWeb noted the growing importance of the Q/V band, including the 40 GHz band,<sup>297</sup> for satellite use cases. They said that the 40 GHz band is expected to be used by fixed satellite service (FSS) earth stations, with deployments including gateways and customer terminals.

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<sup>294</sup> See Condition 8 of the 40 GHz licences.

<sup>295</sup> May 2022 Consultation, paragraph 7.13.

<sup>296</sup> [Amazon response to the May 2022 Consultation](#), p. 3, response to Q.2; [Eutelsat response to the May 2022 Consultation](#), pp. 2-3; [OneWeb response to the May 2022 Consultation](#), pp. 2-3; [GSOA response to the May 2022 Consultation](#), p. 2.

<sup>297</sup> Spectrum frequencies between 33-75 GHz are commonly known as Q/V bands. Q band ranges from 37.5 to 43.5 GHz, V band ranges from 47.2-50.2 GHz and 50.4-51.4 GHz are used for satellite.

- 7.19 We discuss these responses in annex 8. We consider that it should be possible for future mobile services (including 5G) and future satellite services to coexist with coordinated earth stations in the 40 GHz band, and Ofcom will consider how to make the 40 GHz band available for gateway satellite earth stations in low density areas in line with our Space Spectrum Strategy. We do not expect that uncoordinated satellite terminals will be compatible with mobile services in the same band.

## Consultation proposals

- 7.20 In the May 2022 Consultation we asked for stakeholders' comments on:
- a) our initial view that we would make the 26 GHz and 40 GHz bands available on the same or a similar timeframe; and
  - b) our assessment of the options for making the 40 GHz band available for new uses.
- 7.21 In the May 2022 Consultation,<sup>298</sup> we proposed to continue to protect radioastronomy use at Cambridge in these frequencies, regardless of which option we pursued for making the spectrum available for new uses. We said that we would review whether the current exclusion zone remains an appropriate mechanism for ensuring coexistence, considering the parameters for new uses operating in this band.
- 7.22 In line with the position we set out in the May 2022 Consultation, we will protect the radioastronomy use at Cambridge. We are proposing changes to the way we protect this site, and that we will no longer use the current exclusion zone. We set out the detail of our proposals to protect radioastronomy in the 40 GHz band in section 10 (paragraph 10.101-10.104).

## Making 26 GHz and 40 GHz spectrum available on a similar timescale

- 7.23 In the May 2022 Consultation, we set out our provisional view that authorising the 26 GHz and 40 GHz bands for new uses on the same or similar timeframe would be most likely to deliver the best outcomes for people and businesses (paragraphs 2.45-2.54). We said that we would aim to make both bands, totaling around 6 GHz of spectrum, available on the same or similar timeframe (by 2024), regardless of which option we pursue for enabling the 40 GHz band for new uses.
- 7.24 As discussed in more detail in section 2 (paragraphs 2.68-2.76), we consider that this will best ensure spectrum availability is not a barrier to innovation and investment in new uses of mmWave spectrum, by maximising opportunities for operators to obtain large contiguous blocks of spectrum. We also consider that making this spectrum available as soon as possible may provide an incentive for mobile operators to accelerate their network densification plans, to maximise the benefits of this spectrum.

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<sup>298</sup> May 2022 Consultation, paragraph 7.12.

## Making the 40 GHz band available for new uses

- 7.25 In the May 2022 Consultation, we considered four different options for making the 40 GHz band available for new uses:<sup>299</sup>
- **Option 1 – Variation of all licences** to enable existing licensees to deploy new uses in the band, including mobile.
  - **Option 2 – Revocation<sup>300</sup> of all licences**, and reallocation of the entire band (3 GHz) for new uses, including mobile.
  - **Option 3 – Partial revocation of licences**, revoking H3G and MLL’s licences, but not MBNL’s licence. Ofcom would re-allocate the relevant spectrum (2.5 GHz) for new uses, including mobile.
  - **Option 4 – Partial variation and partial revocation of licences**, by varying H3G and MLL’s licences to enable new uses, but only in relation to some of their existing frequencies. Ofcom would revoke and re-allocate the rights to use the other frequencies for new uses. This option would likely be in addition to option 3 (not revoking MBNL’s licence).
- 7.26 Our provisional view was that the more 40 GHz spectrum that is available for re-allocation alongside the 26 GHz band, the greater the likelihood of meeting our objectives. We said that, under certain scenarios, it is possible that we could achieve our objectives by revoking part of, but not all, existing licences. We said this would depend on how much mmWave spectrum operators are likely to require for delivering quality services.<sup>301</sup> We provisionally concluded that option 1 would be unlikely to meet our objectives for the award.<sup>302</sup>
- 7.27 In the remainder of this section we set out our assessment of these options, taking into account responses from stakeholders. In annex 8, we provide further detail about (i) H3G’s suggestion that we should use an incentive auction or a voucher scheme; (ii) the trades that MLL suggested could result in an efficient allocation, and (iii) responses from satellite stakeholders about the optimal use of the 40 GHz band.

### High-level summary of consultation responses

- 7.28 There was no clear consensus as to how we should make the 40 GHz band available for mobile.

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<sup>299</sup> May 2022 Consultation, paragraph 7.22

<sup>300</sup> In this section, we refer to the ‘revocation’ of a 40 GHz licence (or the rights to use certain frequencies under such licence) for ease of reference, even though the re-allocation of certain frequencies authorised under the licence may involve a licence variation (instead of a revocation) where the relevant licence would continue to authorise the use of other frequencies. In these cases, we would generally expect to give five years’ notice before the relevant variation would take effect, in line with the notice period set out in the 40 GHz licences for revoking them for spectrum management reasons. We note that MBNL holds a single combined licence for its 10, 32 and 40 GHz holdings, however this revocation option only concerns its 40 GHz frequencies.

<sup>301</sup> May 2022 Consultation, paragraph 7.4.

<sup>302</sup> May 2022 Consultation, paragraph 7.83.

- 7.29 While all of the MNOs indicated that demand for mobile use will arise in the future in 40 GHz, each of them expressed a different view as to how we should make spectrum available for this use, with three of the four options preferred by at least one operator.
- H3G and BT/EE were in favour of option 1 (variation of existing licences), as well as the incumbent 40 GHz licensee MLL. All three responded that trading would be sufficient to achieve an efficient allocation (with H3G arguing that a simple pre-auction trade could do so).<sup>303</sup> BT's support for option 1 was conditional on Ofcom imposing a cap on H3G's ability to acquire 26 GHz spectrum.<sup>304</sup> H3G proposed an incentive auction or option 4, as approaches which H3G would favour over option 2.<sup>305</sup>
  - VMO2 was in favour of option 2 (full band revocation) and cited the 3.4-3.8 GHz band as an example of trading not working to secure an efficient allocation.<sup>306</sup>
  - Vodafone preferred option 3 (revoking all licences except MBNL's), arguing that MBNL's extensive use of the band, and the uncertain demand for mmWave applications, mean clearing MBNL's use cannot be justified.<sup>307</sup>
- 7.30 Responses were also mixed among other respondents:
- Qualcomm and techUK said that option 1 is consistent with market mechanisms and would allow the market to determine the optimal use of the spectrum.<sup>308</sup>
  - Wildanet, UKWISPA and Caleycom supported our provisional view, as outlined in the May 2022 Consultation (as explained above in paragraph 7.23).<sup>309</sup>
  - Dense Air said that option 2 would best achieve the objectives of promoting efficient allocation, investment and innovation.<sup>310</sup>

## Our decision

- 7.31 Having considered all responses to the consultation, and on the basis of the analytical framework set out below, we have decided to start the statutory process for revoking all existing licences in the band (option 2) because we consider this approach is most likely to achieve our objectives for this award. As specified above, we will consider any further representations that the existing licensees make in response to our notices of proposed revocation before making a final decision to revoke the licences.

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<sup>303</sup> [BT/EE response to the May 2022 Consultation](#), p. 3; [H3G response to the May 2022 Consultation](#), pp. 14-15; [MLL response to the May 2022 Consultation](#), pp. 8-9.

<sup>304</sup> BT/EE, p. 24.

<sup>305</sup> H3G, p. 2 and letter [Three \(options for enabling new uses in 40 GHz band\)](#)

<sup>306</sup> [VMO2 response to the May 2022 Consultation](#), p. 19.

<sup>307</sup> [Vodafone response to the May 2022 Consultation](#), p. 14.

<sup>308</sup> [Qualcomm response to the May 2022 Consultation](#), p. 8, response to question 12; [techUK response to the May 2022 Consultation](#), p. 7, response to question 12.

<sup>309</sup> [Wildanet response to the May 2022 Consultation](#), p. 9, response to question 12; [UKWISPA response to the May 2022 Consultation](#), p. 3, response to question 12; Caleycom agreed "if not simply auctioned at a national level reducing the ability for smaller operators to compete" ([Caleycom response to the May 2022 Consultation](#), p. 2, response to question 12).

<sup>310</sup> [Dense Air response to the May 2022 Consultation](#), p. 4, response to question 12.

## Analytical framework for assessing options

- 7.32 In section 2, we referred to those of Ofcom’s general duties which appear to us to be most relevant in the circumstances and set out our main policy objectives, which derive from our duties. In summary, our main policy objectives for enabling mmWave spectrum for new uses are to: (i) achieve an efficient allocation of spectrum; (ii) sustain strong competition in mobile markets; (iii) encourage investment and innovation in new uses; and (iv) ensure timely availability of spectrum. As set out below, the factors that we have taken into account in assessing options encompass these objectives.
- 7.33 Ofcom has a statutory power to vary or revoke spectrum licences, where this is objectively justifiable. We also have a general duty not to discriminate unduly between operators, and to ensure that our interventions are proportionate, consistent and targeted only at cases in which action is needed.<sup>311</sup>
- 7.34 In the May 2022 Consultation,<sup>312</sup> we explained the factors that we would take into account in considering whether the variation or revocation of licences (or a combination of both) would be objectively justifiable and proportionate. No stakeholders disagreed with our analytical framework, and we have used the same analytical framework in reaching our decision.
- 7.35 The factors we have taken into account in reaching our decision are:
- a) our objective of securing optimal use of spectrum, which encompasses our objectives of:
    - i) achieving an efficient allocation of spectrum,
    - ii) encouraging investment and innovation in services; and
    - iii) ensuring timely availability of spectrum;
  - b) our objective of promoting competition, which encompasses our objective of sustaining strong competition in mobile markets;
  - c) our objective of securing benefits for consumers and citizens; and
  - d) the impact on existing users, and the need to meet our objectives for mmWave without imposing disproportionate costs on existing users.
- 7.36 Our assessment of the options against this analytical framework is set out below.

## Securing optimal use of spectrum

- 7.37 In this sub-section, we set out our assessment of each option against our duty to secure optimal use of spectrum. This assessment focuses primarily on which option is most likely to achieve an efficient allocation of spectrum (the first factor). This is because the option that delivers the most efficient allocation should, in this case, maximise opportunities for

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<sup>311</sup> See annex 5, paragraphs A5.19-A5.22.

<sup>312</sup> May 2022 Consultation, paragraphs 7.25-7.26.

investment and innovation in services (the second factor), while all options perform similarly in relation to timely availability (the third factor).

- 7.38 To contextualise our assessment of options, we first consider what an efficient allocation of mmWave spectrum might entail, and the risk that the current allocation might be inefficient.

## Achieving an efficient allocation of spectrum

- 7.39 Achieving an efficient allocation of spectrum is a key element of securing optimal use of spectrum. In an efficient allocation of spectrum, the spectrum is:

- authorised in a way that allows for efficient use of the band, i.e. that enables its effective use by the service that will provide the most benefits (or value) for society;
- allocated to operators that will use the spectrum to provide the most benefits (or value) to society (we refer to these as ‘efficient users’ throughout this section).

- 7.40 We have considered the efficiency of the 40 GHz allocation together with the 26 GHz band. This is because we expect both bands to be functionally substitutable in the long-run, and we expect mobile operators will be able, in the medium to long term, to use both bands to provide similar services.

### Potential features of an efficient allocation of mmWave

- 7.41 The landscape for new uses of mmWave spectrum is still in a relatively early stage of development. We cannot know the precise allocation of mmWave spectrum that would be the most efficient for new users, especially as new use cases for mmWave spectrum are still emerging.

- 7.42 However, as set out in the May 2022 Consultation, there are some general factors which give an indication of what mmWave spectrum wider area operators (such as MNOs or region-wide FWA operators) may ideally want to hold for new uses, and therefore what an efficient allocation of citywide licences may entail.<sup>313</sup> In particular:

- a) The opportunity to acquire large contiguous amounts of spectrum for these new uses is unique to mmWave bands, as the traditional mobile bands below 6 GHz have much smaller bandwidths. In the May 2022 Consultation, we said that early indications of demand suggest operators may want the opportunity to make use of large blocks of mmWave spectrum (e.g. 1 GHz or more) in the longer term, although we recognised that early demand indications vary widely.<sup>314</sup> Our analysis of the future use cases and demand for mmWave spectrum is set out in section 2 (from paragraph 2.45). There is clear evidence of demand for mmWave spectrum from some operators, and in some cases demand for over 1 GHz of spectrum.

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<sup>313</sup> May 2022 Consultation, paragraph 7.31.

<sup>314</sup> May 2022 Consultation, paragraph 7.31a.

- b) We consider contiguous blocks of spectrum are likely to be an important feature of an efficient allocation, and preferred over fragmented holdings, because:
- i) Many respondents to the May 2022 Consultation expressed a preference for contiguous spectrum.<sup>315</sup> This may be particularly important given that the ECC Decision (22)06 on harmonising the 40 GHz band states that: “the use of contiguous blocks of spectrum for MFCN reduces equipment complexity, provides a more efficient use of spectrum and facilitates spectrum access compared to the use of fragmented, noncontiguous blocks of spectrum.”
  - ii) Operators have in the past suggested that Ofcom should consider wider spectrum fragmentation issues in the context of licence variation requests, where there is an upcoming auction for substitutable frequencies.<sup>316</sup>
  - iii) Although no existing use case cases for mmWave spectrum require blocks of more than a few hundred MHz of contiguous spectrum, we think it important to enable development of future use cases which could require wider blocks of contiguous spectrum, in support of our objectives to promote innovation and effective competition.
  - iv) Using two non-contiguous blocks of spectrum (even if they are proximate to each other) could complicate deployment, as it may make it necessary to deploy at reduced power levels in order to avoid causing interference to adjacent spectrum users.
- c) Operators may want their holdings of mmWave spectrum consolidated in one band, rather than split across bands. This could allow an operator to deploy a single set of equipment in an area to make use of its entire holding, rather than having to incur additional costs of procuring and deploying multiple sets of equipment.

7.43 This suggests an efficient allocation of spectrum for citywide licences is likely to involve operators holding relatively large blocks of contiguous spectrum, to maximise the efficiency and benefits of new uses. Operators could prefer to concentrate their holdings in one of either the 26 GHz or 40 GHz bands to avoid incurring the costs of two sets of equipment.

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<sup>315</sup> VMO2 said the current spectrum configuration in two discontinuous blocks is not compatible with replanning the band for mobile use (VMO2 response, page 20); Ericsson said that spectrum fragmentation makes re-farming more complex and can undermine spectrum harmonisation ([Ericsson response to the May 2022 Consultation](#), p. 3); Qualcomm says: “Should Ofcom decide to re-allocate the 40 GHz band, it would be important that the final outcome results in large contiguous blocks of spectrum for MNOs at least in cities / high density areas.” (Qualcomm, p. 7); in addition, we met with BT/EE on 6 October 2022 to discuss its consultation response, and in this meeting, [CONFIDENTIAL <]. Similarly, VMO2 confirmed by email on 21 November 2022 that [CONFIDENTIAL <]. In addition, as explained in section 9, BT/EE and VMO2 both emphasised the importance of our auction design giving operators the ability to obtain large, contiguous blocks of spectrum.

<sup>316</sup> Ofcom’s Statement, “[Variation of UK Broadband’s spectrum access licence for 3.6 GHz spectrum](#)”, published 14 December 2018, paragraphs 4.10-4.19.

7.44 By making spectrum in both bands available for new uses at the same time, we will maximise opportunities for stakeholders to acquire large blocks of contiguous spectrum in one or both bands.

#### Likelihood that the current allocation is inefficient

7.45 We recognise that existing 40 GHz licensees have value for their existing spectrum holdings:

- a) H3G set out future plans for its licensed spectrum in the 40 GHz band in its consultation response. It identified four main 40 GHz use cases: (i) 5G services on small cells, including self-backhauling; (ii) high speed 5G FWA; (iii) neutral host models; and (iv) private networks.<sup>317</sup>
- b) MLL responded to the consultation setting out plans to use 40 GHz spectrum for a Broadband Fixed Wireless Access (“**BFWA**”) offering for the UK.<sup>318</sup>
- c) MBNL currently has a large number of fixed links in the band. Although we expect MBNL would be able to move its fixed links to other bands or replace them with fibre, it is likely to place a high value on its licensed spectrum due to the costs associated with moving its fixed links.

7.46 However, given the factors above, we consider there is a significant risk that the current allocation of mmWave spectrum is inefficient taking into account both current use and the potential for new uses.

7.47 The 26 GHz band comprises 3.25 GHz of spectrum, of which we have decided to auction 2.4 GHz for citywide licences.<sup>319</sup> Estimates of demand range from around 800 MHz to more than 1 GHz and, as set out in section 2, we consider it appropriate to provide the opportunity for operators to access 1 GHz or more each, in order to enable the industry to realise the potential which mmWave spectrum offers for investment and innovation.<sup>320</sup> We could only provide a more limited opportunity if the current allocation of the 40 GHz band were maintained, because operators other than the current licensees could secure wide area licences for, at most, 2.4 GHz between them in the award. For example, even if only three operators were to bid in the award, they could win an average of 800 MHz of spectrum each.

7.48 Furthermore, now that the 40 GHz band has been globally identified for mobile services, and as a 5G band in Europe, the current licence holdings are unlikely to be optimal. The current allocation resulted from [an auction in 2008](#), before the potential uses of this

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<sup>317</sup> H3G response, p. 31.

<sup>318</sup> MLL response, p. 1.

<sup>319</sup> See section 3: of the remaining 850 MHz, we are proposing to allocate 650 MHz for use on a local basis via our Shared Access licensing framework and implement a nationwide safeguard in the bottom 200 MHz for MOD access.

<sup>320</sup> See section 2, from paragraph 2.53-2.62.

spectrum were well-understood. In particular, there was no general expectation at the time that the 40 GHz band would be used for mobile or 5G services.<sup>321</sup>

7.49 We also note that the 40 GHz band is currently configured with a duplex split, meaning that each operator holds two separate blocks of spectrum rather than one contiguous block. This is because it was originally envisaged that the band would be used for Frequency Division Duplex (“FDD”) services which require separate blocks of spectrum for uplink and downlink. This duplex configuration will not be optimal for new uses, which will use Time Division Duplex (“TDD”) technology and benefit from large contiguous spectrum blocks.

7.50 We also note that:

- a) Existing licensees did not suggest that the existing allocation is efficient. Rather they suggested that it would be possible to reach an efficient allocation without revocation of their licences.
- b) Two of the existing licensees, H3G and MLL, have responded by stating that they are incentivised to trade their spectrum.<sup>322</sup> This could imply that their use plans may not constitute the most efficient use of the spectrum, but that they would prefer to retain their spectrum in order to monetise it. We note that H3G and BT/EE, both of MBNL’s shareholders, expressed support for the 40 GHz band as a 5G band.

7.51 Taking into account all the matters set out above, we think it is unlikely that the current allocation of the 40 GHz band is efficient.

### Summary of responses on the option most likely to achieve an efficient allocation of spectrum

7.52 BT/EE, H3G and MLL responded that liberalising the existing 40 GHz licences to allow mobile use and relying on trading and leasing is the best route to securing optimal use of the spectrum, although BT/EE’s support for option 1 was predicated on Ofcom imposing a safeguard cap on total mmWave holdings in the 26 GHz auction.<sup>323</sup> Qualcomm and techUK also said that option 1 is consistent with market mechanisms and would allow the market to determine the optimal use of the spectrum.<sup>324</sup>

7.53 H3G considered that “revocation of the 40 GHz licences is not objectively justifiable, proportionate, or targeted only at cases where action is needed”.<sup>325</sup> H3G argued that “the

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<sup>321</sup> The 40 GHz band was first identified as a band for study for [wideband 5G services in the 2015 World Radio Congress](#) (paragraph 9.2), with the [RSPG publishing an Opinion in November 2016](#) setting out that it considered 40.5-43.5 GHz a viable option for 5G in the longer term. Prior to this, the ERC in June 1999 designated this Band for multimedia wireless systems, which it defined as terrestrial multipoint systems that provide fixed wireless access (FWA) to the end user for multimedia services (ERC/DEC(99)15). See Ofcom’s Information Memorandum “[Auction of Spectrum: 10 GHz, 28 GHz, 32 GHz and 40 GHz](#)”, published 7 August 2007, paragraph 2.19.

<sup>322</sup> MLL, p. 4: “MLL is incentivised to engage in trading which results in the efficient and competitive use of spectrum.” (MLL p. 4); In a meeting with MLL on 10 October 2022, MLL told us that [CONFIDENTIAL ✕]; H3G, p. 14: “If, as Ofcom believes, the current 40GHz allocation may be inefficient for new uses and existing licensees may not be the highest-value users for all of their 40GHz spectrum, they would have a strong incentive to: ... Trade 40GHz spectrum to higher-value users in full or in part”.

<sup>323</sup> BT/EE noted that if we did decide to rely on trading to secure an efficient allocation of the band (i.e. option 1) then competition concerns would need to be addressed in the design of the 26 GHz band auction. (BT/EE, p. 24).

<sup>324</sup> Qualcomm, p. 8, response to Q.12; techUK response, p. 7, response to Q.12.

<sup>325</sup> H3G, p. 1 (and elsewhere).

number of potential trades needed to allow new uses in the band and deliver an optimal allocation of both 26 GHz and 40 GHz would be manageable”.<sup>326</sup> In particular, H3G noted that 40 GHz can be traded (and leased) before the 26 GHz auction, and that users can negotiate with the three existing 40 GHz licensees, get certainty about their 40 GHz holding and then decide whether to participate in the subsequent 26 GHz auction.<sup>327</sup> MLL said that “two simple trades to move the MLL FDD spectrum to the top and bottom of the band would allow FDD services to continue and make the centre of the band available for allocation to TDD-based IMT”.<sup>328</sup>

- 7.54 H3G said that if we nevertheless believe that central reallocation of 40 GHz is needed, an incentive auction would be a better way of achieving our objectives while respecting licensees’ rights.<sup>329</sup> MLL separately wrote to Ofcom in October 2022 to express its support for H3G’s proposal for an incentive auction.<sup>330</sup> In October 2022, H3G wrote to Ofcom setting out its view that, if Ofcom does not believe it has the power to hold an incentive auction, option 4 “could be an appropriate compromise” which would at least protect some of H3G’s rights and would have some definite advantages over revocation.<sup>331</sup>
- 7.55 Vodafone and VMO2 said that trading was unlikely to produce an efficient allocation of the spectrum. Vodafone said this was because any trading would need to be in tandem with Ofcom’s award of 26 GHz spectrum in order for the acquirer to make an informed choice about the relative levels of spectrum to acquire via trade and auction.<sup>332</sup> VMO2 said that revocation and reallocation of the band “removes the risk of secondary market failure, which might otherwise occur owing to high transaction costs or because legacy licensees are reluctant to trade with rival operators”. VMO2 referenced the 3400-3800 MHz band (which is currently fragmented)<sup>333</sup> as an example of “the failure of the secondary market to efficiently reallocate legacy spectrum when this depends on trading between incumbent operators.”<sup>334</sup>
- 7.56 Vodafone was in favour of option 3, arguing that because of “MBNL’s extensive usage of the band, and the uncertain demand for mm-wave applications”, clearance of MBNL’s use would not be objectively justifiable. Vodafone’s support for option 3 was predicated on the idea that we should revoke MLL and H3G’s existing licences, but we should grandfather

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<sup>326</sup> H3G, p. 2.

<sup>327</sup> H3G, pp. 15-16.

<sup>328</sup> MLL, p. 3.

<sup>329</sup> H3G, p. 2; H3G set out proposals for how an incentive auction could work in its consultation response (pp. 19-28), and it set out a further variation for an incentive auction in a meeting with Ofcom. We also met with H3G on 12 October 2022, during which meeting H3G set out an alternative proposal for an incentive auction, which would require incumbent licensees to consent to the revocation of all their existing spectrum holdings in the 40 GHz band as a pre-condition to participating in the auction, or involve Ofcom revoking their existing licences if the incumbent licensees do not participate in the auction. See the slides presented by [Three at a meeting with Ofcom, 12 October 2022](#).

<sup>330</sup> See [letter from Shaun Ledgerwood to Ofcom](#), dated 25 October 2022.

<sup>331</sup> See letter from Luis Lopez to Gideon Senensieb dated October 2022 [Three \(options for enabling new uses in 40 GHz band\)](#). In its letter, H3G noted that option 4 would not impose undue costs on 40 GHz licensees, would be consistent with Three having a high value for at least some of its 40 GHz spectrum, and would release an additional 1.25 GHz of contiguous 40 GHz spectrum to be auctioned with 26 GHz for new uses and users.

<sup>332</sup> Vodafone, pp. 13-14.

<sup>333</sup> The 3.4-3.8 GHz is currently fragmented, although it could be defragmented by trading.

<sup>334</sup> VMO2 response, p. 19.

existing links into individual leases from the new licensee(s) in the 40 GHz band until such a time that the new licensee(s) wish to use the spectrum.<sup>335</sup>

7.57 VMO2 argued that option 2 is most likely to produce an efficient, pro-competitive allocation, as all potential users will have an opportunity to compete for the spectrum on a “level playing field”. It also said that this option would maximise opportunities for innovation and investment in new uses of mmWave spectrum by all operators as a whole”.<sup>336</sup> Dense Air said that option 2 would best achieve the objectives of promoting efficient allocation, investment and innovation.<sup>337</sup>

### Whether liberalising licences would result in an efficient allocation

7.58 In the May 2022 Consultation,<sup>338</sup> we said that, given the potential that existing users could be efficient users of some of their spectrum, option 1 would be the least intrusive way to enable the 40 GHz band for new uses. Ofcom has varied other spectrum licences in the past, typically in response to a request from the licensee.<sup>339</sup>

7.59 As set out above, we think it is unlikely that the current allocation of the 40 GHz band is efficient. It is possible that, if we were to vary the licences, an efficient allocation could be achieved through spectrum trading. Existing licensees could have an incentive to trade, if there were more valuable uses of the 40 GHz band and other operators were willing to pay more than existing users’ valuations of their licences.

7.60 However, as set out in the May 2022 Consultation,<sup>340</sup> there may be particular barriers to trading which could prevent industry from reaching an efficient allocation in the case of mmWave spectrum. We have summarised these barriers below in paragraph 7.64.

7.61 Our provisional conclusion was that option 1 risks ongoing inefficient allocation of spectrum, if:

- a) operators who do not currently hold 40 GHz spectrum require more mmWave spectrum for new uses than would be available in the 26 GHz band alone, *and*
- b) there are barriers to trading achieving an efficient allocation of mmWave spectrum.

7.62 As we set out above (paragraph 7.47), we think it is likely that operators who do not currently hold 40 GHz spectrum will require more mmWave spectrum for new uses than would be available in the 26 GHz band alone.

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<sup>335</sup> Vodafone response, p. 14.

<sup>336</sup> VMO2, p. 20.

<sup>337</sup> Dense Air, p. 4, response to Q.12.

<sup>338</sup> May 2022 Consultation, paragraph 7.38.

<sup>339</sup> For example, in 2007 we decided to grant UK Broadband’s request to vary its 3.5 GHz licence to remove the limitation to fixed applications, and in 2015 we varied Qualcomm’s 1.4 GHz licence to enable use of Supplemental Downlink. See Ofcom’s Statement “[UK Broadband application for licence variation](#)”, published 22 November 2007, and Statement “[Variation of the Spectrum Access licence for 1452-1492 MHz and changes to fixed link use in the paired bands 1350-1375 MHz and 1492-1517 MHz](#)”, published 29 May 2015.

<sup>340</sup> May 2022 Consultation, paragraph 7.40-1.

7.63 Having considered responses from stakeholders, we remain of the view that option 1 risks an ongoing inefficient allocation of spectrum. We explain our reasoning for this below.

**We cannot rely on trading to achieve an efficient allocation in these bands**

7.64 In the May 2022 consultation,<sup>341</sup> we said that there may be particular barriers to trading which could prevent the industry from reaching an efficient allocation of mmWave spectrum. In particular, we identified that:

- If all other prospective users of mmWave spectrum are constrained to the 26 GHz band to begin with, trading could require a number of complex, multilateral trades across both the 26 GHz and 40 GHz bands in order to reach an allocation with the features we described above.<sup>342</sup> This would involve operators trading to achieve both the optimal amounts of spectrum and either contiguity or proximity of holdings.<sup>343</sup> Although it is theoretically possible for operators to overcome these complexities, this is likely to be difficult and/or costly and could take a long time. As a result, operators may settle for less than optimal amounts of spectrum or incur the costs of split holdings, potentially resulting in poorer services for people and businesses.
- Existing licensees may be disincentivised to trade with potential competitors, which could prevent efficient outcomes. For example, there may be a strategic benefit to H3G in retaining its full 2 GHz of spectrum, even if it were unlikely to use all of it, in order to reduce the amount of spectrum available to other MNOs. This may also be a barrier to trading for MBNL, which is jointly owned by BT/EE and H3G.

7.65 A number of stakeholders provided comments on the likely effectiveness of trading to secure an efficient allocation.

7.66 BT/EE, H3G and MLL argued that revocation is unnecessary, and that an efficient allocation of spectrum (were this to differ from the current allocation) could be achieved by liberalisation and trading.<sup>344</sup> In particular:

- a) H3G proposed that trading could occur before the auction. It argued that users can negotiate with the three existing 40 GHz licensees, get certainty about their 40 GHz holding and then decide whether to participate in the subsequent 26 GHz auction. This could eliminate the need for complex multilateral trades after the auction to remedy an initial inefficient allocation in the 26 GHz band (due to uncertainty about the future availability of the 40 GHz band).<sup>345</sup> H3G also disagreed that even post-auction trades would be complex, given that there are only three existing licensees of 40 GHz

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<sup>341</sup> May 2022 consultation, paragraph 7.40.

<sup>342</sup> In the May 2022 Consultation we noted that operators could also try to secure 40 GHz spectrum before a 26 GHz auction, which would reduce these complexities. See footnote 131 to paragraph 7.42.

<sup>343</sup> For example, if an operator obtained less than its optimal amount of spectrum in the 26 GHz band, it may then need to trade with another (ideally neighbouring) operator in the 26 GHz to buy the additional spectrum it required, with the neighbouring operator being able to buy its optimal amount in the 40 GHz band and sell all of its 26 GHz holdings. Alternatively, it may instead trade its 26 GHz holding to an operator that valued that particular holding enough, and then look to buy its required amount in 40 GHz. This could be the case for a number of operators at once.

<sup>344</sup> BT/EE, p. 3 and p. 24; H3G, p. 10 and p. 14; MLL, p. 3 and p. 8.

<sup>345</sup> H3G, p. 15.

spectrum, and the number of potential would-be traders after the 26 GHz auction is likely to be limited.<sup>346</sup>

- b) H3G also submitted that the suggestion that it may have a strategic incentive to retain its full 2 GHz to deny it to others is incorrect. It said that any licensee retaining spectrum it did not need would incur high costs (including opportunity costs of foregone revenues by not trading, or future 40 GHz ALFs), and that the strategic benefit would be uncertain because the extent of demand in future use of the band is uncertain.<sup>347</sup> H3G also said that our position was inconsistent with our view that the risk of strategic bidding in the mmWave auction was low, and our view that H3G would have an incentive to trade in order to realign the 3.4-3.8 GHz band.<sup>348</sup>
- c) MLL set out a sequence of trades that they said would allow FDD services to continue. This is summarised in annex 8.

7.67 Vodafone and VMO2 agreed with our assessment that trading would be likely to be difficult:

- a) VMO2 said that the current situation in the 3.4-3.8 GHz band is an example of the “failure of the secondary market to efficiently reallocate legacy spectrum when this depends on trading between incumbent operators.”<sup>349</sup>
- b) Vodafone also thought trading is unlikely to produce an efficient outcome, “as any trading would need to be in tandem with Ofcom’s award of 26 GHz spectrum in order for the acquirer to make an informed choice about the relative levels of spectrum acquired via trade and auction”.<sup>350</sup>

7.68 It is not clear that a pre-auction trade or trades would ensure an efficient allocation. While pre-auction trading could simplify the trades required after an auction of 26 GHz spectrum, it would be less likely than full re-allocation of both bands to result in all users each gaining the efficient amount of spectrum, in a contiguous block. The lack of certainty as to the auction outcome at this time is a further potential barrier to trading. In addition, agreeing to a trade before the 26 GHz auction would mean that operators could not consider their acquisition of mmWave spectrum holistically and simultaneously across both bands at the point of the trade. It is also far from certain whether such trades would occur.

7.69 We do not think that MLL’s proposed trades would address the issues that we have set out above. The trades proposed by MLL are addressed in more detail in annex 8. While it is possible that a sequence of trades could result in large contiguous blocks in 40 GHz, we do not think the prospect of this is sufficiently likely to enable us to rely on trading to achieve an efficient allocation across both bands.

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<sup>346</sup> H3G, p. 16.

<sup>347</sup> H3G, p. 18.

<sup>348</sup> H3G, pp. 18-19.

<sup>349</sup> VMO2, p. 20.

<sup>350</sup> Vodafone, p. 14.

- 7.70 We disagree that our assessment of option 1 is inconsistent with our competition assessment or with Ofcom’s view of trading in other bands, as suggested by H3G.
- a) In our competition assessment in section 8, we consider any potential competition concerns that could arise in the proposed auction of 26 GHz and 40 GHz, and whether any competition measures (such as caps) are required. This assessment includes the question of whether there is a risk of strategic bidding in the auction. This is different from the question of whether H3G could have an incentive to retain spectrum leading to a sub-optimal use of the spectrum. Moreover, we note that from an MNO’s perspective, deciding to bid strategically in an auction is not the same as deciding to retain spectrum which it could sell to a rival. For one thing, acquiring spectrum in an auction entails a substantial upfront capital investment which must be justified to investors.<sup>351</sup>
  - b) H3G referred to our comments on H3G’s incentives to trade spectrum in the 3.4-3.8 GHz spectrum bands. However, these comments related to a scenario in which H3G would trade its location in the band, rather than reducing its overall spectrum holdings.<sup>352</sup>
- 7.71 We remain of the view that allowing trading is an important piece of a market-based spectrum management approach. However, we have consistently acknowledged that there is a complementary role for Ofcom when changes of use are contemplated (see paragraphs 7.100-7.101 below). We also note that the evidence of spectrum trading we have seen in the past generally relates to straightforward spectrum ‘swaps’, as opposed to sales of spectrum, and that only five trades of mobile spectrum licences have taken place to date.<sup>353</sup> In our recently published statement, [“Aligning licence terms in the 3.4-3.8 GHz band”](#),<sup>354</sup> we said that differences in licence terms could potentially act as a barrier to spectrum trading, by leading to a complex and protracted negotiation and unnecessary transaction costs. We note this is likely to be the case here too: the trades that would be required would need to relate to spectrum in different bands, of different amounts, and with different licence terms.
- 7.72 The 3.4-3.8 GHz band is a recent example of where trades likely to have benefitted operators and been beneficial for optimal use of the spectrum did not fully materialise. Much of this spectrum was awarded to MNOs via two spectrum auctions: 150 MHz in the 3.4-3.6 GHz band auction in 2018 and 120 MHz in the 3.6-3.8 GHz band auction in 2021. The other available spectrum in the 3.4-3.8 GHz band (three blocks totaling 120 MHz)<sup>355</sup>

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<sup>351</sup> For another, the outcome of an auction depends on the actions of all bidders, which are not known to one another in advance. This uncertainty adds to the risk of strategic bidding. In contrast if H3G were considering whether to trade spectrum the effect of such a trade on relative spectrum holdings between it and its rivals would be foreseeable.

<sup>352</sup> Ofcom has recently aligned licences in this band after H3G and at least one other MNO submitted that they have had difficulties in agreeing trades in the band due to disparities in licence terms. In our view this illustrates there are barriers to trading licences between MNOs, which are not like-for-like spectrum swaps.

<sup>353</sup> Of these, one was a mandated divestment of 1800 MHz spectrum (part of the conditions for the Orange/T-Mobile merger in 2010) and two others were to achieve defragmentation (in the 900 MHz and 3.4–3.8GHz band).

<sup>354</sup> Ofcom’s Statement [“Aligning licence terms in the 3.4-3.8 GHz band”](#), published October 2022.

<sup>355</sup> Two 20 MHz blocks at 3480-3500 MHz and 3580-3600 MHz, and an 80 MHz block at 3600-3680 MHz.

was already licensed to UK Broadband Limited and was not included in the spectrum auctions. The existing holdings in the band prior to the 3.6 GHz award would mean that, without rearrangement, some MNOs' holdings were likely to be fragmented after the 3.6 GHz band award. We recognised that defragmentation<sup>356</sup> could yield benefits for operators,<sup>357</sup> and that there was a general consensus that optimal deployment of 5G is best achieved through the use of large contiguous blocks of spectrum.<sup>358</sup> We were of the view that, depending on the outcome of the auction, defragmentation could be delivered for all MNOs through relatively simple bilateral trades, and that MNOs should have incentives to trade.<sup>359</sup> In that case we also took action to support and facilitate post-auction trading, by including measures to facilitate rearranging ('defragmenting') spectrum holdings in the wider 3.4-3.8 GHz band in the 3.6 GHz auction.<sup>360</sup> Two award winners took advantage of these measures to reach a negotiated agreement. However, following the award, H3G and at least one other MNO told us that they had had difficulties in agreeing trades in the band due to the disparity between the terms of auctioned licences and the terms of the UKB Licences.<sup>361</sup> We have now aligned the terms relating to ALFs in the licences in in the 3.4-3.8 GHz band, in order to reduce barriers to trading.<sup>362</sup> However, the wider 3.4-3.8 GHz band remains fragmented at the date of this document.<sup>363</sup> This is despite the fact that the trades that would be required to defragment the band are more straightforward than those that would be required to achieve an efficient allocation of mmWave spectrum (even a simple bilateral trade would help to defragment the 3.4-3.8 GHz band).

7.73 For all of the reasons set out above, we remain of the view that option 1, which would rely on trading, is less likely than licence revocation to secure an efficient allocation of mmWave spectrum.

7.74 We also note that, by itself, trading would not achieve the geographic licensing split that we consider is appropriate for mmWave spectrum, as the 40 GHz licences are currently national. In order to ensure a consistent approach across the 26 GHz and 40 GHz bands, we would need to vary the existing 40 GHz licences in advance of any trades to limit their geographic scope to the high density areas, which would be a significant change to the existing licences. However, as we have decided to start the statutory revocation process in

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<sup>356</sup> By which we mean a reduction in the distance between operators' holdings (proximity) or elimination of fragmentation spectrum holdings (contiguity).

<sup>357</sup> Ofcom's Statement "[Award of the 700 MHz and 3.6-3.8 GHz spectrum bands](#)", published 13 March 2020, paragraph 6.6.

<sup>358</sup> March 2020 Statement, paragraph 6.10.

<sup>359</sup> March 2020 Statement, paragraphs 6.59-6.61: We said it would require only two separate bilateral trades to achieve full defragmentation in a number of plausible outcomes to the principal stage of the 3.6-3.8 GHz auction.

<sup>360</sup> Ibid, paragraph 6.1: The measures we included in the assignment stage of the auction to facilitate defragmentation of the 3.4-3.8 GHz band were: a) a restriction on winners of 20 MHz or less of 3.6-3.8 GHz spectrum to bidding for (and winning) either the top or the bottom of the band; b) a pause of up to four weeks before processing assignment stage bids, to allow a negotiation period where bidders could agree the assignment of 3.6-3.8 GHz spectrum among themselves. The negotiation period was intended to allow agreement between a subset of bidders if unanimous agreement had not been reached; and c) not to publish the assignment stage bids in the 3.6-3.8 GHz band, to eliminate the potential negative impact that publishing this information could have had on post auction trades to defragment the band.

<sup>361</sup> Ofcom's Statement "[Aligning licence terms in the 3.4-3.8 GHz band](#)", published 10 October 2022, paragraph 3.2.

<sup>362</sup> October 2022 Statement, paragraph 3.2.

<sup>363</sup> [CONFIDENTIAL <] ]

order to revoke all the 40 GHz licences (and subject to the outcome of that process), this variation is unnecessary.

### Revocation of licences

- 7.75 In the May 2022 Consultation,<sup>364</sup> we consulted on three options involving varying degrees of licence revocation:
- **Option 2 – revocation of all licences** and reallocation of the entire band (3 GHz) for new uses, including mobile. We said this would enable all mmWave spectrum to be allocated at the same time, maximising opportunities to achieve an efficient allocation across both the 26 GHz and 40 GHz bands.
  - **Option 3 – partial revocation of licences**, revoking H3G’s and MLL’s licences, but not MBNL’s licence. Ofcom would reallocate the relevant spectrum (2.5 GHz) for new uses, including mobile. We said this option could be appropriate if we considered that MBNL is likely to place a higher value than any potential new users on its 40 GHz holding, given its large number of fixed links in the band.
  - **Option 4 – partial variation and partial revocation of licences**, by varying H3G and MLL’s licences to enable new uses, but only in relation to some of their existing frequencies. Ofcom would revoke and re-allocate the rights to use the other frequencies for new uses. We suggested that this option would likely be in addition to option 3 (not revoking MBNL’s licence). We said this option could be appropriate if we considered that H3G and MLL would be likely to place a higher value on some, but not all, of their existing 40 GHz holdings compared to any potential new users. Under this option, we provisionally considered that re-allocating half of H3G and MLL’s frequencies would be reasonable. This would allow for an additional 1.25 GHz of contiguous spectrum to be allocated for new uses, while allowing H3G and MLL to retain an amount of contiguous spectrum which they could credibly use for new uses.
- 7.76 In the May 2022 Consultation, we set out our provisional view that, if we were to revoke licences in the 40 GHz band, we would allocate new citywide licences through an auction.<sup>365</sup> We considered that this would maximise the chance that the spectrum is awarded to the users with the highest valuations for the spectrum.
- 7.77 For the reasons set out above, we consider that we cannot rely on trading to achieve an efficient allocation in the 40 GHz band. Having considered responses from stakeholders, we set out below why we think that revocation of all existing licences (option 2) is more likely than partial revocation (options 3 and 4) to secure an efficient allocation of mmWave spectrum, and the appropriate regulatory intervention in this case is a revocation of all existing licences in the band (option 2).

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<sup>364</sup> May 2022 Consultation, paragraph 7.22.

<sup>365</sup> May 2022 Consultation, paragraph 3.50; We said that we would allow existing fixed links to remain in low density areas, and that we would grant individual fixed link licences for each of the fixed links continuing to operate in low density areas, following revocation of the relevant blocked assigned licences (May 2022 Consultation, paragraph 7.24).

### **Revocation of all existing licences (option 2) is more likely than option 3 to secure an efficient allocation of mmWave spectrum**

- 7.78 In the May 2022 Consultation,<sup>366</sup> we considered the option of revoking H3G and MLL’s licences, but not MBNL’s licence (option 3). There was less support from stakeholders to revoke the MBNL licence than for the revocation of the H3G and MLL licences. Vodafone favoured option 3, and argued that given MBNL’s extensive use of the band, and the uncertain demand for mmWave applications, it does not believe that clearance of MBNL’s links can be justified.<sup>367</sup> BT/EE made similar points, although it favoured option 1.<sup>368</sup>
- 7.79 As noted above, VMO2 favoured revoking all licences, although it also considered option 3 to be a credible approach. VMO2 said that MBNL has a “relatively modest allocation and is making substantial use of it” and maintaining only its allocation would have a much smaller impact on future efficiency of mmWave deployment. However, it still considered this a less attractive option, because a) the legal basis for revoking some licences and not others may be questionable; b) the owners of MBNL are capable of buying the spectrum back if they want to continue the fixed link use; and c) the current duplex arrangement is not compatible with replanning the band for mobile use.<sup>369</sup>
- 7.80 VMO2<sup>370</sup> and Vodafone<sup>371</sup> said that if the MBNL licence were not revoked, there should be a requirement that the spectrum remains for fixed links only (i.e. the licence should not be liberalised to allow mobile use).
- 7.81 We recognise that there is a significant difference between the extent of current use of MBNL’s licence compared with H3G and MLL’s licences. Whereas there are 63 links across the 2 GHz of spectrum licensed to H3G, and none in the 500 MHz licensed to MLL, there are 4,338 links in the 500 MHz licensed to MBNL. The majority of these (3,924) are in or within 25km of high density areas and could be subject to revocation under option 2.<sup>372</sup>
- 7.82 In the May 2022 Consultation,<sup>373</sup> we said that retaining the MBNL licence while revoking others (i.e. option 3) could be appropriate if we considered that MBNL is likely to place a higher value than any potential new users on its 40 GHz holding, given its large number of fixed links in the band.
- 7.83 It will take some time for an equipment ecosystem to support mobile use in 40 GHz to develop. As set out in section 2,<sup>374</sup> the equipment ecosystem for the 40 GHz band is behind

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<sup>366</sup> May 2022 Consultation, paragraph 7.22.

<sup>367</sup> Vodafone, p. 14

<sup>368</sup> BT/EE, p. 24.

<sup>369</sup> VMO2, p. 20.

<sup>370</sup> VMO2, p. 20.

<sup>371</sup> Vodafone, p. 14; Vodafone confirmed this in a meeting with Ofcom on 21 September 2022.

<sup>372</sup> As proposed in the May 2022 Consultation (paragraph 7.24), we will enable existing fixed links to remain in low density areas where these would not receive interference from users in high density areas. Under our revised approach to high density areas, 2176 of MBNL’s links overlap with one of our high density areas and would need to be cleared under option 2. 3924 links fall within 25km of a high density area, and we may need to clear *up to* this number. In practice this is likely to be lower – we are consulting on the method for identifying fixed links that may not coexist with mobile deployments in high density areas. See paragraph 7.171.

<sup>373</sup> May 2022 Consultation, paragraph 7.22.

<sup>374</sup> See paragraph 2.17

that of the 26 GHz band. Once equipment is available, operators will take time to roll out their networks, taking into account emerging demand. It is therefore possible that MBNL could be the highest value user of this spectrum in the short term until the equipment ecosystem is in place for 40 GHz, and potentially for a period thereafter while demand develops.

- 7.84 However, we think that fixed link use is unlikely to be the higher value use of the 40 GHz band in the longer term:
- It is our view that the optimal use of the 40 GHz band is for mobile. The 40 GHz band has been identified globally for mobile and as a 5G band in Europe, and estimates of spectrum requirements support the need for 40 GHz as well as 26 GHz to be available for future 5G uses.
  - Moreover, the view that the band's optimal use in the longer term is for mobile is supported by the incumbent 40 GHz licensees' requests, in response to the consultation, that the licences be varied to allow mobile use.<sup>375</sup> This suggests that they themselves see mobile use as higher value than their existing fixed links.
- 7.85 We note that MBNL has a number of alternatives if its licence is revoked, such as substituting to fibre connections, or to other bands, including the 10 GHz or 32 GHz bands in which it already operates fixed links. [CONFIDENTIAL ✂].<sup>376</sup> In its confidential response, BT/EE [CONFIDENTIAL ✂].<sup>377</sup> In addition, we note that the MBNL joint venture is set to expire in 2031.
- 7.86 While the timescale of deployment of mmWave services remains uncertain, we consider there is a significant risk to securing the efficient allocation of mmWave spectrum in not revoking MBNL's licence as soon as possible. Retaining the MBNL licence would entail reserving 500 MHz of the 40 GHz band for a legacy use beyond the next five years, by which point the market for new uses may be well-developed.
- 7.87 Allowing MBNL to remain in the band would also constrain our ability to reach an optimal configuration of the whole band for many years. Retaining the MBNL licence may limit the efficient use of the 40 GHz band as a whole by other users:
- MBNL retaining its licence would impact the usability of adjacent spectrum for new mobile services. As set out in our spectrum availability analysis in the May 2020 Consultation (paragraph 7.19), the density of MBNL's links means that MBNL has a heightened risk of 'out of block emissions' interference from medium power deployments in the rest of the band. This reduces the availability for medium power in non-MBNL parts of the band, compared to analogous frequencies in the 26 GHz band. However, revoking the licence will mean that this limitation on the new award licences will be time-limited rather than long term. With all operators in the band operating

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<sup>375</sup> We note that MBNL did not respond to the consultation, however both of the joint venture partners behind MBNL (BT/EE and H3G) have requested to have the MBNL licence varied.

<sup>376</sup> [CONFIDENTIAL ✂]

<sup>377</sup> BT/EE confidential response, pp. 26-27.

under the same licence conditions with a TDD configuration, all operators can synchronise so they do not constrain each other's access to spectrum.

- The continued presence of the duplex MBNL licence would fragment the spectrum available for award into two 1.25 GHz blocks. This could limit the ability of operators to obtain large, contiguous blocks of spectrum in the award.<sup>378</sup>

7.88 In contrast, option 2 would maximise the chance that spectrum is awarded to the users with the highest valuations for spectrum, with the efficient allocation of mmWave spectrum determined by market prices in an auction. It would also 'reset' the band for new uses going forwards, removing any constraints arising from fixed links use and the duplex configuration of the band as well as allowing us to authorise the band differently in high and low density areas.

7.89 For these reasons, we consider that option 2 is more likely to lead to an efficient allocation of spectrum than option 3.

### **Revocation of all existing licences (option 2) is more likely than option 4 to secure an efficient allocation of mmWave spectrum**

7.90 Option 4, partial variation and partial revocation of licences, received very limited support from stakeholders. However, in October 2022 H3G wrote to Ofcom to argue that, should Ofcom believe it has no legal powers to run an incentive auction, H3G considers option 4 could be "an appropriate compromise... and would have some definite advantages over revocation". In the version H3G set out, Ofcom would revoke 1 GHz of H3G's 40 GHz holding and 250 MHz of MLL's holding, but Ofcom would allow MBNL to retain its 500 MHz allocation.<sup>379</sup>

7.91 H3G argued this option would have some definite advantages over revocation, in that a) it would not impose undue costs on 40 GHz licensees; b) it is consistent with H3G having a high value for at least some of its 40 GHz spectrum, [CONFIDENTIAL ✕], and recognises the consumer benefit of [CONFIDENTIAL ✕]; and c) it would release an additional 1.25 GHz of contiguous 40 GHz spectrum to be auctioned with 26 GHz for new uses.

7.92 We have considered H3G's arguments, but do not agree that option 4 would result in a more efficient allocation than option 2. We recognise (see paragraph 7.45) that H3G is likely to place value on at least some of its 40 GHz spectrum, but we consider that H3G would be well-positioned to be able to win spectrum it requires in the upcoming award. As H3G can acquire spectrum in the award, we also do not consider that licence revocation threatens the consumer benefits that H3G outlines. While option 4 would make more spectrum available in a combined 26 GHz and 40 GHz award than option 1, option 4 (like option 3) would continue to fragment the available spectrum. Option 4 would also risk a

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<sup>378</sup> We recognise that with MBNL remaining, it would still be possible that two operators could acquire 1.25 GHz contiguous spectrum each. However, this may not be the optimal allocation.

<sup>379</sup> [Letter from Luis Lopez to Gideon Senensieb](#), dated October 2022.

less efficient allocation than options 2 or 3, because H3G and MLL would continue to hold a total of 1.25 GHz, whether or not they were the highest value users of the spectrum.<sup>380</sup>

7.93 Therefore, for the reasons explained above (see paragraphs 7.78-7.92), we consider that a full reallocation of the band is more likely to result in an efficient allocation than a partial reallocation, and that option 2 is more likely to lead to an efficient allocation of spectrum than option 4. We note that H3G's arguments in favour of option 4 are broader than spectrum efficiency, and are concerned with the costs a revocation would impose on 40 GHz licensees. We consider the costs of different options under 'Impact on existing users', from paragraph 7.124. H3G also considered that option 4 would "protect some of [H3G's] rights".<sup>381</sup> We address licensees' legitimate expectations at paragraph 7.161.

#### **Our decision is consistent with our market-based approach to spectrum management**

7.94 BT/EE argued that to revoke these licences would signal that we are moving away from our market-based approach to spectrum management.<sup>382</sup> H3G said that Ofcom had not explained why it cannot rely on spectrum pricing to achieve its objectives in 40 GHz, and if Ofcom no longer trusts that ALFs can deliver optimal use we should not charge ALFs.<sup>383</sup>

7.95 H3G also commented: "It is extremely important for the confidence of the industry and investors that Ofcom does not undermine property rights, commercial security, and investment without good cause. Three purchased its 40GHz spectrum (together with other spectrum through its £300m acquisition of UK Broadband in 2017) on the expectation that our rights would be respected."<sup>384</sup> MLL made similar points, arguing that revocation will impact future investment incentives, if current investments are seen to be undermined.<sup>385</sup>

7.96 We do not agree that revoking the 40 GHz licences would be a departure from our longstanding market-based approach to spectrum management.

7.97 Since our 2005 Spectrum Framework Review, our spectrum management approach has been guided by the principle of relying on market mechanisms where possible and effective, whilst undertaking regulatory action where necessary. We favour a market-led approach because users have the best knowledge of their own costs and consumer preferences and a strong incentive to respond to market signals, such as prices, to put resources to their best possible use.<sup>386</sup>

7.98 Market mechanisms include spectrum pricing, spectrum trading and leasing, spectrum auctions, and the principle of greater licence flexibility ('liberalisation') to enable changes of use of spectrum. Auctions are a market mechanism because they allow users to bid based on their knowledge of their costs, consumer preferences, and market signals. This is the opposite of 'command and control'.

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<sup>380</sup> May 2022 consultation, paragraph 7.53.

<sup>381</sup> Letter from Luis Lopez to Gideon Senensieb, dated October 2022.

<sup>382</sup> BT/EE, p.3 and pp. 23-4.

<sup>383</sup> H3G, p. 8 and pp. 28-29.

<sup>384</sup> H3G, p. 1.

<sup>385</sup> MLL, p. 3

<sup>386</sup> Ofcom's [Spectrum Framework Review](#), published June 2005, Page 5.

- 7.99 We recognise that revoking and re-awarding spectrum could be perceived as a more intrusive intervention than liberalisation and trading. However, for the reasons set out above, we consider that relying on an auction, instead of trading, is more likely to deliver an efficient allocation of spectrum in this specific case, and that, in all the circumstances, this greater degree of intrusion is justified.
- 7.100 Our approach is consistent with our longstanding view that there is an important and complementary role for Ofcom to play in ensuring the optimal use of spectrum when major changes are being contemplated and frequencies need to be recycled. We have set out this view in various documents. In particular, in both our 2014 and 2021 spectrum strategy statements, we concluded that a combination of both market mechanisms and regulatory action may be required to achieve our spectrum management objectives, including when there is a change of use in a frequency band and frequencies need to be recycled.<sup>387 388</sup>
- 7.101 Several major changes in spectrum use have involved regulatory action, including revoking existing licences to clear a spectrum band and allocate it to new users. For example, we cleared the 700 MHz and 800 MHz bands of broadcasting use, and the 3.6-3.8 GHz band of fixed links and satellite users, to facilitate future mobile use. Indeed, we are minded to clear fixed links users from high density areas in the 26 GHz band as part of this award.
- 7.102 Regarding H3G's comments about investment certainty and that it purchased its 40 GHz spectrum on the expectation that their rights would be respected, we note that the wireless telegraphy licences granted under the Wireless Telegraphy Act 2006 are public law instruments that "constitute statutory authorisation permitting the licensees to undertake activities which would otherwise be unlawful"<sup>389</sup>. We note that the existing 40 GHz licences were awarded with a clear clause enabling Ofcom to revoke such licences for spectrum management reasons by giving 5 years notice (which could not expire before February 2023), and this revocation clause has remained part of the licences since they were awarded. The fact that we have not previously revoked an auctioned, nationwide licence for spectrum management reasons does not mean that we cannot do so in appropriate cases, in accordance with the terms of that licence.

## Conclusion

- 7.103 For the reasons set out above, we are of the view that option 2 is the option which is most likely to result in the most efficient allocation of the spectrum in both mmWave bands.

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<sup>387</sup> Ofcom's Statement "[Supporting the UK's wireless future. Our spectrum management strategy for the 2020s](#)", published July 2021, paragraphs 2.19 and 2.20.

<sup>388</sup> Ofcom's Statement "[Spectrum Management Strategy: Ofcom's strategic direction and priorities for managing spectrum over the next 10 years](#)", published April 2014, paragraph 1.12.

<sup>389</sup> See paragraph 88 of the [judgment of the High Court of Justice](#) dated 28 May 2010 in the Data Broadcasting International Limited case ([2010] EWHC 1243 (Admin)).

## Supporting innovation and investment

- 7.104 In the May 2022 Consultation,<sup>390</sup> we said that, by enabling the 40 GHz band to support the development of new uses of mmWave spectrum, all options would support innovation and investment to an extent. However, our view was that the options that are more likely to lead to an efficient allocation of mmWave spectrum are also likely to support more innovation and investment.
- 7.105 We said that the options involving licence variation (options 1 and 4) would enable investment and innovation in services by existing licensees. However, these options would make less mmWave spectrum available to other prospective new users for new uses. We said that this could potentially prevent these prospective users delivering the services they otherwise could under the most efficient allocation, particularly in the longer term, depending on their total demand for mmWave spectrum (across 26 GHz and 40 GHz).<sup>391</sup>
- 7.106 We said that option 3 would make more spectrum available to prospective users of mmWave spectrum than options 1 and 4, but less than option 2. Therefore the same risk to prospective users' services in the licence variation options would apply, though the risk would be reduced.
- 7.107 We said that option 2 would maximise opportunities for innovation and investment in new uses of mmWave spectrum by all operators as a whole. Both existing licensees and other prospective users would be able to access all mmWave spectrum simultaneously to acquire the spectrum they might need to provide quality services.
- 7.108 We remain of the view that the option that delivers the most efficient allocation should, in this case, maximise opportunities for investment and innovation in services. For the reasons set out above (paragraphs 7.64-7.74), we consider that there is significant uncertainty as to the likelihood that trading will secure the efficient allocation of this band. For similar reasons, we consider spectrum leasing, which is intended to enable short term use of spectrum, is unlikely to secure the long term efficient use of the spectrum. As a result, we consider that option 2 is most likely to support innovation and investment in mmWave spectrum, from a wide range of users, in line with our objectives for this award.

## Timely availability of spectrum

- 7.109 As set out in section 2 of this document (from paragraph 2.63), we consider it appropriate to make mmWave spectrum available for new uses as quickly as possible to provide industry with the certainty of access to enable innovation and realise the full benefits of mmWave spectrum for new uses. Our view is that all of the options we have considered would make the spectrum available on a similar timeframe:
- a) Under option 1, the spectrum would be immediately available to the existing licensees, but would only be available to other uses if and when the spectrum is traded; and

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<sup>390</sup> May 2022 Consultation, paragraph 7.55.

<sup>391</sup> May 2022 Consultation, paragraph 7.56.

- b) Under option 2, the whole band would be available to the sector as a whole. We would grant licences to the winners of 40 GHz spectrum in the award, and we are proposing that deployments by these licensees in 40 GHz spectrum could be coordinated with those of existing licensees during the notice period, thereby enabling new users to deploy immediately where the spectrum is not otherwise being used.
- 7.110 Options 3 and 4 are variations of these options. We therefore consider that under any option the spectrum would be available for new uses at around the same time.
- 7.111 We note H3G's suggestion that, if we were to revoke its licence, its intention to deploy the spectrum during the notice period would prevent new licensees from accessing the spectrum in a timely manner.<sup>392</sup> However, as explained from paragraph 7.118 below, we think this is unlikely to have a material impact in practice.

## Promoting competition

- 7.112 BT/EE said that if we opted for option 1 (variation of all licences), there would be "a significant risk that H3G gains an unmatched advantage in serving high traffic areas and hotspots". As a result, BT/EE considered that, if we decide to pursue option 1, we should impose a 'precautionary' mmWave spectrum cap of 37% in the award of 26 GHz, to mitigate risks to competition.<sup>393</sup>
- 7.113 VMO2 noted that option 2 [CONFIDENTIAL ✕].<sup>394</sup>
- 7.114 MLL also said that "the most likely outcome of the auction is that the spectrum will be purchased by established MNOs", and that "revocation of MLL's licence will remove the one credible challenger that is still in the market. The overall effect on competition is clearly detrimental."<sup>395</sup>
- 7.115 We summarise and respond to comments stakeholders provided on our high-level competition assessment proposals in section 8 of this document.
- 7.116 As we set out in the May 2022 Consultation,<sup>396</sup> we consider that the options involving revocation of all or most licences (options 2 and 3) would be more likely to promote competition than option 1, by enabling more operators to access mmWave spectrum. This also applies to option 4, though to a lesser extent, as it involves partial revocation and partial variation of H3G and MLL's licence. As explained in section 3, we consider that any potential wide area operator will have the opportunity to participate in the auction to acquire an award licence.
- 7.117 In reaching our view that option 2 is most likely to achieve our objectives, we have taken into account that it is more likely to promote competition than option 1. However, we do not expect any of the options we have considered would have a material detrimental

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<sup>392</sup> H3G, pp. 4 and 40-41.

<sup>393</sup> BT/EE, pp. 40-41.

<sup>394</sup> VMO2 confidential response, p. 20.

<sup>395</sup> MLL, p.10

<sup>396</sup> May 2022 Consultation, paragraphs 7.63-7.64.

impact on competition. This aligns with our view that competition measures are not necessary in this award (see section 8).

## Securing benefits for consumers and citizens

- 7.118 As set out in the May 2022 Consultation,<sup>397</sup> we expect that if we enable an efficient allocation of mmWave spectrum, this in turn will maximise the amount of investment and innovation in mmWave services and thereby secure the greatest benefits to consumers and citizens. Promoting competition would also further support benefits for consumers and citizens. As noted above, we consider that option 2 is most likely to result in an efficient allocation of spectrum.
- 7.119 In response to the May 2022 Consultation, several stakeholders said that revoking the existing 40 GHz licences would delay rollout in the band. H3G provided two reasons for this concern:
- a) “Firstly, 40GHz rollout requires intensive engagement between operators and device/equipment vendors over years – no UK operator will be having these discussions with vendors for several years if Ofcom chooses to revoke 40GHz licences. We would expect this to delay the rollout of 40GHz spectrum; and
  - b) Secondly, Ofcom proposes that new 40GHz licensees would be able to use the spectrum wherever existing users are not using it during the 5-year notice period – but our intention to deploy the spectrum during the notice period could prevent new licensees from accessing the spectrum in a timely manner.”<sup>398</sup>
- 7.120 BT/EE and MLL raised similar points. BT/EE said the current licensees would still be entitled to deploy new links during the revocation period, and this would give rise to uncertainty for both award winners and existing licensees.<sup>399</sup> MLL said clearing the band will effectively cease development, innovation and investment for five years due to the revocation notice period. It said that after the auction there would be no incentive for incoming spectrum owners and incumbents to cooperate given the companies are likely to be competitors.<sup>400</sup>
- 7.121 We have considered whether revocation of 40 GHz licences could lead to delayed deployments of new uses in the 40 GHz band, and therefore reduced benefits to consumers and citizens. However, we do not think revocation of licences is likely to lead to a significant delay in practice. This is because our intention is to issue notice of proposed revocation shortly after publication of this decision, and, subject to any further consideration of the issues in the course of that process, to hold the auction in early 2024. This means that, at most, any delay to operators’ discussions with equipment and device vendors will be a year. In the context of the timeframe for the development of the 40 GHz

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<sup>397</sup> May 2022 Consultation, paragraph 7.65.

<sup>398</sup> H3G, p. 4.

<sup>399</sup> BT/EE p. 21-22

<sup>400</sup> MLL, p. 3

ecosystem, we do not expect this would significantly delay benefits to citizens and consumers.

- 7.122 We have also considered whether H3G's intention to deploy spectrum during the notice period could delay rollout in the band. Our intention is that new users of the 40 GHz band will co-ordinate with existing users during their notice periods (see section 10 for our coordination proposals). We also expect that if H3G wins any spectrum in the 40 GHz award, it would prioritise deploying spectrum authorised by its new licence. This is because: (i) its new licence would authorise use of the spectrum over a longer period of time, and (ii) the technical conditions in the award licence would be more appropriate for mobile use than the conditions in the existing licence. Therefore, we think the risk that new deployments by the incumbent licensees during their notice periods materially reduce spectrum availability for new licensees is limited.
- 7.123 We therefore think the limited risks outlined by H3G and others are outweighed by the likelihood that option 2 will lead to the most efficient allocation of the spectrum, thereby leading to the greatest benefits to citizens and consumers.

## The impact on existing users

- 7.124 We have given careful consideration to the impact of the options on existing licensees, including to the question of the proportionality of our decision in light of that impact. Our assessment in the May 2022 Consultation,<sup>401</sup> focused on the impact and costs of options 2, 3, and 4 on existing licensees. Option 1 would impose no costs on existing licensees and would instead be likely to increase the value of their licences.

## Summary of responses

- 7.125 In their responses to the consultation, H3G, BT/EE and TechUK argued that we had significantly underestimated the costs of clearing fixed links from the 40 GHz band.<sup>402</sup> Vodafone did not agree with our estimated costs, but said the difference is unlikely to be significant enough to change Ofcom's decision making.<sup>403</sup>
- 7.126 UKWISPA agreed with Ofcom's analysis and cost estimates.<sup>404</sup>
- 7.127 VMO2 did not comment on our specific cost estimates, but said that the costs involved in reallocating fixed links are not large compared with the potential long term value creation from reallocating the band. VMO2 noted that incumbent users will have five years notice to replan their fixed links in high density areas, and that as per the proposed 26 GHz regime, links outside (current or future) high density areas may remain.<sup>405</sup>

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<sup>401</sup> May 2022 Consultation, paragraphs 7.67-7.81.

<sup>402</sup> H3G, p. 44; BT/EE, p. 26; techUK, p. 7, response to Q.13.

<sup>403</sup> Vodafone, pp. 12-13.

<sup>404</sup> UKWISPA, p. 3, response to Q.13.

<sup>405</sup> VMO2, pp. 33-34 and 19.

- 7.128 BT/EE said that if we were to revoke the licences, we should make spectrum efficiency grants to cover the costs of clearing existing links, perhaps some of them sooner than the 5 years' notice and on condition of stopping new deployments in the band.<sup>406</sup> In particular, BT/EE thought that revocation of MBNL's licence would not be proportionate or fair given that MBNL would encounter substantial additional costs whereas other existing licensees would not.<sup>407</sup> TechUK also said that if revocation is used then grants for spectrum efficiency would be appropriate to compensate licensees.<sup>408</sup>
- 7.129 Airwave<sup>409</sup>, Joint Radio Company (JRC)<sup>410</sup> and [CONFIDENTIAL <math>\times</math>]<sup>411</sup> identified some additional costs, above the costs we included in the May 2022 Consultation, related to configuration for resilience purposes.
- 7.130 Please see annex 7 for a more detailed summary of stakeholders' comments on our cost modelling.

### Cost of moving fixed links

- 7.131 In the May 2022 Consultation we said that we would look to clear fixed links in high density areas if we were to revoke licences.<sup>412</sup> Option 2 would impose clearance costs on MBNL and H3G, which have both deployed fixed links in their frequencies. MBNL would face the highest costs, as it has more links in the high density areas (and in total in the band) than H3G. MLL would not face costs of moving any existing services under any option, as it does not have current deployments in the 40 GHz band. However, the auction design rules which we are proposing would prevent any existing licensee winning back spectrum in a duplex configuration. MLL would therefore lose the opportunity to realise its existing plans for the spectrum.
- 7.132 We modelled the potential costs of clearing fixed links in high density areas in the 40 GHz band for the May 2022 Consultation.<sup>413</sup> We said:
- a) MBNL had around 4,500 fixed links in the 40 GHz band. We estimated that it could cost MBNL around £2.9m-£4m to move its fixed links, depending on the number of high density areas we identify. MBNL may also face separate licence fee costs, though this would depend on which band it moved its fixed links to. MBNL could move its fixed links to other bands where it has block assigned licences (e.g. 32 GHz and 10 GHz), which would not incur additional licence fee costs for adding the links currently in 40 GHz. However, any fixed links it moved to an Ofcom managed band (e.g. 38 GHz) would be subject to technical coordination and would incur licence fees for each link. As a

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<sup>406</sup> BT/EE's confidential response, p. 22.

<sup>407</sup> BT/EE, p.23.

<sup>408</sup> techUK, p. 7, response to Q.13.

<sup>409</sup> [Airwave response to the May 2022 Consultation, p. 6.](#)

<sup>410</sup> [JRC response to the May 2022 Consultation, p. 5.](#)

<sup>411</sup> [CONFIDENTIAL <math>\times</math>] confidential consultation response, annex 1

<sup>412</sup> May 2022 Consultation, paragraph 7.69; We proposed that, if we were to revoke the 40 GHz licences, we would allow existing fixed links to remain in low density areas by granting individual fixed link licences (May 2022 Consultation, paragraph 7.24).

<sup>413</sup> May 2022 Consultation, paragraphs 7.69-7.72.

conservative estimate, we suggested that these licence fees could amount to around £1.8m-£2.4m per year.<sup>414</sup> However, we may impose annual licence fees on existing licences in the 40 GHz band after 21 February 2023. We cannot say at this point whether there is likely to be a material difference between the fees that would apply in an Ofcom managed band and annual licence fees in 40 GHz.

- b) H3G had around 60 fixed links in the 40 GHz band. We estimated in the consultation that these could cost around £50,000-£60,000 in total to move. As with MBNL, it could move its links to other Ofcom managed or block assigned bands (e.g. 28 GHz). We estimated it could incur licence fee costs of around £30,000-£40,000 per year if it were to move its fixed links to an Ofcom managed band.<sup>415</sup> As above, it is not yet clear how this would compare to the annual licence fees that would apply if it were to retain its 40 GHz licence.

### Stakeholders' comments on our cost estimates

- 7.133 In their responses to the consultation, H3G and BT/EE argued that we had significantly underestimated the costs of clearing fixed links from the 40 GHz band.
- 7.134 Both BT/EE and H3G (MBNL's shareholders) provided estimates of how much it would cost MBNL to clear its links. BT/EE estimated that clearing all of MBNL's 40 GHz fixed links could cost [CONFIDENTIAL <].<sup>416</sup> In its consultation response, H3G estimated that it would cost MBNL £24.8m to clear its 40 GHz fixed links, assuming we identified 80 high density areas.<sup>417</sup> However, H3G later wrote to us to revise its estimate to £84m.<sup>418</sup>
- 7.135 H3G said that we had "significantly under-estimated the costs of MBNL moving its fixed links out of the 40GHz band" because we had:
- a) under-estimated the unit cost of replacing microwave equipment;
  - b) under-estimated the useful life of microwave equipment; and
  - c) not included the costs of deploying additional microwave sites in the baseline scenario it relies on".<sup>419</sup>
- 7.136 H3G reiterated these points and provided additional detail in a further letter sent to Ofcom in January 2023. It also said that [CONFIDENTIAL <].<sup>420</sup>

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<sup>414</sup> Based on an average fixed link licence fee in 26 GHz and 38 GHz which is around £610 per year, and assuming MBNL would move between 2,936 (20 high density areas) and 3,956 (80 high density areas) fixed links into an Ofcom managed band. In practice, we would expect MBNL would move a portion of its links to its other block assigned holdings at 32 GHz or 10 GHz.

<sup>415</sup> As with our licence fee estimate for MBNL, this is based on an average fixed link of £610 per year, and assumes H3G would move between 45 (20 high density areas) and 63 links (80 high density areas) into an Ofcom managed band.

<sup>416</sup> BT/EE confidential response, p. 25.

<sup>417</sup> H3G response, p. 48

<sup>418</sup> [H3G letter to Ofcom](#), dated January 2023.

<sup>419</sup> H3G, pp. 4 and 44.

<sup>420</sup> H3G letter to Ofcom, dated January 2023, confidential version.

- 7.137 BT/EE said that if we did revoke MBNL’s licence, we should compensate MBNL with a grant for spectrum efficiency, noting that such a grant would need to be subject to approval from the Treasury.<sup>421</sup>
- 7.138 BT/EE also said that the proposed changes to the 40 GHz band would have a significant impact on its current strategy, and that while it is supportive of the longer-term approach to this band – and it agrees with the need for more millimetre wave spectrum for 5G NR – it would be significantly impacted by any formal band clearance notification.<sup>422</sup>
- 7.139 We requested further information from MBNL relating to its costs.<sup>423</sup> In its response<sup>424</sup> MBNL estimated the overall cost of clearance of all of its links in the band to be [CONFIDENTIAL ✕], and it provided further information on equipment and site costs, asset lives and other related costs.
- 7.140 In addition, H3G identified certain additional costs that could result from clearance of fixed links from the 40 GHz band.<sup>425</sup> These were the impact on mobile users as link replacement could lead to outages of around 6 hours, the potential degradation of service if alternative bands are not able to support services with similar capacity, and the impact of directing a large amount of limited skilled engineering resources towards link replacement which would limit other programmes such as 5G rollout.

#### Our revised cost estimates under different options

- 7.141 We have revised our estimates of the costs of revoking 40 GHz licences, in light of stakeholders’ responses to the consultation and information we have sought from MBNL using our statutory information gathering powers.
- 7.142 The key changes to our modelling approach are:
- a) increasing the overall equipment, planning, deployment and installation cost of a link from £10.5k to £18k to reflect stakeholders’ responses on costs being underestimated or missing;
  - b) increasing the asset life of equipment from 7 to 12 years to take a more conservative approach given the range of stakeholder responses;
  - c) including the cost of 2% of sites requiring an additional hop in the base-case, rather than as a high-cost scenario assumption;
  - d) increasing the costs associated with an additional hop; and
  - e) adjusting the ‘uplift’ of per-link average costs as the approach used in the consultation reflected some missing costs which are now included, and did not account for some other costs that have now been included.

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<sup>421</sup> BT/EE, p. 26.

<sup>422</sup> BT/EE, p. 28.

<sup>423</sup> See statutory information request sent to MBNL dated 23 November 2022.

<sup>424</sup> MBNL response dated 13 December 2022 to Ofcom’s s35 request dated 23 November 2022

<sup>425</sup> H3G, p. 49.

- 7.143 Our updated estimates of the costs associated with moving fixed links under each of the options we proposed are that:
- Under option 1, licensees would not be subject to clearance costs, but would likely be subject to annual licence fees (“ALFs”). ALFs reflect market value, while if incumbents acquired 40 GHz spectrum in the auction they would also pay market value. Either way licensees will face the market value for any 40 GHz spectrum they continue to hold.
  - Under option 2, MBNL and H3G would incur the costs of moving their fixed links. Having considered the submissions of H3G, MBNL and BT/EE, we estimate this would cost MBNL £35.90m (previously £4m) and H3G £0.6m (previously £0.1m).
  - Option 3 would eliminate the cost of clearance for MBNL, substantially reducing the costs associated with intervention overall compared to option 2. However, H3G would still incur the £0.6m cost of clearance.
  - Option 4, if combined with option 3, would impose the same cost of clearance as option 3. MBNL would not face cost of clearance, while H3G would still face the full cost of clearance due to the duplex nature of its fixed links.<sup>426</sup>
- 7.144 We have also considered the additional costs identified by H3G which do not directly relate to the costs of clearance but rather the knock-on impact on users and other programmes. We have not been able to quantify these costs but have considered them in the round with the costs of clearance. We note that we have been very conservative in our cost modelling, and we do not think that any explicit adjustment for these additional costs would have a material impact on our overall estimates. As such, we have decided not to make any further explicit adjustment for the additional costs identified by H3G.
- 7.145 Although we acknowledge that they are non-trivial, we remain of the view that the estimated costs of clearing fixed links in the 40 GHz band are proportionate in light of the potential benefits of clearing the band for securing optimal use of spectrum and securing benefits for citizens and consumers, as set out in this section (from paragraph 7.37). The costs of clearing fixed links to make the band available for mobile are transitory in nature. The benefits of making the band available for mobile, while not quantifiable at this point, will benefit a large number of citizens and consumers and will be enduring.
- 7.146 Therefore, although we have taken into account that option 3 would reduce the costs associated with intervention overall compared to option 2, we remain of the view that option 2 does not impose a disproportionate burden on existing licensees. We explain at paragraphs 7.78–7.89 above why we consider that allowing MBNL to continue to operate its fixed links in the band would be unlikely to result in optimal and efficient use of the band as a whole. We recognise that the majority of the costs of the intervention would fall on one stakeholder – MBNL. We consider nevertheless that it would be objectively justifiable and proportionate that we exercise our power under MBNL’s licence to revoke it because we would be doing so in order to secure optimal use of the band, and because we

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<sup>426</sup> Fixed links each use two channels – one for uplink and the other for downlink. In the 40 GHz band, one of these channels would be in the lower block of each licensee’s holdings, and the other in the upper block. If we were to revoke half of H3G’s licence, this would therefore mean it has to move all of its fixed links.

intend only to revoke those of MBNL's links which we assess could suffer interference from new uses in high density areas (see from paragraph 7.170 below).

- 7.147 We also note that there are options available for some 40 GHz licensees to mitigate the impact of revocation, including the potential to bid in the award. However, the auction design rules which we are proposing would prevent any existing licensee winning back spectrum in a frequency division duplex configuration.

### Stakeholders' proposals for compensation for cost of moving fixed links

- 7.148 As set out above, BT/EE said that if we were to revoke the licences, it would be appropriate for us to make use of the provisions in section 1(5) of the Wireless Telegraphy Act 2006 to make grants for spectrum efficiency and spectrum management purposes. BT/EE suggested that such a grant could cover the costs of clearing existing fixed links, perhaps enabling clearance of some links sooner than the 5 years' notice and on condition of stopping new deployments in the band. BT/EE noted that in the past, grants have been made to displaced PMSE users, and the cost of clearing broadcasting from the 800 MHz band and later the 700 MHz band were paid for by government.<sup>427</sup>
- 7.149 BT/EE also suggested an "auction winners fund" as an alternative solution. Such a fund would entail all auction participants committing to contributing to a "clearance fund" should they win an encumbered lot, and equally existing licence holders would need to agree (prior to the auction) to accepting to sell at that pre-arranged price list (set before the auction).<sup>428</sup>
- 7.150 We have considered BT/EE's argument that Ofcom should pay compensation to licensees. We do not agree that funding is appropriate in this case.<sup>429</sup> In the past, we have used our power to make grants under s1(5) of the WT Act 2006 (which specifically requires HM Treasury's approval) sparingly and in very different circumstances, such as the ones applying in the cases mentioned by BT. In the case of PMSE users, when funding was provided for the clearance of channel 69 (as part of the 800 MHz clearance programme), we noted that "funding is only likely to be appropriate where we have not provided adequate notice to cover a licensee's reasonable expectation of continuous access to particular spectrum".<sup>430</sup> Likewise, the funding provided to PMSE users as part of the 700 MHz Spectrum Clearance programme was granted on the basis that PMSE users had to vacate the 700 MHz band earlier than expected.<sup>431</sup> Different considerations applied in relation to the funding provided by the new licensees in relation to the co-existence of new services in the 800 MHz band with digital terrestrial television ("**DTT**"), where the purpose

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<sup>427</sup> BT p. 23.

<sup>428</sup> BT p. 23.

<sup>429</sup> Under section 1 of the WT Act Ofcom may only make a grant of funding to any person with the consent of the Treasury and where the making of the grant is likely to promote (a) the efficient use in the UK of the electromagnetic spectrum for wireless telegraphy; or (b) the efficient management of that use.

<sup>430</sup> Ofcom's Statement "[Clearing the 800 MHz band](#)", published 5 August 2010, paragraph 4.13.

<sup>431</sup> Ofcom's Statement and Consultation "[PMSE clearing the 700 MHz band](#)", published 23 August 2018, paragraph 2.5.

of the funding scheme was to deal with the specific risk of interference and disruption to DTT consumers across the UK.<sup>432</sup>

- 7.151 We do not consider that the circumstances of the 40 GHz band make compensation appropriate in this case, as we will give licensees reasonable periods of notice in accordance with the terms and conditions of their licences. Similarly, we did not make any grant for the clearance of fixed links from the 3.6-3.8 GHz band, and we do not consider that compensation for the clearance of fixed links from the 26 GHz band would be appropriate.
- 7.152 We consider that the 'auction winners fund' proposed by BT/EE is a matter for award winners, rather than Ofcom. We do not consider it is necessary for Ofcom to implement this as we consider it is appropriate for us to make the spectrum available in 5 years' time. Should new licensees wish to access the spectrum sooner, this is something they would be free to agree on a commercial basis.

### Costs related to acquiring the spectrum for new uses

- 7.153 Under options 2 and 3, the existing licensees would face costs from participating in the process for awarding the new award licences, if they wanted to acquire spectrum in the 40 GHz band.<sup>433-434</sup>
- 7.154 Acquiring spectrum in an auction would give rise to two sets of costs: (a) administrative costs relating to preparing for, and participating in, the auction, and (b) the auction prices for licences.
- 7.155 We consider the administrative costs of participating in the auction are likely to be low in the context of the value of the spectrum to the participant.
- 7.156 We note that auction prices may be more substantial. However, we consider it appropriate for licensees to pay the market value of spectrum that they use, as incumbents would do if they acquired 40 GHz spectrum in the auction. If we did not revoke the licences, incumbents would be subject to ALFs, which would also be set to reflect market value.<sup>435</sup> Either way licensees will face the market value for any 40 GHz spectrum they are authorised to use.

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<sup>432</sup> Ofcom's Statement "[Assessment of future mobile competition and award of 800 MHz and 2.6 GHz](#)", published 24 July 2012, section 11 and [annex 6](#).

<sup>433</sup> These costs would be an additional cost compared to if we were to vary licences, unless they would participate in the process to acquire 26 GHz regardless of the option we take.

<sup>434</sup> We note that the auction design rules which we are proposing would prevent any existing licensee winning back spectrum in a duplex configuration.

<sup>435</sup> We recognise that in practice ALFs set based on our estimate of market value might not be the same as the market value of spectrum revealed through an auction.

## Costs related to delayed deployments

7.157 For the reasons set out in paragraph 7.118-7.123 (securing benefits for citizens and consumers), we do not expect delayed deployments to have a material impact on the time at which citizens and consumers can benefit from mmWave spectrum.

## Loss of opportunity to profit from trades

7.158 We note that revoking operators' spectrum licences means they will lose the opportunity to profit from giving up those licences (i.e. in a trade). However, in circumstances where we have concluded that revocation is the course most likely to achieve optimal use of spectrum, and to serve our statutory objectives, and where the existing licences clearly include terms which enable us to revoke them on giving 5 years notice, we do not consider that this factor can carry substantial weight in our decision-making.

## Other impacts

### Risk of undue discrimination

7.159 H3G said that revocation of 40 GHz spectrum would discriminate against H3G and would not be consistent with other interventions by Ofcom. H3G said that Ofcom should liberalise 40 GHz in the hands of existing licensees to enable mobile use as it has always done when enabling new technologies in bands held by MNOs.<sup>436</sup> H3G argues that in a recent Ofcom consultation proposing to liberalise Vodafone's licences for 5G, Ofcom has not assessed either the risk that the current allocation of Vodafone's licences may be inefficient, nor analysed whether Vodafone may be "the highest value user" for this spectrum [CONFIDENTIAL ✕].<sup>437</sup>

7.160 We assess each licence variation or revocation on its merits, on a case-by-case basis. The specific circumstances of the examples cited by H3G were different from the case of the 40 GHz licences. For example, unlike the 40 GHz licences, the relevant licences in those examples already authorised mobile use and the variations enabled operators to upgrade use of these bands for later generations of mobile technology. We do not consider that revoking the 40 GHz licences (option 2) would amount to undue discrimination against any existing or potential new licensee. Although this option would have a differential effect on operators, that is a consequence of operators' different factual situations (as regards, for instance, their spectrum holdings in the 40 GHz band and their level of use (or expected use) of the frequencies licensed to them) and not of any unequal treatment by Ofcom.

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<sup>436</sup> H3G gave the examples of: (1) Ofcom liberalised 2G 900 MHz and 1800 MHz licences in 2011 to enable 3G services, as required by the Secretary of State; (2) Ofcom liberalised EE's 1800 MHz licence in 2012 to allow the use of 4G; (3) Ofcom's proposals to liberalise Vodafone's 900 MHz, 1800 MHz, 2100 MHz spectrum to enable 5G, and to make similar changes to other MNO licences upon request. We have subsequently published a statement that we have decided to update the technical conditions of licences held by Vodafone in the 900 MHz, 1800 MHz, 2100 MHz and 2.6 GHz bands [Ofcom's decision to update the technical conditions of Vodafone's and Telefonica's mobile licences to enable the deployment of newer technologies including 5G](#), statement September 2022.

<sup>437</sup> H3G confidential response, pp. 29-30

### Legitimate expectations

- 7.161 H3G said that it had “purchased its 40GHz spectrum (together with other spectrum through its £300m acquisition of UK Broadband in 2017) on the expectation that our rights would be respected. We expected to be able to use our spectrum, not to be forced to vacate the band without compensation.”<sup>438</sup>
- 7.162 We do not consider any of the existing 40 GHz licensees, or any potential new licensee, enjoys a legitimate expectation that we would proceed with any particular option as regards liberalisation or revocation of the 40 GHz band. As noted above, the existing 40 GHz licences contain a clear clause enabling Ofcom to revoke or vary the licences, and this clause has remained part of the licences since they were awarded. Our consultation was the first time Ofcom has discussed how it intends to treat existing 40 GHz licences at the end of their initial term. Therefore, our view is that no licensee or other operator has any legitimate expectation about the exercise of Ofcom’s powers to vary or revoke these licences at the end of their initial term. We do not agree with H3G’s characterisation of our approach as not “respecting” their rights since we are simply exercising a revocation power which has been written into the relevant licences since 2008.

### Conclusion and next steps

- 7.163 Our main duty in managing the radio spectrum is to secure its optimal use. For the reasons set out above, we consider that the optimal use of mmWave spectrum is mobile, and that it is appropriate to make all of the spectrum available for mobile in order to encourage investment and innovation. We must also ensure that the allocation of mmWave spectrum is efficient. For the reasons set out above, we think that revoking spectrum in the 40 GHz band, and reallocating it at the same time as we allocate spectrum in the 26 GHz band (option 2), is more likely to ensure that the spectrum is allocated efficiently, compared to the other options that we have considered. We also consider that allocating the spectrum for mobile, and ensuring the allocation is efficient, will secure the most benefits for citizens and consumers.
- 7.164 We have taken into account that revoking and reallocating the spectrum is likely to have an impact on existing users of the spectrum, particularly MBNL, which is currently using its spectrum extensively. We have also taken into account the information we have received as to the likely scale of that impact. However, we have concluded that alternatives to revocation are less likely to secure an efficient allocation of the spectrum, and, in any case, the cost associated with requiring MBNL to move its fixed links are justifiable in light of the potential benefits of clearing the band. We also note that there are options available for some 40 GHz licensees to mitigate this impact, including the potential to bid in the award.<sup>439</sup>

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<sup>438</sup> H3G, p. 1.

<sup>439</sup> We note that the auction design rules which we are proposing would prevent any existing licensee winning back spectrum in a duplex configuration.

## Notice period

- 7.165 The existing 40 GHz licences include a provision which enables us to revoke them for spectrum management reasons by giving the licensee at least 5 years' notice.
- 7.166 Revoking the existing licences as early as possible is most likely to meet our objectives for this award. This is because revocation of the existing licences will enable us to make the whole 40 GHz band available for new uses, without constraints, from the end of the notice period.
- 7.167 We acknowledge that revocation of existing licences will require MBNL to remove and replace up to 3,924 links within 5 years. We have considered whether we should allow for a longer notice period. However, we note that if MBNL considers its value for certain frequencies in certain areas is greater than that of the award winner, then it is open to MBNL to negotiate with the award winners to allow it to keep certain links in place for a longer period under the Local Access licensing framework.<sup>440</sup>

## Next steps for implementation

- 7.168 We will shortly commence the statutory revocation process, which involves notifying the existing 40 GHz licences of the proposed revocation.<sup>441</sup>
- 7.169 Licensees will have a period of one month within which to make representations on our proposals for their licences. We will take into account any representations before reaching a final decision in relation to each licence. We will write to affected licensees within one month of the deadline for their representations to confirm our final decision for their licence.

## Continued use of existing links in low density areas

- 7.170 In the May 2022 consultation,<sup>442</sup> we said that if we were to revoke some or all 40 GHz licences, we would expect to reflect the same approach as proposed in relation to use of the 26 GHz band in low density areas. In particular, that existing fixed links would remain in low density areas, and to make spectrum available for Shared Access on a first come, first served basis. In the 40 GHz band, this would involve granting individual fixed link licences for each of the fixed links continuing to operate in low density areas, following revocation of the relevant block assigned licences.
- 7.171 In line with our consultation proposals, subject to the outcome of the revocation process, we have decided to offer to grant individual fixed link licences for links already in place in the 40 GHz band where these are not in or around high density areas, consistent with our approach in the 26 GHz band (set out in section 5). We are consulting on the method for identifying fixed links that are likely to receive interference from mobile deployments in high density areas (details are set out in annex 16). As a result, we cannot yet say which

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<sup>440</sup> Ofcom's webpage "[Local Access Licences](#)".

<sup>441</sup> [WT Act 2006](#), Sch. 1, paragraph 7.

<sup>442</sup> May 2022 Consultation, paragraph 7.24.

existing 40 GHz links we will be able to license. Using the method we are consulting on, 3,262 of MBNL's 4,338 links would need to be cleared. This is fewer than the 3,924 links we have used for our cost modelling (which is based on the number of links that fall within 25km of a high density area).<sup>443-444</sup> We expect to confirm our method and the links that would be able to be licensed in our next statement, which we intend to publish in Q3 of FY2023/4.

- 7.172 While we recognise that incumbent 40 GHz licensees may choose to make additional deployments in the 40 GHz band until their licence is revoked, we are not minded to grant licences for any deployments (fixed link or otherwise) that incumbent licensees choose to make following publication of this document. This is because these deployments would have been made in the knowledge that the band is subject to revocation. To give effect to this, we will issue a formal request for information to provide information on all currently active deployments.
- 7.173 Our intention is that we will offer to migrate the links already in place which are not in or around high density areas from the existing 40 GHz licences to new fixed link licences on the same terms and conditions as for retained links in the 26 GHz band. This includes that we will not provide an option for any technical variations to licences,<sup>445</sup> and that licences will have an indefinite duration. The 40 GHz band will be closed to any new links other than as described above.
- 7.174 Because deployments under the existing 40 GHz licences are not managed by Ofcom, incumbent licensees may have deployed links in ways that would fail coordination in an Ofcom-managed band due to risk of interference between their own links. As these links have coexisted until now, we do not expect to take self-interference into account when licensing these legacy links in the band. Going forward, we will coordinate these legacy links with other new users of the band, such as Shared Access licensees.
- 7.175 We will contact licensees closer to the end of the revocation period to confirm which of their eligible links they would like Ofcom to migrate to a new fixed link licence. We will issue these new licences ahead of the expiry of the existing 40 GHz licences to ensure that links can continue to operate uninterrupted.
- 7.176 As part of this process we will need to set a fee for the new fixed link licences in the 40 GHz band. The formula for calculating fees for point-to-point fixed links is set out in Schedule 3 of the Wireless Telegraphy (Licence Charges) Regulations 2020.<sup>446</sup> We are asking stakeholders whether they agree that the fees for 40 GHz links should be the same as for the 26 GHz band.<sup>447</sup>

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<sup>443</sup> The detail of our cost modelling is set out in annex 7.

<sup>444</sup> 62 of H3G's 63 links would need to be cleared under our proposed method, compared to all 63 in our cost modelling.

<sup>445</sup> Ofcom's notification to stakeholders "[Closure of 26 GHz band to new fixed link licence applications and technical variations](#)", published 18 January 2022.

<sup>446</sup> [Wireless Telegraphy \(Licence Charges\) Regulations 2020](#)

<sup>447</sup> By which we mean using the formula for point-to-point fixed links and the same band factor (0.26) as for 26 GHz in the Wireless Telegraphy (Licence Charges) Regulations 2020

### Making the band available for Shared Access in low density areas

- 7.177 As set out above, in the May 2022 Consultation,<sup>448</sup> we proposed to make the 40 GHz band available for Shared Access in low density areas.
- 7.178 We are still minded to make the band available for Shared Access use in low density areas. However, as explained in section 3 as the existing licences are subject to a 5 year notice period, our current intention is to make Shared Access licences available after the end of the revocation period.<sup>449</sup> This will reduce the co-ordination burden on existing 40 GHz licensees during the 5 year revocation period, and help manage Ofcom’s internal resource.

### Annual licence fees (ALFs)

- 7.179 We note that we have the power to apply ALFs to the 40 GHz licences from February 2023. Administered Incentive Pricing’s (“AIP’s”) role in securing optimal use of the spectrum is in providing long-term signals of the opportunity cost of spectrum.<sup>450</sup> If we revoke the 40 GHz licences, we do not expect to set ALFs during the 5 year notice period.

## Consultation question

**Question 3:** Do you agree that the licence fee for fixed links that we allow to remain in the 40 GHz band should be the same as the fee in place for the 26 GHz band? If not, please give reasons.

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<sup>448</sup> May 2022 Consultation, paragraph 7.24.

<sup>449</sup> Paragraphs 3.74-3.76.

<sup>450</sup> Ofcom’s Statement “[SRSP: The revised Framework for Spectrum Pricing](#)”, published 17 December 2010, p. 3.

## 8. Competition assessment

### Summary

- 8.1 One of our objectives in this award is to ensure that people and businesses continue to benefit from strong competition in the provision of mobile services.<sup>451</sup> Examples of such benefits could include lower prices, more innovation in the market and greater choice for consumers. In this section, we consider any potential competition concerns that could arise in the proposed auction of new 26 GHz and 40 GHz licences in high density areas.
- 8.2 For the purpose of this analysis, we have assumed that we would revoke existing spectrum licences in and around high density areas in the 26 GHz band and auction new licences, and also revoke existing 40 GHz licences and auction new licences, which is in line with our decision to start the revocation process, as set out in section 7 of this document.
- 8.3 In summary, our assessment is that, given the current market structure<sup>452</sup> and the assumptions outlined in the paragraph above, competition concerns are unlikely to occur in the context of this award and that therefore competition measures are not required. We have therefore decided not to impose any competition measures in this award. Our reasoning for this decision is set out in full in this section.

### Background

- 8.4 Both the 26 GHz and 40 GHz spectrum bands have been identified for International Mobile Telecommunications.<sup>453</sup> As set out in the May 2022 Consultation, we believe that these two spectrum bands will be functionally substitutable and we therefore consider the relevant spectrum bands for the purposes of our competition assessment to be the 26 GHz and 40 GHz bands.<sup>454</sup> We have not included holdings of lower frequency (sub-6 GHz) spectrum licences in our analysis as we consider that mmWave spectrum is likely to be used by MNOs in a very different way from lower-frequency bands. The large bandwidths available in the mmWave bands will enable extremely high speed data transfer and large data capacity, but the associated coverage area is much smaller than for lower frequency spectrum bands.<sup>455</sup>
- 8.5 The specific potential uses of these mmWave spectrum bands are still emerging and there is uncertainty as to how much of this spectrum MNOs will require to compete effectively in future. As a result, there is considerable uncertainty as to which specific auction outcomes could give rise to competition concerns. As set out in the May 2022 Consultation, in

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<sup>451</sup> As set out in the [May 2022 consultation](#) (paragraph 11.14), whilst we do not expect the use of 26 GHz and 40 GHz spectrum to be limited to mobile operators, we have not identified any potential impact on competition in other markets.

<sup>452</sup> As described in paragraph 8.6. It is possible that the structure of this market could change in the future or new markets could emerge based on innovative services.

<sup>453</sup> May 2022 Consultation, paragraphs 2.10 and 2.14.

<sup>454</sup> May 2022 Consultation, paragraph 11.7.

<sup>455</sup> May 2022 Consultation, paragraph 2.4.

general terms, we would tend to be concerned if there were a significant imbalance in spectrum holdings which could lead to an enduring weakening of competition.<sup>456</sup>

- 8.6 There are currently four MNOs in the UK: BT/EE, Vodafone, VMO2 and H3G. VMO2 currently has the largest market share (40%), followed by BT/EE (31%), Vodafone (17%) and H3G (11%).<sup>457</sup> We consider that the current market for the provision of mobile services is functioning well, with competition between the MNOs delivering positive outcomes for consumers.
- 8.7 In general, the need for competition measures depends on the amount of spectrum being made available and also on the existing spectrum holdings of market participants. In terms of this specific award, none of the MNOs has spectrum holdings in the 26 GHz and 40 GHz bands which they can currently use for mobile. If we were to vary the 40 GHz licences, both H3G and MBNL, which is jointly owned by H3G and BT/EE, could use their 40 GHz licences for mobile. However, as set out in section 7, we have decided to start the process for revoking all current 40 GHz licences, and to grant individual licences for links already in place where they are not in or around high density areas.<sup>458</sup> If we revoke the 40 GHz licences, none of the MNOs will have any spectrum holdings in either the 26 GHz or 40 GHz bands which could be used for mobile in high density areas. In total, we are minded to make 5.4 GHz of spectrum available by auction in high density areas – 2.4 GHz of 26 GHz spectrum and 3 GHz of 40 GHz spectrum.

## Consultation proposals

- 8.8 For the purposes of our initial competition assessment set out in the May 2022 Consultation, we focused our analysis on mobile markets and high density areas, as we considered that if any competition concerns were to occur it would be in these sectors. We considered that the proposed auction was unlikely to have a notable impact on competition for Fixed Wireless Access as connectivity could be provided by using other mmWave spectrum bands and its main substitute, fixed broadband, is widely available in the UK.
- 8.9 We provisionally assumed that we would revoke existing spectrum licences in high density areas in the 26 GHz spectrum band and auction new licences. We also outlined four different potential options for the 40 GHz band and considered the potential competition concerns that might arise under each one.
- 8.10 Our provisional views on competition concerns associated with these four options are summarised below:

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<sup>456</sup> May 2022 Consultation, paragraph 11.8.

<sup>457</sup> On a consumer subscriber basis in Q2 2022 – Source: [Ofcom Main Technology Tracker 2022](#) Table 56 QM4: “Which mobile network do you use most often?”. Figures for VMO2 include giffgaff, Sky Mobile, TalkTalk and Tesco Mobile; figures for BT/EE include Plusnet, and Utility Warehouse; figures for Three include iD Mobile and Smarty; and figures for Vodafone include Asda Mobile, Lebara, Lyca Mobile, and Talk Mobile.

<sup>458</sup> See paragraph 7.8.

- **Option 1: Variation of all current 40 GHz licences** for new uses including mobile, without reallocating spectrum. We considered that under this option, it might be appropriate to impose a competition measure such as a ‘precautionary cap’ to prevent H3G from acquiring large amounts of 26 GHz spectrum.
- **Option 2: Revocation of all 40 GHz licences** and reallocation of the entire band (3 GHz) for new uses, including mobile. Our provisional view was that a competition concern would be unlikely to arise in this situation, as there would be a large quantity of spectrum available and none of the MNOs would start out with holdings of mmWave spectrum which could potentially be suitable for mobile use. Our provisional conclusion was that it was unlikely that competition measures would be required under this option.
- **Option 3: Partial revocation of 40 GHz licences** – revocation of H3G and MLL’s licence, but not MBNL’s licence.<sup>459</sup> Again, our provisional view was that a competition concern would be unlikely to occur under this option due to the large quantity of spectrum available to all MNOs and the fact that none of the MNOs would start out with holdings of mmWave spectrum which could potentially be suitable for mobile use (as MBNL’s licence would not be varied). As with option 2, our provisional view was that it was unlikely that competition measures would be required under this option.
- **Option 4: Partial variation and partial revocation of 40 GHz licenses**, by varying H3G and MLL’s licences to enable new uses, but only in relation to some of their existing frequencies.<sup>460</sup> Our provisional view was that a competition concern was less likely to arise than under option 1 as, although H3G would begin the auction process with existing holdings of mmWave spectrum, these would be much lower than in option 1 and a larger amount of spectrum would be available in the auction. Similarly, it was less likely (although still possible) that we would need to impose a competition measure such as a cap under this option, than under option 1.

8.11 We sought views on our assessment of the competition concerns and potential competition measures in the May 2022 Consultation.

## Consultation responses

8.12 Of a total of 28 consultation responses received, nine specifically mentioned competition issues. BT/EE, Qualcomm, techUK, UKWISPA, VMO2 and Vodafone all agreed with our assessment that competition concerns were unlikely to arise in the situation where all 40 GHz licences were revoked (option 2).

8.13 In terms of a potential competition measure, none of the respondents disagreed with our provisional conclusion that a ‘precautionary cap’ on H3G’s holdings was likely to be required under option 1. However, three respondents (techUK, VMO2 and Vodafone)

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<sup>459</sup> Under this option, we would not vary MBNL’s licence.

<sup>460</sup> We provisionally proposed that we would vary half of H3G and MLL’s 40 GHz licences and revoke and reallocate the other half.

suggested that a 'safeguard' spectrum cap would be beneficial even if 40 GHz licences were revoked (options 2 and 3).

- 8.14 Vodafone proposed a 1 GHz cap on 26 GHz spectrum on the basis that the 40 GHz ecosystem would lag behind that of 26 GHz.<sup>461</sup> techUK also suggested that "There is also merit in having a general safeguard cap on 26 GHz e.g. at 1 GHz max."<sup>462</sup>
- 8.15 VMO2 argued that "there is a strong case for a precautionary cap of 1,000 MHz in each of the 26 GHz and 40 GHz bands, with respect to high density exclusive licences. Thus, each bidder would be limited to acquiring at most 2,000 MHz in total, a maximum of 1,000 MHz at 26 GHz and a maximum of 1,000 MHz at 40 GHz."<sup>463</sup> It also argued that "Precautionary caps are necessary to eliminate the possibility of one or two operators attempting to acquire over-large holdings now, when industry demand for mmWave spectrum may be soft, in expectation of excluding rivals in the long term. We agree that this risk is greatest if Ofcom does not revoke 40 GHz licences, but the risk remains even if Ofcom does revoke"<sup>464</sup> and that "If there is a case for precautionary caps to stop any single bidder buying excessive quantities of mmWave spectrum, then this case applies irrespective of whether particular bidders enter the auction with a spectrum holdings advantage."<sup>465</sup> It also argued that this approach was desirable as it would allow three winners in each band and also be in line with international caps.<sup>466</sup>
- 8.16 Additional comments referring to competition provided by Luminet and MLL did not relate to the specific competition concerns and competition measures discussed in the May 2022 Consultation. These responses are considered in section 3 and section 7 respectively.<sup>467</sup>

## Our decision

- 8.17 As we set out in section 7, we have decided to start the process for revoking all existing 40 GHz licences in order to reallocate the entire band for new uses, including mobile, alongside the 26 GHz band. Therefore, our further assessment of potential competition concerns and any measures required has focused on this option (option 2 in the May 2022 Consultation).

## Our provisional view

- 8.18 Our provisional view, as set out in the May 2022 Consultation, was that a competition concern was unlikely to arise if we were to revoke all 40 GHz licences due to the large amount of mmWave spectrum that would be available for mobile use, combined with the

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<sup>461</sup> Vodafone, p. 20.

<sup>462</sup> techUK, p. 8.

<sup>463</sup> VMO2, p. 27.

<sup>464</sup> VMO2, p. 35.

<sup>465</sup> VMO2, p. 27.

<sup>466</sup> VMO2, p. 28.

<sup>467</sup> Paragraph 3.51; paragraphs 7.52-7.54.

fact that none of the MNOs would begin the auction process with any existing holdings of such spectrum in high demand areas.<sup>468</sup>

- 8.19 The large amount of spectrum to be made available under this option means that we expected that MNOs would be able to acquire as much mmWave spectrum as they required in the auction. Whilst we said that we might in theory be concerned about a hypothetical outcome in which one MNO obtained a very high proportion of the total spectrum available in the 26 GHz and 40 GHz bands, we considered that such an outcome would be extremely unlikely to occur in practice and that likewise the risk of strategic bidding appeared to be low. We provisionally concluded that no competition measures would be required in this scenario as no potential competition concerns had been identified.

## Our assessment

### Potential competition concerns

- 8.20 As in the May 2022 Consultation,<sup>469</sup> we have focused our analysis of competition concerns on the mobile market<sup>470</sup> and in high density areas. We have also focused on the assessment of competition concerns which could potentially arise in the scenario where all 40 GHz licences are revoked (option 2) as we have decided to start the process for revoking all 40 GHz licences.
- 8.21 In general terms, we would be concerned if there was a significant imbalance in spectrum holdings which led to a sustained weakening in competition in the mobile market. In order for this to take place, the following steps would need to occur:
- One (or more) MNOs acquires a very large share of mmWave spectrum in the award.
  - New uses for mmWave spectrum emerge which require very large holdings, as a result of which, only an MNO with a large share of mmWave spectrum can compete in provision of these services.
  - These services are so highly valued by consumers that it leads to an unmatched competitive advantage being created in the market.
  - This leads to a persistent weakening of competition and poorer outcomes for consumers.
- 8.22 In assessing competition concerns, such as that set out above, we would evaluate both the likelihood of any concern occurring, and the severity of any such concern. We consider each below.
- 8.23 Firstly, we have considered scenarios which could arise in which one or more MNOs acquires a very large share of spectrum in this award, preventing other MNOs from acquiring the amount of spectrum which they need in order to compete effectively.

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<sup>468</sup> May 2022 Consultation, paragraphs 11.18-11.21.

<sup>469</sup> May 2022 Consultation, paragraph 11.3.

<sup>470</sup> Although the range of possible uses for 26 GHz and 40 GHz spectrum is wider than this, including for example Fixed Wireless Access, we have not identified any potential concerns relating to other uses of this spectrum.

- 8.24 If all 40 GHz licences are revoked (option 2), a total of 5.4 GHz of mmWave spectrum will be made available via auction in high density areas. Given that this represents a large amount of spectrum, in order for an operator to prevent one of its rivals from acquiring the spectrum which it needs to compete effectively, that operator would have to acquire a very large amount of spectrum.
- 8.25 As set out in section 2, there is a wide range of estimates as to the amount of mmWave spectrum which MNOs are likely to require, with the top end of this range of estimates being around 800 MHz to over 1 GHz.<sup>471</sup> There is no current evidence that having more mmWave spectrum than this would allow an MNO to provide services that their competitors could not, although we acknowledge that this is an evolving market and it is possible that such uses could develop in the future.
- 8.26 However, even if such a use of spectrum were to occur in the future (i.e. requiring a very large amount of mmWave spectrum, such that it could only be provided by an MNO with very large holdings of mmWave spectrum), this in itself is not sufficient to lead to a competition concern occurring unless these services are so highly valued by consumers that it leads to an unmatched competitive advantage being created in the market and other MNOs cannot compete in other areas of service provision. Given that such uses of this spectrum are only speculative at the moment, it appears highly unlikely, although not impossible, that this could be the case.
- 8.27 As set out in section 12, we are minded to set a fixed term of 15 years for the 26 GHz and 40 GHz licences awarded in the auction, instead of granting indefinite licences. Whilst our assessment that a competition concern is highly unlikely to occur would not change even if we were to grant indefinite licences, the use of fixed-term licences as proposed would further reduce the likelihood of any persistent competition concern occurring, given that spectrum could be re-awarded at the end of the licence term and any competition issues taken into account at this point.
- 8.28 In light of the above, our view is that competition concerns are unlikely to arise from the mmWave award.

### Competition measures

- 8.29 As set out in the section above, the risk of serious and persistent competition concern arising as a result of this award appears to be extremely low.
- 8.30 Whilst it appears unlikely that a competition concern would arise as a result of this award, we recognise that there is still a high degree of uncertainty surrounding future market developments and uses of mmWave spectrum. On this basis, we have considered whether a spectrum cap could still be an appropriate option for this award, as suggested by some respondents.<sup>472</sup>

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<sup>471</sup> Paragraphs 2.53-2.61.

<sup>472</sup> Paragraphs 8.13 to 8.14.

- 8.31 We note that imposing a competition measure such as a spectrum cap in the auction would be an intervention in the market. In general, we seek to ensure that the level of intervention is not more onerous than is required to achieve our policy objectives.
- 8.32 Firstly, we have considered the argument for applying a spectrum cap to the 26 GHz band specifically, as proposed by Vodafone and techUK.<sup>473</sup> As set out in the May 2022 Consultation, we consider that any potential competition concerns would be unlikely to arise in the short term.<sup>474</sup> In view of this, we consider that the difference in timing of availability of the spectrum bands, which will also be a short term effect, is unlikely to result in competition problems and that therefore such a cap is not justified.
- 8.33 We have also considered the case for applying a cap to both the 26 GHz and 40 GHz bands (as proposed by VMO2)<sup>475</sup> in order to prevent operators acquiring large shares of mmWave spectrum whilst demand is low and potentially excluding rivals in the longer term.
- 8.34 We note that the uncertainty of future demand is relevant to both a bidder seeking to foreclose a rival and to the potential target of such a foreclosure. For the bidder seeking to foreclose, the future uncertainty around demand for the spectrum increases the risk that, if future demand is less than it predicts, it will incur the cost of acquiring spectrum with limited intrinsic value, without successfully foreclosing. In terms of the potential target of foreclosure, in our view the large amount of spectrum available means that all bidders will have sufficient opportunity to acquire the spectrum they need.
- 8.35 Although a spectrum cap would remove the risk of one or more MNOs acquiring a very large share of mmWave spectrum, which could potentially lead to a competition concern in the future in certain scenarios, there are also several potential downsides associated with such a spectrum cap. In general, the purpose of having an auction is to allow bidders to express their valuations across the different bands and to ensure that spectrum is acquired by the highest value user, consistent with our duty to secure the optimal use of spectrum.
- 8.36 The more tightly a spectrum cap is set, the more likely it is that the allocation of spectrum will be determined by the cap, rather than by the relative valuations of bidders. For example, it is possible that one bidder is in a position to make more extensive use of mmWave spectrum than the others, and a restrictive cap would prevent this. A cap could therefore prevent an economically efficient allocation of spectrum from being achieved. We note that competition measures such as this may unintentionally harm consumers' interests if they prevent an outcome that would be beneficial. For example, if competition measures mean that spectrum is not allocated to operators that have the highest intrinsic value, and could therefore provide innovative and/or competitive services, they might be against consumers' interests.

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<sup>473</sup> Paragraph 8.13.

<sup>474</sup> May 2022 Consultation, paragraphs 11.15 and 11.23.

<sup>475</sup> Paragraph 8.14.

- 8.37 On the other hand, a much looser spectrum cap would reduce the risk of this occurring, but it is quite possible that it would be ineffective in preventing any competition problems from arising.
- 8.38 An optimal cap would minimise, or at least limit, the risk of competition problems, while also allowing bidders to express their relative intrinsic valuations for the spectrum. Given the uncertainty about how demand for the bands will develop in the coming years, we do not think we are in a position to identify the level at which a cap could be set to achieve this optimal outcome.
- 8.39 In its response, VMO2 also noted that in countries that have released mmWave spectrum,<sup>476</sup> regulators have typically set band specific caps of 800-1000 MHz.<sup>477</sup> However, we note that these countries have not typically made available other mmWave bands alongside 26 GHz and that therefore the total amount of spectrum awarded is much smaller than the amount that will be available if we revoke all the 40 GHz licences (option 2). As set out above, we believe the large amount of spectrum to be made available in this award makes it unlikely that a competition concern would occur.
- 8.40 We therefore conclude that no competition measures are required in this award as there is no evidence of a serious and persistent competition concern that is likely to arise, and in any case it is not clear that a spectrum cap would be an effective remedy to solve this problem or that we are in a position to identify the level at which an optimal cap could be set.

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<sup>476</sup> Including South Korea, Italy, Finland, Greece, Taiwan, Denmark, Thailand, Slovenia, Croatia, Brazil and Australia.

<sup>477</sup> VMO2, p. 28.

## 9. Auction design

### Summary

- 9.1 In this section, we set out our auction design proposals for the award of the 26 and 40 GHz bands, which we have developed taking account of stakeholders' comments to the May 2022 consultation.
- 9.2 We propose an auction design with the following features:
- a) **A principal stage and an assignment stage:** the auction would have two bidding stages: the principal stage and the assignment stage. The principal stage would determine the amount of spectrum won by bidders bidding for frequency generic lots. The assignment stage would determine the precise frequencies awarded.
  - b) **A clock format for the principal stage:** the principal stage would comprise of successive rounds with ascending prices and would end when there is no excess demand for spectrum in any lot category.
  - c) **Combine high density areas:** we are proposing to combine all high density areas so that each lot would authorise spectrum use in all high density areas. We will consider disaggregating specific high density areas if we see evidence of likely demand for individual areas in response to this consultation.
  - d) **Three lot categories:** the lots categories would be designed as follows.
    - i) 26 GHz lower (25.1-26.5 GHz); 14x100 MHz lots; 1.5 eligibility points per lot.
    - ii) 26 GHz upper (26.5-27.5 GHz); 10x100 MHz lots; 1.5 eligibility points per lot.
    - iii) 40 GHz (40.5-43.5 GHz); 30x100 MHz lots; 1 eligibility point per lot.
  - e) **Reserve prices:** mmWave reserve prices would fall within the range £0.25m to £2m per lot; and our current view is that reserve prices of £1m for 26 GHz and £0.5m for 40 GHz would be appropriate.
  - f) **Eligibility rule:** the maximum number of lots a bidder could bid for in a round would be constrained by an eligibility points-based activity rule. Bidders would only be able to maintain or reduce their demand, measured in eligibility points, as bidding progresses. Each lot within the 26 GHz band would be assigned 1.5 eligibility points, while each lot within the 40 GHz band would be assigned 1 eligibility point.
  - g) **Bid types:** bidders would be allowed to submit two types of bids: "simple bids" and "all or nothing bids". These would be processed by the electronic auction system (the "EAS") and then accepted or rejected. Simple bids may be accepted either in part or in their entirety, while all or nothing bids, which could only be used for requesting a reduction in demand, may only be accepted in full or rejected.
  - h) **Information policy:** after the end of each clock round, other than the final clock round, we would inform bidders of the level of excess demand in each lot category.

- i) **Assignment stage format:** each assignment stage round would have a sealed-bid, single-round format with a second-price rule. The 40 GHz band would have a standard assignment stage round due to the single principal stage lot category in 40 GHz.
- j) **Three assignment stage rounds in 26 GHz:** for the 26 GHz lots, there would be an initial assignment stage round for lower frequencies (25.1-26.5 GHz) and a separate initial assignment stage round for upper frequencies (26.5-27.5 GHz), both of which would determine the frequency assignment until the revocation of the 26 GHz fixed link licences (in and around high density areas). If these rounds do not result in all bidders holding contiguous lots, there would be a subsequent assignment stage round (the “final assignment stage round”) for lower and upper frequencies (25.1-27.5 GHz) which would determine the frequency assignment after the revocation of the 26 GHz fixed link licences (in and around high density areas). Across these 26 GHz assignment stage rounds, we propose to have rules that would seek to minimise the need to change frequencies before and after the revocation of the relevant fixed link licences. We are also proposing to give licensees six months to migrate to the new frequencies.

## Introduction

- 9.3 As discussed in section 3, we are proposing to auction 2.4 GHz of spectrum in the 26 GHz band and 3 GHz in the 40 GHz band. The award winners would be authorised to use the spectrum won in the 68 high density areas identified in section 4. In the rest of this section, we describe our proposals in the following order: (i) lot structure, (ii) principal stage, (iii) assignment stage, (iv) reserve prices, (v) deposit and (vi) illustrative auction procedures.
- 9.4 In developing these proposals, we have taken account of our policy objectives for mmWave spectrum (set out in section 2, paragraphs 2.30-2.43), which derive from our statutory duties. We have also aimed to ensure that the criteria for spectrum allocation would be: (i) objectively justifiable in relation to the 26 GHz and 40 GHz bands; (ii) not unduly discriminatory; (iii) proportionate to what they are intended to achieve; and (iv) transparent.<sup>478</sup>

## Lot structure

### Combined high density areas

- 9.5 In the [May 2022 Consultation](#),<sup>479</sup> we consulted on using geographic lot categories to reflect differences in demand for mmWave spectrum in different high density areas by allowing bids for individual cities. In particular, we said there may be operators that would consider deploying in individual or specific cities, but would not consider doing so across all high density areas.
- 9.6 We considered two options:

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<sup>478</sup> [Wireless Telegraphy Act 2006](#), Section 14(3B)

<sup>479</sup> [May 2022 Consultation](#), paragraphs 9.6-9.14.

- a) **“Geographic” lot categories.** This would either involve separate lot categories for each high density area in the principal stage, or multiple high density areas could be aggregated into a single lot category on the basis of bidders’ preferences in the application stage.
- b) **“Subnational” lot categories.** These lots would cover all high density areas, meaning that winners would obtain the same amount of spectrum and the same frequencies in each high density area.

9.7 The main advantage of geographic lot categories is that they would enable entry from operators with use cases in specific cities and towns. We said that this entry would likely facilitate a more efficient allocation of spectrum, as the operators with the highest value for spectrum in each particular area would be more likely to win that spectrum. It would also maximise the amount of investment and innovation in the band and potentially enable a more diverse range of use cases.

9.8 We said that national operators may face some additional costs from geographic lots, such as increasing the complexity of the auction and logistical costs in deploying equipment. However, we considered that costs would be relatively small and that bidders could manage the complexity of bidding.

9.9 We therefore favoured geographic lots, as our initial view was that the potential benefits in terms of enabling entry and a more efficient allocation are likely to outweigh the costs to national operators. We also welcomed views on the alternative approach of aggregating geographic areas before the principal stage.

### Stakeholder responses

9.10 BT/EE, H3G, VMO2 and Vodafone preferred subnational lots.<sup>480</sup> They considered the option of offering geographic categories unduly complex. They raised concerns that winning different frequencies in different areas would bring additional cost and complexity for their network rollout. They argued it would be difficult to accurately value spectrum for specific high density areas. BT/EE and H3G commented that this meant geographic lots were unlikely to lead to a more efficient allocation.

9.11 BT/EE, H3G, VMO2 and Qualcomm suggested that users with demand for spectrum in specific geographic areas could use shared access licenses or local access licences.<sup>481</sup> BT/EE and Vodafone considered holders of subnational licenses could trade or lease licences in geographic areas to address local demand.<sup>482</sup>

9.12 Luminet said that it “agrees that it would be appropriate that spectrum should be auctioned separately for individual high density areas” and made the following comment: “Luminet operates in London only and would not wish access to spectrum in other high

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<sup>480</sup> [BT/EE response to the May 2022 Consultation](#), pp. 33-34; [H3G response to the May 2022 Consultation](#), p. 63; [VMO2 response to the May 2022 Consultation](#), p. 20; [Vodafone response to the May 2022 Consultation](#), p. 17.

<sup>481</sup> BT/EE, pp. 33-34; H3G, p. 65; VMO2, p. 20; [Qualcomm response to the May 2022 Consultation](#), p. 1.

<sup>482</sup> BT/EE, p. 34; Vodafone, p. 17.

density areas. Allocating access across all high density areas would lead to inefficiencies”.

<sup>483</sup>

- 9.13 Ericsson commented that licenses “could be nationwide licences or if this is not preferred then we would suggest a minimum of city/suburban wide licences where the mobile operator is assigned the same spectrum across all cities/suburban areas”.<sup>484</sup> Furthermore, it discussed the challenges that operators with different frequencies across multiple areas would face, adding that “This could present challenges managing their supply chain, inventory and ability to offer a consistent service”.<sup>485</sup>

### Ofcom response

- 9.14 All MNOs were strongly against the option of offering geographic lot categories, preferring subnational lot categories instead. We agree that there are additional costs associated with offering geographic lot categories, such as increased complexity in valuing lots, increased complexity in bidding and increased logistical complexity where different frequencies are won by a national operator. However, we consider that these are moderate costs, on the basis that:
- a) We would expect experienced bidders to have the resources and capacity to value spectrum for each high density area.
  - b) There are numerous examples of successful auctions using geographic lot categories, including Austria, Australia, Canada, Denmark, Ireland, and the US.
  - c) We have spoken to some equipment vendors and understand that having different frequencies in different areas is a logistical challenge, rather than a technical challenge, as the tuning range of equipment is likely to span the whole band.<sup>486</sup>
- 9.15 We also consider that while operators may face additional costs from winning licences authorising them to use different frequencies in different areas, this would likely only occur if some bidders won spectrum only in a subset of high density areas. Otherwise, operators would likely win licences authorising them to use identical frequencies in every area. In this scenario, we consider the benefits of enabling entry from operators with use cases in specific cities and towns would outweigh the additional costs to operators.
- 9.16 However, given that we did not receive significant evidence of demand for mmWave spectrum in individual cities (in response to the May 2022 Consultation), we are now proposing to offer subnational lot categories. If respondents to this consultation demonstrate a credible intention to participate in the award and that they wish to bid only for lots relating to specific high density areas, we will consider disaggregating the relevant high density areas from the subnational lot categories, where appropriate. If we do so, we will specify which high density areas will be disaggregated in our final statement. The example below illustrates how a high density area could be disaggregated from the

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<sup>483</sup> [Luminet response to the May 2022 Consultation](#), p. 8.

<sup>484</sup> [Ericsson response to the May 2022 Consultation](#), p. 3.

<sup>485</sup> Ericsson, p. 3.

<sup>486</sup> In particular, we have received information [CONFIDENTIAL &lt;].

subnational lot category. We use the Greater London high density area (“**London**”) as an illustrative example.

### Option to disaggregate high density areas

9.17 If London was disaggregated from the subnational lots, the lot structure would be as follows:

- Subnational lots (except London) – 26 GHz lower
- Subnational lots (except London) – 26 GHz upper
- Subnational lots (except London) – 40 GHz
- London – 26 GHz lower
- London – 26 GHz upper
- London – 40 GHz

9.18 We propose not to allow any switching of demand between the subnational lot categories and any disaggregated area lot categories in the principal stage of the auction. This is for simplicity and to mitigate potential gaming risks. In practice, eligibility points for geographic areas would be siloed, i.e. eligibility points for the subnational lot categories could not be used to bid for the London lot categories. Bidders would still be able to switch demand between lot categories within a geographic area, for example - between “London 26 GHz lower” to “London 40 GHz”.

### Lot sizes

9.19 A lot size determines the minimum amount of spectrum that can be bid on, and the additional increments that bidders can bid on. The lot size should be small enough to allow bidders the flexibility to bid for spectrum in the quantities that they desire, and be large enough to reduce the risk that bidders win spectrum in amounts that are too small to be utilised. Every lot within a generic lot category has the same lot size.

9.20 We did not consult on lot sizes in the May 2022 Consultation. Nonetheless, stakeholders provided the comments summarised below.

### Stakeholder responses

9.21 VMO2 gave a provisional view that “100 MHz lots are the appropriate units for the 5G mobile business case. We are concerned that 50 MHz lots may be too small relative to 100 MHz units that appear favoured in the emerging ecosystem, whereas 200 MHz lots may not allow enough flexibility for bidders”.<sup>487</sup>

9.22 BT/EE considered a “200 MHz lot size to be appropriate”, although it also said that “there should be a mechanism for a guarantee of not winning less than a total of 400 MHz”. It also considered that “larger bandwidths are likely to be required by operators in order for

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<sup>487</sup> VMO2, p. 22.

mmWave deployments to be most viable (i.e. [CONFIDENTIAL <del>X</del>] MHz per operator, which would be compatible with the 200 MHz lot size)".<sup>488</sup>

### Ofcom response

- 9.23 For this award, we propose to set the same lot size for all lot categories. This is because the ecosystems for the 26 GHz and 40 GHz bands have similar technical standards, which support the deployment of similar quantities of spectrum. An equivalent lot size in the two bands would also make switching demand between bands in the auction easier.
- 9.24 Lot sizes are more likely to be suitable for bidders if they are compatible with the quantities of spectrum that equipment for mmWave can support. The smallest amount of spectrum that can be deployed with mmWave equipment is 100 MHz. Larger blocks of spectrum that can be deployed are in multiples of 100 MHz or 200 MHz. This suggests that a lot size of 100 MHz would allow all amounts that are compatible with technical standards to be won, while 200 MHz would allow for most of these to be achieved.
- 9.25 BT/EE commented that "larger bandwidths are likely to be required by operators in order for mmWave deployments to be most viable [...] which would be compatible with the 200 MHz lot size".<sup>489</sup> However, we note that larger bandwidths would also be compatible with a 100 MHz lot size.
- 9.26 A lot size of 200 MHz may marginally lessen the risk of winning suboptimal amounts of spectrum, compared to 100 MHz. In the clock auction format, bidders can be at risk of winning less spectrum than they bid for. A bidder can win as little as one lot of spectrum, when it originally bid for more spectrum earlier in the auction and may prefer to instead win no spectrum. Such a bidder may therefore find that a 200 MHz lot size would marginally mitigate this risk compared to a 100 MHz lot size.
- 9.27 However, we do not consider this to be a significant concern. There will be a large supply of spectrum in this award, especially compared to previous awards. We expect bidders to be able to win large blocks of contiguous spectrum if they have sufficient value. We consider that 100 MHz is a significant amount of spectrum, and if a bidder were to win 100 MHz, it could either deploy it or trade it after the auction.
- 9.28 We therefore consider that a lot size of either 100 or 200 MHz would be appropriate. On balance, we propose a 100 MHz lot size to give bidders additional flexibility to bid on the amounts they prefer.
- 9.29 Finally, BT/EE suggested that "there should be a mechanism for a guarantee of not winning less than a total of 400 MHz".<sup>490</sup> We do not consider such a mechanism to be appropriate for this award. Such a mechanism would introduce complexity in the design and gaming risks, as well as the risk of unsold spectrum when it would be efficient to allocate it. We therefore propose not to include such a mechanism.

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<sup>488</sup> BT/EE, p. 33.

<sup>489</sup> BT/EE, p. 33.

<sup>490</sup> BT/EE, p. 33.

## 26 GHz lot categories

- 9.30 When specific frequencies are likely to have similar values to bidders, these can be placed into the same lot category and therefore be auctioned as “**generic lots**” in the principal stage. Alternatively, if there are likely to be significant differences in valuation between frequencies, it could be appropriate to split the band into separate lot categories so that bidders can reflect these differences in values in the principal stage. In both cases, specific frequency assignments would be determined in the assignment stage.
- 9.31 In the May 2022 Consultation,<sup>491</sup> we consulted on whether to separate the 26 GHz band into two lot categories. This was due to the presence of fixed links in the 25.1-26.5 GHz range, which would pose restrictions to new deployments in that part of the band until the revocation (with 5 years’ notice) of the links in and around high density areas. We considered the following options:
- a) **One lot category.** In the principal stage, bidders would bid for generic lots that could be anywhere between 25.1 GHz and 27.5 GHz. Winning principal stage bidders could then bid in the assignment stage to reflect any differences in value between the encumbered and unencumbered spectrum.
  - b) **Two lot categories.** In the principal stage, bidders would bid for generic lots in the following two lot categories:
    - i) 26 GHz lower: 25.1-26.5 GHz (currently encumbered by fixed links)
    - ii) 26 GHz upper: 26.5-27.5 GHz (unencumbered spectrum)
    - iii) There would then be one assignment stage which would determine specific frequencies within each lot category.
  - c) **Two lot categories with re-arrangement for long-term contiguity.** As in option (b), in the principal stage there would be two lot categories (25.1-26.5 GHz; 26.5-27.5 GHz). Winning principal stage bidders would then be invited to bid in two separate assignment stages. The first would determine specific frequencies bidders would hold in each lot category while the spectrum remains encumbered by fixed links during the five year notice period for revocation. The second would determine the contiguous frequency assignment bidders would hold once the 5 years’ notice period for revoking the fixed link licences in and around high density areas ends.<sup>492</sup>
- 9.32 We sought views from stakeholders and indicated that we preferred option (a) or option (c), as they would guarantee contiguous spectrum for all bidders (although only in the long term, in the case of option (c)).

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<sup>491</sup> May 2022 Consultation, paragraphs 9.15-9.19.

<sup>492</sup> We define the assignment stage rounds for 26 GHz lower and upper (i.e. before fixed links vacate the band) as the initial assignment stage rounds. We define the assignment stage round for the entire 26 GHz band (i.e. after fixed links vacate the band) as the final assignment stage round.

## Stakeholder responses

- 9.33 BT/EE and Vodafone supported option (c). In particular, they made the following comments:
- a) BT/EE considered “[...] that the value of the lower and upper part of the 26 GHz band is sufficiently different to warrant two separate lot categories”.<sup>493</sup> However, BT/EE also placed importance on operators having contiguous holdings after fixed links vacated the band, which led it to supporting option (c). BT/EE suggested that option (c) should be designed in such a way as to limit the need for rearrangement between assignment stages, and gave some examples of how to do this. In particular, it suggested that if a winner only won spectrum in one lot category, it could be placed at the very bottom of the band if it was in the lower category, or at the very top in the upper lot category.
  - b) Vodafone commented that “Both options (a) and (b) would result in short term distortions caused by encumbered spectrum being reflected into long term fragmentation of spectrum holdings (absent secondary trading)”.<sup>494</sup>
- 9.34 VMO2 was in favour of one lot category, option (a).<sup>495</sup> It placed importance on each operator achieving contiguous holdings for the duration of the licence term to aid network planning purposes. While it did consider that fixed links will lower the value of the bottom of the band, it considered that this loss is constrained to the first 5 years, when VMO2 claimed that mobile deployment would be limited in most locations. Furthermore, VMO2 said option (a) would simplify the auction design.

## Ofcom response

- 9.35 All stakeholders that commented on this issue placed a high degree of importance on contiguity, and none of them were in favour of option (b). We therefore focus on options (a) and (c).
- 9.36 BT/EE and Vodafone believe that the impact of fixed links is great enough to warrant two lot categories. We see value in BT/EE’s suggestion to limit the number of winners to be rearranged. Bidders who win spectrum in one lot category only would be positioned at the extremities of the band. Such winners would have contiguous holdings already and would not split other winners’ holdings; and would therefore not have to change frequencies in the future.
- 9.37 Were we to adopt BT/EE’s suggestion with option (c) as discussed in the preceding paragraph, a bidder that had VMO2’s view that fixed links were not constraining enough to warrant a future rearrangement could bid in only the bottom lot category in order to guarantee that it would not need to change frequencies in the future. We therefore believe that two lot categories with this suggestion would substantially mitigate the concerns raised by VMO2 of bidding complexity.

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<sup>493</sup> BT/EE, pp. 32-33.

<sup>494</sup> Vodafone, p. 18.

<sup>495</sup> VMO2, p. 21.

9.38 Option (c) would have the advantage of enabling bidders to express, in the principal stage of the auction, their value for deploying during the revocation period in the part of the band unencumbered by fixed links. However, as noted by VMO2, it would also have the disadvantage of adding complexity to the auction design in having multiple principal stage lot categories and further rules to the assignment stage. Although option (c) is currently our preferred option, we invite further comments from stakeholders' on options (a) and (c), taking into account that: (i) the number of fixed links in the 26 GHz band is declining; (ii) we are proposing further rules in the assignment stage which would limit the number of bidders having to rearrange their holdings after the revocation of fixed link licences; and (iii) our proposals on coordination between award winner and fixed link providers to manage interference, as described in section 10 (paragraphs 10.72-10.94).

### Proposals on rearrangement of frequencies in the 26 GHz band once the 5 years' notice for revoking fixed link licences expire

9.39 With option (c) there is a question of how much time would spectrum users have to change the frequencies they are using, once the 5 years' notice for revoking fixed link licences has expired. [CONFIDENTIAL ✂] suggested that it would be useful to have a transition period, where [CONFIDENTIAL ✂] suggested this should last around six months, during which licences would overlap to facilitate the changing of frequencies.<sup>496</sup>

9.40 On this basis, to facilitate the transition, we propose that licensees would have six months to do so.

9.41 We propose to implement this approach by awarding the following 26 GHz licences to a 26 GHz winner that needed to migrate frequencies:

- a) **Initial licence:** the initial licence would be valid until the expiry date of the 5 years' notice of revocation of the fixed link licences (in and around high density areas). This initial licence would cover the frequencies assigned in the initial assignment stage round.
- b) **Migration licence:** the migration licence would be valid for 6 months from the end date of the initial licence. It would be a concurrent licence. This means that (a) the migration licensee would share frequencies with other migrating users, and (b) the migration licence would cover the licensee's frequencies assigned in both the initial assignment stage rounds and the final assignment stage round. The holders of migration licences would be required to co-ordinate the process of frequency transition to avoid undue interference.<sup>497-498</sup>

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<sup>496</sup> [CONFIDENTIAL ✂]

<sup>497</sup> To aid migration of radio equipment, each licensee would be required to ensure that at any point in time its use of the frequencies authorised by the migration licence in any given location shall not exceed the amount of spectrum authorised under its final licence.

<sup>498</sup> In case of interference between two concurrent licensees, we would generally expect to regard the licensee who held an initial licence for the frequencies in question to be the priority user or victim, and the other concurrent licensee to be the offender.

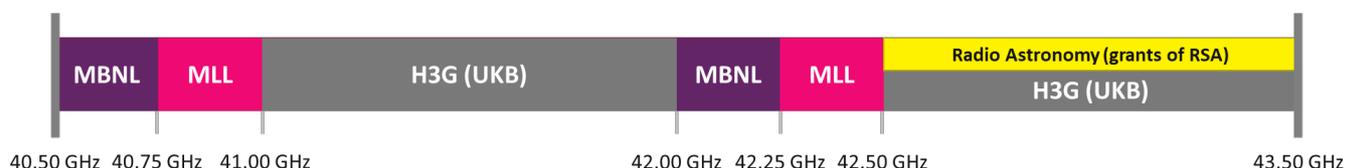
- c) **Final licence:** the final licence would be valid from the end date of the migration licence. According to our current proposals for licence duration (see section 12), this licence would be valid for 15 years, minus the durations of the initial and migration licences. This licence would cover the frequencies assigned in the final assignment stage round.

- 9.42 The process above would not apply to auction winners who are assigned the same frequencies before and after the revocation of fixed links. For example, if a winner was assigned contiguous spectrum at the very bottom of the 26 GHz band. In this case, the winner would be granted a single licence.
- 9.43 We welcome stakeholders’ views on the proposals above, including the proposed 6-month duration of the migration licences.

### 40 GHz lot categories

- 9.44 As set out in section 3, we are minded to award citywide licences authorising use of the 40 GHz band (40.5-43.5 GHz) in high density areas. However, existing licensees will continue to be allowed to access to the spectrum which is currently licensed to them until the end of the 5 years’ notice period for revoking their licences. This means that during such period, winners of 40 GHz licences will need to coordinate their use of this spectrum with existing licensees. Our proposals for coordinating new and existing licensees in the 40 GHz band during this period are explained in section 10 (paragraphs 10.72-10.104). Section 7 details the current use of the 40 GHz band (see paragraphs 7.9-7.14).

**Figure 9.1: Existing users of the 40 GHz band**



- 9.45 We have considered whether to offer the 40 GHz band as one lot category or multiple lot categories.
- 9.46 The benefits of offering the 40 GHz band as one lot category would be simplicity and guaranteed contiguity in the short and long terms. Multiple lot categories may entail multiple assignment stages and potentially more complex rearrangement than in the 26 GHz band, as many or all frequency holders may need to be rearranged to guarantee contiguity. The benefit of multiple lot categories would be that bidders could express a monetary preference for spectrum that is currently less encumbered (i.e. not the frequencies licensed to MBNL) versus spectrum that is currently more encumbered (i.e. the frequencies licensed to MBNL).
- 9.47 We propose to offer only one lot category in the 40 GHz band, in contrast with the 26 GHz band, in which we propose to offer the spectrum in two lot categories. This is because:

- a) we expect that constraints imposed by fixed links during the revocation period of current licences on deployment of new uses in the 40 GHz band will apply over a shorter period than the corresponding constraints in the 26 GHz band, since the developments of equipment and handset ecosystem for the 40 GHz band are behind those for the 26 GHz band;
- b) bidders who win wide blocks of spectrum in the 40 GHz band would, in the immediate term, be able to access at least some useable spectrum. This will be true even if their holdings end up overlapping with either or both of MBNL's two licenced frequency blocks of 250 MHz, which are currently the most intensively used parts of the band. For example, the frequencies of a winner of a 1 GHz block in the 40 GHz band would overlap with, at worst, one of MBNL's 250 MHz blocks. This operator would therefore have access to at least 750 MHz of less encumbered spectrum during the revocation period, although its useable spectrum could be split into two non-contiguous blocks during that period; and
- c) bidders who prefer narrower blocks, and may therefore be more constrained during the revocation period if they win frequencies in the 40 GHz band which overlap with one of MBNL's licenced blocks, could either bid in the assignment stage for less encumbered spectrum in the 40 GHz band or bid for spectrum in the 26 GHz band.

## Principal stage

### Format

9.48 In the May 2022 Consultation,<sup>499</sup> we consulted on the format for the principal stage. We considered three options:

- a) '**Clock format**'. A clock auction is an ascending auction for different lots of spectrum that takes place over a number of rounds. In this format, Ofcom would set a round price for lots in each category (and may set different prices for different lot categories). Bidders would then place bids specifying the number of lots they are willing to win in each lot category at those prices, bidding for all categories they are interested in at the same time. When demand for a particular lot category is greater than supply, the price per lot of that category increases. The auction proceeds through successive rounds with increasing prices until the point at which demand is equal to supply. This format includes a feature that allows bidders to submit extra bids during a round at any price in between the price in the last round and the current round's price (these are known as "intra-round bids").<sup>500</sup>
- b) '**SMRA format**'. The simultaneous multiple round ascending ("SMRA") auction is similar to the clock auction. Unlike the clock auction, Ofcom would allocate standing high

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<sup>499</sup> May 2022 Consultation, paragraphs 9.20-9.27.

<sup>500</sup> Intra-round bids can be used when a bidder's demand changes between the price in one round and the next. In this case, a bidder can submit an intra-round bid indicating the precise price at which its demand changes, allowing it to bid its specific valuation for the spectrum.

bidder status to the bidder with the highest bid(s) placed on each lot category after each round.<sup>501</sup> When the auction ends, these would become winning bids and the bidders would pay the amounts they bid. In a SMRA auction, intra-round bids are not allowed.

- c) **'CCA format'**. The combinatorial clock auction ("**CCA**") format has two distinct phases. The first is a series a series of 'clock' rounds with ascending prices (similar to the clock auction described above) and a final round of sealed bids, called the Supplementary Bids Round. In both phases, the bids are submitted for packages of lots across different lot categories. Bidders are either awarded a package of lots for which they bid in its entirety or nothing at all. In the CCA, the price for each winning bid is calculated according to a second price rule, which reflects the highest losing bid (or opportunity cost). In contrast, in the clock and SMRA formats, bidders pay the amount that they bid for the lots that they win (a "pay as bid" price rule).

- 9.49 We considered that the main reason for choosing a CCA format would be to mitigate the aggregation and substitution risks the bidder may face. However, we considered the aggregation and substitution risks for this award not to be sufficiently large to justify the complications and increased complexity of a package bidding auction such as the CCA.
- 9.50 Additionally, we considered the clock auction to be faster and simpler for bidders than a SMRA auction as it does not have the standing high bid mechanism, present in the SMRA. We therefore proposed the clock format.

### Stakeholder responses

- 9.51 VMO2 and Vodafone supported the use of the clock format.<sup>502</sup> According to VMO2, combinatorial bidding is not necessary for this award and the "clock format facilitates a faster and simpler auction design than the SMRA".<sup>503</sup>
- 9.52 BT/EE noted that either a clock or an SMRA format would be appropriate for this award. It did not consider the CCA to be appropriate as it would represent unnecessary and unwanted complexity. It expressed a slight preference for a SMRA format over the clock format, as it has been used in previous UK awards and BT/EE does not see a need for intra-round bids.<sup>504</sup>

### Ofcom response

- 9.53 All stakeholders supported either a clock or SMRA format for the principal stage. Two stakeholders (VMO2 and Vodafone) supported the clock design, while BT/EE expressed a slight preference for the SMRA design, as it has been used in previous awards.

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<sup>501</sup> Standing High Bids are either be bids placed at the round price (which are randomly selected if there a more bids at that price than number of lots), or, where there are insufficient bids at the current round price, standing high bids are also selected among bidders who bid at a lower price in previous rounds.

<sup>502</sup> VMO2, p. 22; Vodafone, p. 18.

<sup>503</sup> VMO2, p. 22.

<sup>504</sup> BT/EE, p. 31.

- 9.54 Following consideration of stakeholders' responses and in line with our initial proposals, and for reasons set out in paragraph 9.50, our provisional view is that a clock auction would be faster and simpler for bidders than a SMRA auction.
- 9.55 BT/EE raised that it does not see a need for intra-round bids. We note that bidders do not need to use this feature and will not be disadvantaged by avoiding using this feature. We believe that the rest of the auction would be easy to understand, and we intend to run mock auctions for prospective bidders to ensure familiarity with the format before the start of the principal stage.
- 9.56 For these reasons, we propose a clock format.

## Bidding

- 9.57 The principal stage consists of a number of rounds in which bidders bid on generic lots of spectrum for each lot category. Before the start of the auction, Ofcom will announce the available supply of lots and the reserve prices for each lot category.
- 9.58 In the first round, bidders may demand a number of lots (in each lot category) at the reserve price. In the following rounds, bidders may submit "simple bids" to maintain, increase or decrease their demand from the previous round.
- 9.59 Following the first round, bidders may submit simple bids at a price falling between the "opening price" and the "clock price". The "opening price" is the lowest price in this range, whereas the "clock price" is the maximum price in the range. All bids to maintain demand are submitted at the clock price. By default, the electronic auction system ("EAS") would set any increase or decrease in demand at the opening price for that lot category.<sup>505</sup> If a bidder wishes to increase the price for the bid, it may do so up to and including the clock price.<sup>506</sup>
- 9.60 At the end of each round, simple bids would be processed by the EAS. The EAS would determine the number of lots (in each lot category) that have been accepted – for each bidder - at the end of the round (the "processed demand") on the basis of the following rules:
- a) A bid to maintain previous demand is always accepted in full.
  - b) A bid to increase previous demand is accepted in full if the increase will not cause the bidder's processed demand to exceed its eligibility limit for the round.<sup>507</sup>
  - c) A bid to decrease is accepted in full if the reduction will not cause aggregate demand for that lot category to fall below available supply, or to fall further if it is already below supply (that is, if it will not cause excess demand to fall below – or further below –

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<sup>505</sup> Note that if a bidder submits multiple bids in the same lot category to increase or decrease demand, each subsequent bid to the first would be set at an increment higher to ensure that multiple bids do not have the same price.

<sup>506</sup> This would mean the bid is placed at an intra-round price (as it is above the opening price).

<sup>507</sup> More detailed information on eligibility is provided from paragraph 9.73 onwards.

zero).<sup>508</sup> We define this as the “no unsold spectrum” rule; it guarantees that, once aggregate demand for a lot category is greater than, or equal to, available supply, there will not be unsold spectrum for that lot category.

d) Each bid to decrease or increase demand may be accepted partially, or not at all, if it cannot be accepted fully.

9.61 The principal stage bidding process would end when, at the end of a round, aggregate processed demand is less than or equal to the supply of lots in every lot category (i.e. when excess demand is zero or negative in every lot category). If instead there would be excess demand in at least one lot category, there would be another principal stage round.

### Illustrative example of bid processing by the EAS

9.62 To illustrate with an example, suppose that a bidder has ended the previous round with a demand of 8 lots and, in the current round, the opening price is equal to 100 and the clock price is equal to 110. If the bidder requests to decrease its previous demand by 4 lots (so that the bid is for a total of 4 lots at 100), the EAS would interpret the bid as the bidder’s willingness to buy:

- any number of lots between (and including) 4 and 8 at a price of 100, with a preference for the lower amount.
- 4 lots at a price higher than 100 and up to 110.

9.63 Alternatively, the bidder could request to change its demand at any price between the opening and clock prices for the round (i.e. a simple bid submitted at an intra – round price). The bidder could request to decrease its previous demand by 4 lots (so that the bid is for a total of 4 lots) at price 105. The EAS would interpret the bid as the bidder’s willingness to buy:

- 8 lots at a price higher than (or equal to) 100 and lower than 105.
- any number of lots between 4 and 8 (inclusive) at a price of 105, with a preference for the lower amount.
- 4 lots at a price higher than 105 and up to 110.

9.64 The EAS would process the bid to decrease illustrated in paragraph 9.62 according to the no unsold spectrum rule specified in paragraph 9.60c), that is the request to decrease cannot cause excess demand to fall below (or further below) zero:

- If excess demand (at the time the bid is assessed) is greater than (or equal to) 4 lots, the bid is accepted in full. The bidder ends the round with a processed demand for 4 lots.
- If excess demand (at the time the bid is assessed) is greater than 0 lots but lower than 4 lots, the bid is accepted partially. The bidder ends the round with a processed demand for a number of lots between 5 and 7, depending on the level of excess

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<sup>508</sup> Excess demand is calculated as the difference between aggregate processed demand for spectrum lots and the available supply of lots in a lot category. Excess demand can be positive, zero or negative.

demand. Excess demand of 2 lots would result in the bidder ending the round with a processed demand for 6 lots.

- If excess demand (at the time the bid is assessed) is equal to (or less than) 0 lots, the bid is not accepted at all. The bidder ends the round with a processed demand for 8 lots.<sup>509</sup>

### Mitigating aggregation and substitution risks

9.65 Following the first round, bids to decrease would not be fully (or partially) accepted if they violate the no unsold spectrum rule. Thus, a bidder may end up with a processed demand for a number of lots different from its desired quantity (referring to the above example, the bidder requests 4 lots but may end the round with a processed demand for an amount of lots between 4 and 8). There are therefore two risks to bidders in a clock auction:

- **Aggregation risk:** When changing demand within a lot category, bidders may win a sub optimal amount of spectrum. The greatest aggregation risk is winning an amount of spectrum which the bidder considers too small for service deployment.
- **Substitution risk:** When switching demand across lot categories, bidders may win a sub optimal combination of spectrum. In this award, the main substitution risks would arise when bidders switch from the 26 GHz to the 40 GHz band (or vice versa). Bidders with a preference to only win spectrum in one band may end up with spectrum holdings in both.

9.66 In the standard clock auction format, the following tools mitigate aggregation and substitution risks:

- **Information on excess demand in each lot category in each round:** As explained in more detail below, we are proposing to reveal the aggregate level of excess demand at the end of each round. Low excess demand acts as an indication for bidders of the risk that their bid may not be fully applied.
- **Small price increments:** Increasing prices between rounds in small increments makes it more likely that there will be fewer changes in demand in a round, and thus bidders will have more accurate excess demand information. This allows bidders to place bids that are more likely to be accepted in full rather than partially. We intend to use small price increments. However, we will provide more information on our intended approach to price increment closer to the auction (e.g. in the bidder guidance).<sup>510</sup>

9.67 Additionally, we have considered whether all or nothing bids may help mitigate the aggregation and substitution risks further.

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<sup>509</sup> Note that if excess demand were equal to (or less than) 0 lots in every lot category at the end of the round, the principal stage would end.

<sup>510</sup> We have received comments from VMO2 on price increments (VMO2, pp. 24-25). We will take the comments into account when considering our price increment approach.

### All or nothing bids

- 9.68 With an all or nothing bid, a bidder specifies that it wants to change its demand either by an exact number of lots or not at all.
- 9.69 For example, suppose that: (i) the bidder has ended the previous round with a processed demand of 4 lots; (ii) in the current round, the opening price is equal to 100 and the clock price is equal to 110; and (iii) the bidder places an all or nothing bid to decrease its previous demand by 4 lots (so that the bid is for a total of 0 lots) at price 100. If its bid can only be partially accepted (e.g. if there are only 3 lots of excess demand), the all or nothing bid would not be accepted at all. Therefore, the bidder's processed demand at the end of the round would still be 4 lots at a price of 110 now.
- 9.70 For this award, we propose that bidders could only use all or nothing bids to decrease (but not to increase) previous demand at the new prices. All or nothing bids for increases in demand may lead to bidders inadvertently ending up with significantly less spectrum than they requested, and we are thus not considering them.<sup>511</sup>
- 9.71 The advantages of all or nothing bids are:
- a) All or nothing bids can be used to address substitution risks. When switching demand across lot categories, all or nothing bids may help bidders to avoid winning spectrum holdings across multiple bands if they prefer their holdings to be in a single band.<sup>512</sup>
  - b) All or nothing bids can help bidders, when changing demand within a lot category, to avoid winning a sub optimal amount of spectrum (e.g. an amount of spectrum they deem too small for service deployment), when they would instead prefer to win the larger amount. This may mitigate BT/EE's concern that "there should be a mechanism for a guarantee of not winning less than a total of 400 MHz".<sup>513</sup> From the example in paragraph 9.69, the bidder may prefer to carry on bidding on 4 lots of spectrum rather than to reduce its demand to 1, 2 or 3 lots.

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<sup>511</sup> Suppose a bidder places a simple bid to reduce demand by 8 lots in 26 GHz upper and an all or nothing bid to increase demand by 8 lots in 26 GHz lower. If the first bid is not fully acceptable – because of insufficient excess demand – the second bid would not be accepted at all as total demand from a bidder cannot increase (i.e. the bidder's eligibility limit for the round cannot be exceeded. We will discuss eligibility in detail from paragraph 9.73 onwards). Thus, the bidder will end up (at the end of the round) with a significantly lower amount of spectrum than requested and with decreased eligibility for the next round.

<sup>512</sup> Suppose a bidder ends the previous round with a processed demand of 8 lots in 26 GHz lower and 0 lots in 40 GHz. The bidder wishes to move its entire demand from 26 GHz lower to 40 GHz and therefore places a simple bid to reduce demand by 8 lots in 26 GHz lower and a simple bid to increase demand by 8 lots in 40 GHz. If the first bid is not fully acceptable (because of insufficient excess demand) the bidder may end up with demand in both bands when it prefers demand in a single band. This could have been avoided if the bidder placed an all or nothing bid to reduce demand by 8 lots in 26 GHz lower and (a simple bid to increase demand by 8 lots in 40 GHz); if the bid could not be accepted in full, it would not be accepted at all and the bidder would end the round with 8 lots in 26 GHz lower and 0 lots in 40 GHz.

<sup>513</sup> BT/EE, p. 33.

- c) All or nothing bids can be used to target specific amounts of spectrum. For example, bidders only interested in winning spectrum in multiples of 200 MHz may use all or nothing bids to express this preference.<sup>514</sup>

9.72 We recognize that all or nothing bids may only partially mitigate the substitution and aggregation risks the bidders may face, as they would not help a bidder to reduce demand in a lot category if there is insufficient excess demand in that lot category. Nevertheless, for the reasons set out above, we are proposing to allow bidders to submit all or nothing bids to decrease demand in the principal stage, on the basis that they would provide a useful additional tool to mitigate aggregation and substitution risks.

## Eligibility points

- 9.73 Each bidder would have a number of eligibility points at the start of each round (i.e. the “eligibility limit”) and can use these points to bid on lot categories. Each lot category would have a certain number of eligibility points associated with it, and bidders could not bid on a number of lots whose total eligibility points exceed their current eligibility limit.
- 9.74 The eligibility limit a bidder starts with in any round would be the total number of eligibility points associated to its processed demand in the previous round. A bidder’s eligibility points in the first clock round would be based on its deposit payment before the start of the principal stage.
- 9.75 Eligibility rules encourage truthful bidding and price discovery by deterring bidders from strategically withholding their true demand until relatively late into the auction, which can distort the outcome. For example, by depriving rivals of demand information that can inform accurate price discovery.
- 9.76 The ratio of eligibility points between two lot categories would also affect bidders’ options to substitute demand between lot categories. For example, with a 1:1 ratio between 26 GHz spectrum and 40 GHz spectrum, a bidder switching away from 26 GHz could demand the same or a lower amount of lots in 40 GHz, but it could not demand more spectrum in 40 GHz.
- 9.77 We aim to set eligibility points to reflect how bidders may substitute demand. As the price of a lot category that a bidder is bidding in becomes more expensive, bidders may bid to substitute demand to a relatively cheaper lot category. A bidder may consider the following when substituting demand:
- a) How near it is to its budget: a bidder near its budget limit in the original lot category, which is more expensive, may wish to bid for more spectrum in the lot category it is substituting its demand to as it is cheaper per lot. This would favour setting eligibility points based on the expected relative value between bands.

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<sup>514</sup> By placing an all or nothing bid, bidders may precisely decrease their demand from 800 MHz to 600 MHz, then to 400 MHz without the risk of winning 700 MHz or 500 MHz due to insufficient excess demand.

b) The technical or commercial differences between lot categories: bidders may seek to substitute between suitable relative amounts of spectrum in different bands based on technical or commercial reasons.

9.78 In the May 2022 Consultation, we did not consult on eligibility points. However, we have received some comments from a stakeholder, which we summarise below.

### Stakeholder responses

9.79 VMO2 commented that the auction design rules need to be sufficiently flexible to accommodate bidders “targeting the same quantity of spectrum in either band; vs bidders that may be interested in 40 GHz only if they can buy a larger quantity of spectrum, so as to offset concerns about weaker propagation and delayed ecosystem development.”<sup>515</sup>

9.80 VMO2 also commented that “For the first category of bidder, it would be acceptable to have a 1:1 eligibility points ratio across the 26 GHz and 40 GHz bands. However, the second category of bidder would need to be able to switch to larger quantities at 40 GHz, so would prefer a larger ratio. A compromise approach might be to adopt uniform eligibility ratios, but to allow bidders to bid some superset of the eligibility when active at 40 GHz”.<sup>516, 517</sup>

### Ofcom response and proposals

9.81 First, we consider the eligibility point ratio we should set between the 26 GHz lower and upper lot categories. The two lot categories are very similar, but there may be some difference in relative value between the two lot categories due to the temporary encumbrance in the 26 GHz lower frequencies. However, we expect that bidders would want to substitute on a one-to-one ratio between 26 GHz lower spectrum and 26 GHz upper as the spectrum is the same in all other regards and can be used for the exact same use cases, meaning bidders would likely want a similar amount of mmWave in either lot category. As such we propose to set the same eligibility points for the 26 GHz lower and upper lot categories.

9.82 Secondly, we have considered the eligibility point ratio we should set between the 26 GHz lot categories and the 40 GHz lot category. Our provisional view is that the following specific factors could affect the rates of substitution between 26 GHz and 40 GHz spectrum for this award:

- As explained in section 2, we expect the 26 GHz and 40 GHz bands to be functionally substitutable in the long run, and as a result we expect that (all else equal) a bidder would likely want a similar amount of spectrum in the 26 or 40 GHz band. This is

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<sup>515</sup> VMO2, p. 23.

<sup>516</sup> VMO2, p. 23.

<sup>517</sup> Our understanding of VMO2’s “superset” is a mechanic that allows a bidder to demand more 40 GHz when it switches demand from 26 GHz lots, while still having a 1:1 eligibility point ratio between the two bands.

because the use cases and ecosystem in the long term for the bands are similar, which support the deployment of similar quantities of spectrum.<sup>518</sup>

- 26 GHz spectrum can be deployed immediately, and as such there may be more demand for 26 GHz spectrum than 40 GHz spectrum at the start of the auction. Bidders with plans to deploy mmWave spectrum immediately, or in the near future, would likely place higher value on 26 GHz spectrum as the equipment ecosystem is more developed. Such bidders are more likely to focus on 26 GHz at first, and then switch to 40 GHz as the price of 26 GHz spectrum increases.
- There is a greater supply of 40 GHz spectrum than 26 GHz spectrum (3 GHz of 40 GHz spectrum vs 2.4 GHz of 26 GHz spectrum).

9.83 In light of the above, we could either set the same number of eligibility points for lots in either band, reflecting that the bands are very close substitutes, or we could set a lower number of eligibility points for a 40 GHz lot, to reflect that bidders may choose to substitute into the 40 GHz band once 26 GHz prices rise. We have considered the following range of eligibility ratios, which would allow for straightforward calculations, and hence would facilitate substitutions between the two bands:

- **Option A:** 1 point for a lot of 26 GHz lower, 1 point for a lot of 26 GHz upper, and 1 point for a lot of 40 GHz (1:1 eligibility ratio between 26 GHz and 40 GHz).
- **Option B:** 1.5 points for a lot of 26 GHz lower, 1.5 points for a lot of 26 GHz upper, and 1 point for a lot of 40 GHz (1.5:1 eligibility ratio between 26 GHz and 40 GHz).
- **Option C:** 2 points for a lot of 26 GHz lower, 2 points for a lot of 26 GHz upper, and 1 point for a lot of 40 GHz (2:1 eligibility ratio between 26 GHz and 40 GHz).

9.84 With a per MHz eligibility ratio of 1.5:1 between 26 GHz spectrum and 40 GHz spectrum, bidders could, for example, substitute 400 MHz of 26 GHz spectrum with 600 MHz of 40 GHz spectrum, or 800 MHz of 26 GHz spectrum with 1.2 GHz of 40 GHz spectrum, without losing eligibility. By contrast, a per MHz ratio of 2:1 between 26 GHz and 40 GHz spectrum would allow bidders to substitute 400 MHz of 26 GHz spectrum with 800 MHz of 40 GHz spectrum, or 800 MHz of 26 GHz spectrum with 1.6 GHz of 40 GHz spectrum. The latter would represent a larger value difference between 26 GHz and 40 GHz spectrum.

9.85 We currently prefer option B as we consider it would allow bidders to demand more spectrum when they substitute from 26 GHz to 40 GHz spectrum, as well as keeping the two bands closely substitutable.

9.86 Finally, our provisional view is that the substitution risks in this award are unlikely to be severe enough to require additional auction design mechanics to mitigate such risks. As we are considering assigning less eligibility points for a lot of 40 GHz band (compared to a lot of 26 GHz), this would allow bidders to win more spectrum when switching demand from the 26 GHz to the 40 GHz band and thus mitigate VMO2's concerns.

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<sup>518</sup> We have considered VMO2's suggestion that bidders may want larger amounts of 40 GHz spectrum to offset VMO2's concerns about weaker propagation, however, on balance, we expect bidders to view the bands as functionally substitutable.

- 9.87 We propose 1.5 points for a lot of 26 GHz lower, 1.5 points for a lot of 26 GHz upper, and 1 point for a lot of 40 GHz. We welcome stakeholder comments on our proposals.

## Information policy

- 9.88 In line with the approach that we took in our previous auctions (such as the 2021 award of the 700 MHz and 3.4-3.6 GHz spectrum bands), we propose to disclose the total number of qualified bidders and their identity before bidding starts.
- 9.89 We consider that, once the bidding has started, information on the level of aggregate demand during the principal stage can be useful. For example, it can help bidders identify amounts of spectrum they are most likely to win. It can also help substitution between lot categories, as bidders have more information to mitigate the risk that they will be prevented from moving demand between two lot categories. In circumstances where there is “common value uncertainty” (i.e. the value of the spectrum is common but unknown to bidders), information about the level of aggregate demand in each frequency lot category may also help bidders improve estimates of spectrum value. Therefore, we propose to reveal the aggregate level of excess demand for each lot category at the end of each round in the principal stage.<sup>519</sup>

## Assignment stage

- 9.90 At the end of the principal stage, winning bidders would have won a combination of generic lots grouped into the three proposed lot categories. The specific frequencies assigned to each winning bidder would then be determined in the assignment stage.

## Format

- 9.91 In the May 2022 Consultation,<sup>520</sup> we considered a single-round, sealed bid auction with a second price rule for the assignment stage.<sup>521</sup> This was in line with what Ofcom had done in previous auctions.<sup>522</sup>
- 9.92 Under this format, bidders would place bids for the exact location of their frequencies, amongst the permissible assignment plans. Ofcom would then identify the highest value combination of bids that can be accommodated given the outcomes of the principal stage. The price paid by a bidder for the winning assignment would follow a second price rule, which is the second-highest bid for those frequencies or the opportunity cost.

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<sup>519</sup> In the 2.3 and 3.4 GHz SMRA award in 2018 and the SMRA award of 700 MHz and 3.6-3.8 GHz in 2021, we revealed limited information during the principal stage. Due to the standing high bidder mechanism, bidders were still able to make informed bidding decisions, for example when substituting between lot categories. Since there is no such mechanism in a clock auction, limiting the amount of principal stage information would make it more difficult for bidders to make informed bids, which could compromise the efficiency of the auction. We do not see the benefits of limiting information, in this instance, to outweigh the efficiency risk to the auction of doing so.

<sup>520</sup> May 2022 Consultation, paragraphs 9.28-9.30.

<sup>521</sup> The second price rule means that the price paid is the second-highest bid (or opportunity cost).

<sup>522</sup> For example, the UK 4G auction in 2013, the 2.3 and 3.4 GHz award in 2018 and the award of 700 MHz and 3.6-3.8 GHz in 2021.

### Stakeholder responses

- 9.93 BT/EE, and Vodafone supported our consultation position:
- a) BT//EE said that “we have no objection to a second price sealed bid auction being used for the assignment stage where generic lots are awarded”.<sup>523</sup>
  - b) Vodafone said that “we agree the usage of a single round sealed bid auction”.<sup>524</sup>
- 9.94 VMO2 suggested that “[...] some of the potential bidders in this auction are also incumbent fixed links operators in the 26 GHz and/or 40 GHz bands. Subject to preserving contiguity of assignments for all bidders, these operators should be directly assigned to the spectrum they themselves are impairing”.<sup>525</sup>

### Ofcom response

- 9.95 We continue to consider the second price sealed bid auction format to be appropriate for the assignment stage, given its speed and likelihood to achieve the most efficient allocation. This format was also supported by all stakeholders who commented on the assignment stage.
- 9.96 VMO2 suggested that potential bidders would be directly assigned to any spectrum they currently utilise under their existing licences. Although we accept that this suggestion might have some benefits (including allocating clear spectrum to other bidders and negating any possible strategic delay in clearing fixed links), we do not propose to implement it because it would increase the complexity of the auction while our proposed auction design would already allow bidders to express preferences, through monetary bids, for the spectrum they wish to be assigned.
- 9.97 Since we are now proposing two lot categories in the 26 GHz band (with an initial and a final assignment of frequencies), as well as auctioning 40 GHz spectrum, we set out below further proposals on how the assignment stage would work.

### Further proposal on the assignment stage

- 9.98 We are proposing two lot categories in the 26 GHz band, which would have an initial assignment until the end of the revocation period of the relevant fixed link licences, and a final assignment thereafter. We propose that the initial assignment of 26 GHz lower and upper frequencies are determined in a sequential order, rather than at the same time. This is because a bidder’s placement in one lot category will affect its valuations in the other, and because a package bidding auction format across the two lot categories is likely to be unnecessarily complicated.
- 9.99 We also propose that the initial assignment of 26 GHz lower frequencies occur first as bidders may have particular preferences for where they are placed in the 25.1-26.5 GHz

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<sup>523</sup> BT/EE, p. 31.

<sup>524</sup> Vodafone, p. 18.

<sup>525</sup> VMO2, p. 25.

frequencies, based on the frequencies fixed links use in this frequency range. Afterwards, the initial assignment of 26 GHz upper frequencies can occur, followed by the final assignment stage for frequencies in the entire 26 GHz band (25.1-27.5 GHz).

- 9.100 In the 40 GHz band we propose only one lot category in the principal stage. This means that we only need one assignment stage round. We propose to run the 40 GHz assignment at the same time as the initial assignment stage round for the lower 26 GHz frequencies.
- 9.101 In summary, we propose to run the following assignment stage rounds:
- a) An initial assignment stage round for the initial assignment of the 26 GHz lower frequencies (25.1-26.5 GHz) and a parallel assignment stage round for the 40 GHz frequencies. These would run at the same time.
  - b) An initial assignment stage round for the initial assignment of the 26 GHz upper frequencies (26.5-27.5 GHz).
  - c) A final assignment stage round for the final assignment of the 26 GHz frequencies (25.1-27.5 GHz).
- 9.102 These rounds would run sequentially after the principal stage. We propose that bidders are informed of their own frequency allocations and associated assignment prices at the end of each assignment round before proceeding with the following round. The final assignment stage round would only take place if the initial assignment stage rounds for the 26 GHz band do not produce contiguous holdings for all bidders.
- 9.103 In every assignment stage round, we propose that bidders would only be given options in which their holdings in each principal stage lot category would be contiguous in frequency.
- 9.104 BT/EE suggested that “[the assignment for final frequencies] would need careful design and there might be circumstances where winners would be exempted from taking part, for example if in the initial auction assignment phase a winner has a single assignment that is located at the very top or very bottom of the band it may be appropriate not to require them to participate in a [final] assignment round as they are not an obstacle to other parties with split assignments being made contiguous”.<sup>526</sup> We agree with this suggestion, and we are proposing further rules to increase the likelihood of bidders achieving contiguity in the initial assignments and limiting the need for a subsequent assignment stage round to rearrange the frequencies. The further rules we propose are:
- Bidders that have won spectrum in the principal stage in only one lot category would only offered the option to bid for frequencies at the bottom of the band if the only 26 GHz lots they won are in the 26 GHz lower lot category, and at the top of the band if the only 26 GHz lots they won are in the 26 GHz upper lot category. These bidders would not participate in the final assignment stage round.
  - If only one bidder wins spectrum in both lot categories in the principal stage, it would automatically be assigned the higher frequencies in 26 GHz lower and lower

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<sup>526</sup> BT/EE, p. 33.

frequencies in 26 GHz upper. In this case, the final assignment stage round would not take place.

- If multiple bidders have won spectrum in both lot categories in the principal stage, they would be offered the option to bid for the higher frequencies in 26 GHz lower. Whoever wins the highest frequencies in 26 GHz lower would be automatically assigned the lowest frequencies in 26 GHz upper. This bidder would still participate in the final assignment stage round. The rest of the bidders who have won spectrum in both lot categories would then be offered the option to bid for the lower frequencies in 26 GHz upper (excluding the lowest frequencies).

## If we separate out any high density area

- 9.105 If we disaggregate any high density areas as separate geographic lots in the principal stage, as discussed in paragraph 9.16, we propose to run multiple assignment stage rounds to determine exact frequency locations within each geographic lot category. We propose to run these rounds sequentially, with bidders being informed of their own frequency allocations and associated assignment prices for each disaggregated high density area at the end of each assignment round before proceeding with the following round. Bidders would not be informed of winnings relating to other bidders.
- 9.106 We would also consider aggregating geographic lot categories with identical principal stage results in a band (i.e. in both 26 GHz lot categories, and separately in the 40 GHz lot category). For example, if the same bidders have each won the same amounts of spectrum across multiple geographic areas, these could be combined into a single assignment stage round.<sup>527</sup> As a result, assignment stage bids would determine the same precise frequencies across all of those combined high density areas, ensuring bidders win the same frequencies across this subset of areas.

## Reserve prices

- 9.107 The reserve price is the minimum price for one lot in a lot category. In the first round of the auction, the price of lots in each lot category is set to the corresponding reserve price.
- 9.108 Low reserve prices have several advantages. They reduce the risk of unsold spectrum, encourage entrants to participate in the award and provide more opportunities for price discovery. However, reserve prices that are too low could invite frivolous bids, and could increase the incentive to strategically withhold demand, to gain lower spectrum prices.
- 9.109 To inform our choice of reserve prices, we propose to use benchmarks of prices from auctions in other jurisdictions, and set reserve prices which we think will be materially lower than possible market value.

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<sup>527</sup> For example, if Bidders A, B and C each win 1 GHz of spectrum in 40 GHz, in each of the subnation lot, London and Manchester, these areas would be combined into a single assignment stage round, so that the bidders could bid on the precise frequencies they would win across all three categories. However, if Bidders A, B and D won spectrum in Liverpool this would be a separate assignment stage round.

## Benchmarks for market value

- 9.110 To determine benchmarks for market value, we have identified eleven spectrum awards of 26 GHz spectrum. Eight awards took place in European countries, which we consider to be more comparable to the UK, as well as awards in Australia, Brazil, and the US. No European countries have awarded the 40 GHz band.
- 9.111 We have used prices from these awards to derive UK equivalent value benchmarks for 26 GHz spectrum. We applied a series of adjustments to these price benchmarks to control for cross-country variations. Our process was to consider:
- if the payment was made in instalments, we calculate the present value of the payment,<sup>528</sup>
  - we make adjustments to reflect our minded position to have a 15-year award licence duration,<sup>529</sup>
  - we account for differences in purchase power parity of the relevant country and the UK at the time of the award,<sup>530</sup>
  - we project the prices of the awards to Q1 2024 prices, using UK CPI inflation between the date of the country's award until the expected date of our award,<sup>531</sup>
  - we account for difference in population between the award country and the total population of high density areas,<sup>532</sup>
  - we account for any delay between the auction date and the licence start date.<sup>533</sup>
- 9.112 Our method may not account for other differences in auction values, which are more difficult to address in a robust way. For example, the propagation characteristics of higher-frequency bands may be more or less important depending on the level of urbanisation and population density in a country.
- 9.113 The results of our analysis are shown in Figure 9.2 below. In the figure, green (Italy, Slovenia, Australia, Brazil, and United States) denotes that spectrum lots were sold above reserve price; orange denotes that spectrum lots were sold at reserve price; and purple denotes that the reserve price was used to calculate the benchmark. There are two countries in the purple category: Denmark and Montenegro. In Montenegro, we used the reserve price as all lots were unsold. In Denmark, we used the reserve price as the award

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<sup>528</sup> The discount factor we use is the pre-tax nominal cost of debt, 3.6 %, and the corporate tax rate, 19%. The pre-tax cost of debt is from Ofcom's Statement "[Wholesale Fixed Telecoms Market Review 2021-26](#)", annexes 1-26, table A20.1.

<sup>529</sup> For simplicity, we use the pre-tax nominal Weighted Average Cost of Capital ("**WACC**") for the mobile sector in the UK, 7.8%, and the corporate tax rate, 19%, as the discount factor. See Ofcom's Statement "[Wholesale Voice Markets Review 2021-26](#)", annex 1-4, p. 21.

<sup>530</sup> We use PPP conversion factors from the [World Bank | World Development Indicators database](#), [World Bank | Eurostat-OECD PPP Programme](#).

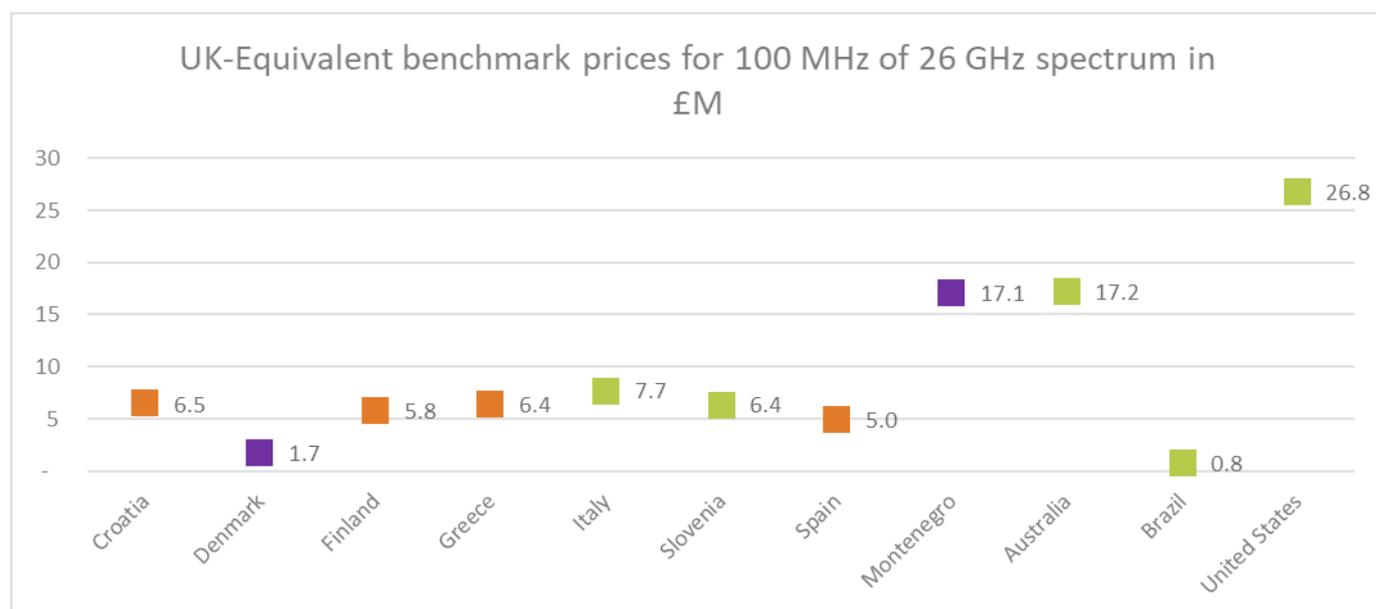
<sup>531</sup> We use CPI data and forecasts from [the Office for Budget Responsibility](#).

<sup>532</sup> We use population data from [the World Bank](#).

<sup>533</sup> For simplicity, we use the pre-tax nominal WACC for the mobile sector in the UK, 7.8%, and the corporate tax rate, 19%, as the discount factor. See Ofcom's Statement "[Wholesale Voice Markets Review 2021-26](#)", annex 1-4, p. 21.

was combinatorial, so band-specific prices would be difficult to derive accurately. Some spectrum lots in the awards in Spain, Australia, Brazil and United States were also unsold.

**Figure 9.2: 26 GHz UK equivalent benchmarks for 100 MHz based on Q1 FY 2024/5 prices**



9.114 Our results show that the average of the UK equivalent of all prices in the analysis is approximately £9.2m per 100 MHz lot. The range is from approximately from £0.8m to £26.8m. However, for our benchmark, we propose to only use prices from European countries, i.e. exclude results from Australia, Brazil and United States. We also propose to exclude the price from Montenegro as all spectrum lots were unsold. The remaining prices have an average of £5.6m, and a range of £1.7m to £7.7m. We propose to use these figures as the benchmarks.

9.115 We have also considered whether the benchmarks in this latter range could be over or under-estimates of UK equivalent market value benchmarks based on certain factors. In our view these values could be overestimates because:

- a) The spectrum in Croatia, Finland and Greece was sold at reserve prices, and in Spain some spectrum remained unsold. Therefore, in these countries the UK equivalent market value benchmarks calculated should likely be lower.
- b) We are proposing to make more mmWave spectrum available in our award than in awards which have been run in other countries.

9.116 Conversely, these benchmarks may be underestimates of UK equivalent market value benchmarks because:

- a) We are only awarding spectrum in high density areas, where the population density is highest, whereas the benchmarks are based on awards of nationwide licences which also take into account less dense areas than we are proposing.
- b) The spectrum in Denmark has been assumed to be sold at reserve price due to the difficulty in disaggregating combinatorial clock auction results for the 26 GHz band.

- 9.117 Overall, we interpret these international benchmarks with a degree of caution, due to the reasons above and because there are relatively few benchmarks available. We have focused on the lower end benchmarks in order to propose reserve prices that are materially lower than possible market values.
- 9.118 We therefore propose that mmWave reserve prices should fall within the range £0.25m to £2m per lot to increase the likelihood of a market driven price and to allow for price discovery to occur. Our current view is that reserve prices of £1m for 26 GHz and £0.5m for 40 GHz would be appropriate. The lower reserve price for 40 GHz lots reflects the less developed ecosystem compared to 26 GHz.
- 9.119 We propose to set the same reserve price across both the upper and lower 26 GHz lot categories, and let bidding in the principal stage determine any price difference between these two categories. However, we are open to views on whether we should reflect some difference across these two categories in the reserve price based on their different useability in the first few years.

#### Reserve prices in the event we separate out any high density areas

- 9.120 If we were to award a high density area separately, we would aim to set the reserve price in the high density area based on the subnational reserve price, weighted by the population in the separated high density area. The reserve price for the high density area would equal the reserve price divided by the population covered by all high density areas multiplied by the population of the high density area.
- 9.121 We propose to take the high-level approach described above where possible. However, if this leads to reserve prices that could present a significant risk of attracting frivolous or unintended bidding, we may consider appropriate to set higher reserve prices.
- 9.122 For illustrative purposes, we set out below potential reserve prices for the following high density areas for a lot of 26 GHz, supposing a reserve price of 1m per lot:

**Table 9.1: Illustrative example of disaggregated 26 GHz high density area reserve prices**

City	Population	Proportion of population	Reserve price (£)
Greater London	9,927,978	30%	299,525
Greater Manchester	2,450,435	7%	73,929
Greater Glasgow	1,280,089	4%	38,620

City	Population	Proportion of population	Reserve price (£)
Greater Birmingham	2,360,475	7%	71,215
Cardiff & Newport	493,864	1%	14,900

## Deposit

- 9.123 We propose that, along with their application, applicants would be required to submit an initial monetary deposit which might be forfeited, in whole or in part, if the applicant subsequently breaches the award regulations. In addition, before the first round of the auction, qualified bidders would need to provide an additional deposit to Ofcom which would determine the bidder's initial eligibility level. Any interest made by Ofcom while holding the deposits would be returned to the Consolidated Fund.
- 9.124 We propose that the initial eligibility will correspond to the maximum number of spectrum lots that could be acquired by a bidder using their total deposit at the reserve prices. We also propose that, at any point during the auction, Ofcom may require bidders to increase their deposits up to an amount equal to the highest bid submitted so far by the bidder.
- 9.125 We will publish more information on the deposit requirements, including guidance on the deposit requirements for all possible initial eligibility levels, closer to the start of the auction (e.g. in the bidder guidance document).

## Illustrative auction procedures

- 9.126 As part of our work on the proposed award process, Ofcom has drafted some illustrative procedures, set out in annex 9. These are an initial draft and are being shared as part of this consultation so that stakeholders can obtain a more in depth understanding of our design. The procedures are evolving, and it is quite likely that there will be changes especially when Ofcom commences work on implementing these processes into a statutory instrument. There are strict rules on the drafting of legislation, and it might well be that there are changes and adjustments to the processes that are necessary for that reason. Nevertheless, we considered it helpful to share our current thinking with stakeholders and we would welcome any comments and suggestions on this as part of our consultation exercise.

## Consultation questions

**Question 4:** Do you have any comments on the proposed rules of our auction?

**Question 5:** Do you have an interest in bidding for specific high density areas in this award? If so, please provide evidence that you have a credible intention to do so.

**Question 6:** Do you consider it appropriate to have one or two 26 GHz lot categories?

## 10. Coexistence and coordination

### Summary

10.1 In this section we present our proposed approach to ensure coexistence without harmful interference and ensure efficient use of spectrum between all licensed users of the 26 GHz and 40 GHz bands once new uses are authorised. The proposals build on the high-level approach we set out in the May 2022 Consultation.<sup>534</sup>

### Coordination between Shared Access licensees' deployments

10.2 In the 26 GHz band, we propose to use technical assignment to coordinate deployment of Shared Access licensees' medium power base stations (which will only be allowed outside high density areas), and to require minimum separation distances between low power base stations. Table 10.1 below summarises how we propose to manage coexistence between Shared Access licensees.

**Table 10.1: Shared Access to Shared Access coordination method in the 24.25-27.5 GHz band**

Existing users	Low power (indoor)	Low power (outdoor)	Medium power
Low power (indoor)	Separation distance 100 m	Separation distance 200 m	Technical assignment
Low power (outdoor)	Separation distance 200 m	Separation distance 200 m	Technical assignment
Medium power	Technical assignment	Technical assignment	Technical assignment

10.3 In the 40 GHz band we propose to make Shared Access licences available only after the end of the revocation period of current licences in that band, and then only in low density areas. However, we will consult on detailed technical parameters of coordination before Shared Access use of the 40 GHz band becomes available in low density areas.

### Coexistence between Shared Access licensees' and award licensees' deployments

10.4 To address the risk of interference between new users of mmWave spectrum, we propose:

- a) a field strength limit, at the boundary of any high density areas, on transmissions from all medium power base stations (both those of award licensees, within high density areas, and those of Shared Access licensees, outside high density areas); and

<sup>534</sup> May 2022 Consultation, paragraphs 8.32-8.37 and table 8.1.

- b) a minimum separation distance between any low power base station and the boundary of any high density area.

## Protection of fixed links

- 10.5 We are considering how to protect fixed links in and around high density areas, during their revocation periods, from undue interference from award winners' deployments. We currently favour coordinating deployment of medium power base stations ourselves and invite stakeholders' views on two coordination methods we could adopt:
- a) Ofcom provides maps for award winners to use for coordination, either a base station power restriction pixel map or fixed link locations with exclusion zone vectors; or
  - b) Ofcom coordinates stations for award winners using our existing coordination tools.
- 10.6 We also invite views on two other options:
- a) that award winners coordinate their own deployments of medium power base stations with fixed links; or
  - b) during the revocation periods, we do not allow award winners to deploy medium power base stations frequencies which overlap with the fixed link frequency range in the 26 GHz band (25.1-26.5 GHz) and in the entire 40.5-43.5 GHz band, nor low power deployment in the spectrum currently licensed to MBNL (40.5-40.75 GHz and 42-42.25 GHz).
- 10.7 We consider that, after the end of the revocation period of the 26 GHz and 40 GHz licences, the proposed field strength limits on new uses would mitigate appropriately the risk of interference from those uses into any remaining fixed links outside high density areas.
- 10.8 We also propose to coordinate all deployments of 26 GHz Shared Access low power outdoor and medium power licences with fixed links during the revocation periods of those links, and continue to coordinate with any remaining links in low density areas indefinitely.

## Protection of satellite earth stations

- 10.9 We propose to coordinate any new Shared Access low power outdoor and medium power deployments with all satellite earth stations in the 25.5-26.5 GHz band.

## Radio astronomy protection at the eMerlin sites (26 GHz) and the Cambridge site (40 GHz)

- 10.10 In July 2022, we decided to apply exclusion zones around the six radio astronomy sites that comprise the eMERLIN array, in which we will not allow the deployment of outdoor 26 GHz base stations.<sup>535</sup>

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<sup>535</sup> Ofcom's Statement "[Protecting passive services at 23.6-24 GHz from future 26 GHz uses](#)", published July 2022, paragraph 2.20.

- 10.11 We propose to protect the Cambridge radio astronomy site by requiring all award licensees in the 40 GHz band to limit their emissions into the 42.5-43.5 GHz range with:
- a) a 50km coordination zone; and
  - b) a spectrum quality benchmark.

## Protection of earth exploration satellite service (EESS) operating below 24 GHz

- 10.12 In July 2022, we decided to limit the density of outdoor base stations in the 24.25-25.05 GHz range, in order to protect EESS operating below 24 GHz.<sup>536</sup>

## May 2022 Consultation proposals

- 10.13 In the May 2022 Consultation,<sup>537</sup> we proposed to manage coordination between Shared Access users and existing users in the 26 GHz band via a range of coordination procedures, including:
- a) technical assignment;
  - b) “reuse distances” (to which we are now referring in our updated proposals as “separation distances”);
  - c) exclusion zones;
  - d) field strength limits; and
  - e) deployment density limits.
- 10.14 We said that the approach outlined for the 26 GHz band could be extended to the 40 GHz band in the future.<sup>538</sup>

## Consultation responses

- 10.15 We received broad support for the May 2022 Consultation proposals.<sup>539</sup> Below, we address stakeholders’ comments on these proposals and set out our updated position based on those comments. In summary, stakeholders’ comments focused on two main areas:
- Some stakeholders sought more details on our coordination proposals; and
  - Some fixed link stakeholders were concerned about the effectiveness of coordination to prevent interference to fixed links

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<sup>536</sup> July 2022 Statement on protecting passive services at 24 GHz, paragraph 2.26.

<sup>537</sup> May 2022 Consultation, paragraphs 8.32-8.37 and Table 8.1.

<sup>538</sup> May 2022 Consultation, paragraph 8.4.

<sup>539</sup> May 2022 Consultation, Table 8.1.

## Requests for further detail about our coordination proposals

10.16 In the May 2022 Consultation,<sup>540</sup> we set out our high-level proposals for managing coordination between new and existing users. Joint Radio Company (JRC) and Western Power Distribution (WPD) sought more detail on our coordination proposals and said that they looked forward to seeing more detailed proposals for the licence conditions.<sup>541</sup> We acknowledge that the coordination proposals set out in the May 2022 Consultation were high-level, and we provide more details on our revised proposals in the rest of this section.

## Concerns about the effectiveness of coordination to prevent interference to fixed links

10.17 In the May 2022 Consultation, we proposed that Ofcom would coordinate outdoor 26 GHz Shared Access users with existing fixed links to prevent harmful interference and ensure efficient use of spectrum.<sup>542</sup> We also said that we expected coordination between new users of 26 GHz spectrum in high density areas (referred to as “**26 GHz Award Winners**” in the remainder of this section) and fixed links in and around high density areas would be necessary to prevent harmful interference during the revocation period.<sup>543</sup> Similarly, we considered that coordination would also be required in the 40 GHz band to manage the risk of new services causing interference to existing fixed links in the 40 GHz band.<sup>544</sup>

10.18 Airwave said it was concerned about its 26 GHz network performance if new authorisations are made without verifying the risk of interference and the effectiveness of technical coordination, as it is “technically almost impossible to avoid interference from mobile operators on Airwave fixed links”. Airwave noted that its concerns were based on its experience of interference from mobile into fixed links in L-band (1.452-1.492 GHz).<sup>545</sup> We have taken Airwave’s comments into account in our revised detailed coordination proposals. For more detail, please see paragraphs 10.48-10.53 for Shared Access and paragraphs 10.81-10.100 detailing 4 options for award winners, when coordinating with existing fixed links. We believe that all our proposed options will ensure coexistence.

## Our updated proposals

10.19 The remainder of this section is structured as follows:

- a) First, we explain the framework we have used to determine what type of coordination we consider appropriate in any given circumstance.
- b) Then, we outline our proposals for coordinating new Shared Access users with other authorised users in the following scenarios:

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<sup>540</sup> May 2022 Consultation, paragraphs 8.32-8.37 and table 8.1.

<sup>541</sup> [JRC response to the May 2022 Consultation](#), p. 7; [WPD response to the May 2022 Consultation](#), p. 6.

<sup>542</sup> May 2022 Consultation, table 8.1, “Fixed Links” row.

<sup>543</sup> May 2022 Consultation, paragraph 5.81.

<sup>544</sup> May 2022 Consultation, paragraph 7.15.

<sup>545</sup> [Airwave response to the May 2022 Consultation](#), pp. 7-8.

- i) Coordination between new 26 GHz Shared Access users (in high and low density areas) in the 26 GHz band with other Shared Access users of the 26 GHz band;
  - ii) Coordination between new 26 GHz Shared Access users (in high and low density areas) in the 26 GHz band, with existing users of the 26 GHz band (fixed links, satellite earth stations, radio astronomy and the earth exploration satellite service (“EESS”).
  - iii) Coordination between new Shared Access users in the 40 GHz band (in low density areas) with other Shared Access users of the band; and
  - iv) Coordination between new Shared Access users in the 40 GHz band (in low density areas) with existing users of the 40 GHz band (fixed links, satellite earth stations, and radio astronomy).
- c) Next, we set out the options we have considered for coordinating award winners of spectrum in the 26 GHz and 40 GHz bands (in high density areas) with existing users of the bands, during the revocation period.
- d) Finally, we set out proposals for:
- i) Coordinating users of spectrum at the boundaries between high and low density areas (in both the 26 GHz and 40 GHz bands); and
  - ii) International coordination.

## Coordination framework

10.20 Below we explain the general approach we have taken to determining what type of coordination is appropriate in different circumstances.

- a) **Separation distances** may be appropriate for coordination when the geographical distances between different licensees’ deployments are small and where full technical coordination might be disproportionate to manage the interference risk. For example, we use a separation distance to coordinate between [26 GHz indoor Shared Access users](#).<sup>546</sup>
- b) **Technical assignment** may be appropriate when we are seeking to coordinate with systems that would generally be high power and/or require a high availability of service. To undertake this form of coordination, Ofcom will carry out detailed coordination calculations between a new user and existing users, using the technical parameters of each deployment to determine whether the deployments would interfere with each other if the new user’s deployment were approved. For example, this is the approach we currently take to coordinating fixed links, permanent earth stations and Shared Access licences<sup>547</sup>.

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<sup>546</sup> Ofcom’s Technical Frequency Assignment Criteria “[OfW 590 Technical Frequency Assignment Criteria for Shared Access Radio Services \(v1.2\)](#)” published 20 September 2022, p. 16.

<sup>547</sup> These users include those in the 1800 MHz, 2300 MHz and 3.8-4.2 GHz bands, as outlined in OfW 590.

- c) **Power flux density limits at a boundary** may be appropriate when we are coordinating without precise knowledge of where the deployments are either side of a boundary. In these cases, any new base station deployments should not exceed a certain power flux density (“**pf**d”) limit at a specified geographic boundary.
- 10.21 Our July 2022 Statement on [“Protecting passive services at 23.6-24 GHz from future 26 GHz uses”](#) (the **“July 2022 Statement on protecting passive services at 24 GHz”**),<sup>548</sup> outlined how we would protect users of the 23.6-24 GHz band. We decided to limit the number (within any 300km<sup>2</sup> area) of outdoor 26 GHz base stations which can be deployed in the lowest 800 MHz of the 26 GHz band (i.e. 24.25-25.05 GHz), in order to protect Earth Exploration Satellite Services (EESS) operating in the adjacent 24 GHz band from new users of 26 GHz spectrum. Later in this section we detail how we propose to implement this in our Shared Access coordination.

## Coordination proposals for the 26 GHz band

- 10.22 As explained in section 3, we have decided to authorise new Shared Access use of the 26 GHz band in both high and low density areas. We explain below how we propose to coordinate these new Shared Access users with (i) other Shared Access users, and (ii) other existing users of the 26 GHz band (fixed links, satellite earth stations, radio astronomy and the earth exploration satellite service (“**EESS**”)).
- 10.23 As per the existing Shared Access framework we propose to coordinate base stations for medium power Shared Access licences and a proxy base station for low power Shared Access licences at the centre of a 50m radius area licence. Low power Shared Access is an area licence and authorises the low power base stations operating within an area, including all the associated fixed and installed terminals connected to a base station. Medium power Shared Access is a per base station licence, and it authorises both the base station and the associated fixed and installed terminal stations in the same licence. The mobile and nomadic terminals connected to licensed base stations will be licence exempt in line with existing exemptions for mobile terminals which connect to a licensed network. We discussed this in the July 2019 Statement [“Enabling wireless innovation through local licensing”](#).<sup>549</sup>

## Proposals for coordinating Shared Access users of the 26 GHz band with each other

### Summary of Shared Access coordination approach in the 26 GHz band

- 10.24 As shown in Table 10.2 below, we propose to either use a separation distance or carry out detailed technical assignment when coordinating new low and medium power deployments with existing low and medium power deployments at the time of

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<sup>548</sup> July 2022 Statement on protecting passive services at 24 GHz, paragraph 2.26

<sup>549</sup> Ofcom’s Statement, [“Enabling wireless innovation through local licensing”](#), published 25 July 2019, paragraphs 3.51 and 3.66.

coordination request submission. For the coordination between medium power and low power indoor and outdoor, we initially proposed a “reuse distance” (i.e. separation distance) in the May 2022 Consultation.<sup>550</sup> Having reviewed our initial analysis, we are now proposing technical assignment, since we consider this coordination method to be more appropriate in such cases.

**Table 10.2: Shared Access to Shared Access coordination method in the 26 GHz band**

Existing users	Low power (indoor)	Low power (outdoor)	Medium power
Low power (indoor)	Separation distance 100 m	Separation distance 200 m	Technical assignment
Low power (outdoor)	Separation distance 200 m	Separation distance 200 m	Technical assignment
Medium power	Technical assignment	Technical assignment	Technical assignment

### Separation distances

- 10.25 For low power indoor (26 GHz Shared Access) users, we are proposing to apply the separation distance of 100m which we are currently using for [26 GHz Shared Access low power indoor](#).<sup>551</sup>
- 10.26 For low power outdoor users, we note that our coexistence studies (see annex 16) show that the clutter in urban environments between users impacts the separation distance required to avoid harmful interference and ensure efficient use of spectrum, and that the separation distances are highly variable depending on the urban scenario. For example, the separation distance required is higher for users in an urban park than users in an area with a lot of buildings.<sup>552</sup> Noting that the specific characteristics of the environment surrounding different low power outdoor deployments is likely to be highly relevant for coordination purposes, we consider that a separation distance of 200m would be appropriate since it should normally avoid overlapping coverage between base stations, being twice as long as the typical radius of a micro cell ([which is 100m](#)).<sup>553</sup>
- 10.27 The proposed separation distances between new users and incumbent users are set out later in this section.

### Technical assignment

- 10.28 For coordination between a medium power deployment and either low power indoor or low power outdoor deployment, we propose to carry out detailed technical assignment.

<sup>550</sup> May 2022 consultation, table 8.1.

<sup>551</sup> OfW 590, section 6, table: Band specific issues, row: 26 GHz.

<sup>552</sup> We explain the separation distances for various scenarios in more detail in annex 16.

<sup>553</sup> GSMA, “[Vision 2030: mmWave Spectrum Needs](#)”, published June 2022, table A8.

We explain below (paragraphs 10.29-10.44) how we propose to model base stations in our technical assignment tool.

### Coordination areas

10.29 The existing [Shared Access Framework](#)<sup>554</sup> sets out the coordination areas for low and medium power base stations. We propose to use the same coordination areas as we use for other Shared Access bands: 20km for low power base stations; and 115km for medium power base stations.

### Summary of base station parameters for technical assignment

10.30 Table 10.3 below sets out the base station parameters that we propose to use to undertake technical coordination of 26 GHz low and medium power base stations.

**Table 10.3: Proposed parameters for technical coordination of low and medium power base stations in the 26 GHz band**<sup>555</sup>

	low power (indoor)	low power (outdoor)	medium power
<b>26 GHz permitted deployment location</b>	High & low density area	High & low density area	low density area only
<b>Authorised bandwidth</b>	User specified in units of 50, 100, 200, 400 & 800 MHz	User specified in units of 50, 100, 200, 400 & 800 MHz	User specified in units of 50, 100, 200, 400 & 800 MHz
<b>Base station power</b>	49 dBm / 200 MHz EIRP <sup>556</sup>	49 dBm / 200 MHz EIRP	User specified, up to a maximum of: 58 dBm / 200 MHz peak EIRP
<b>Antenna type</b>	Omni	Omni	Omni
<b>Antenna height AGL</b>	Default 5m	User specified up to a maximum of 10m	User specified with no limit
<b>Peak antenna gain towards the horizon</b>	22 dBi	22 dBi	28 dBi
<b>Average antenna gain towards the horizon</b>	10 dBi	10 dBi	16 dBi

<sup>554</sup> OfW 590, section A2.

<sup>555</sup> Above ground level (AGL).

<sup>556</sup> The technical procedures for channel assignment include a protection radius for Low Power systems, this is managed by adding 2 dB to the EIRP which is included in the value of 49 dBm / 200 MHz here.

	low power (indoor)	low power (outdoor)	medium power
<b>Interference to Noise (I/N)</b>	1 dB	1 dB	0 dB
<b>Noise Figure (NF)</b>	13 dB	13 dB	10 dB

### Out-of-block emissions

10.31 For the purposes of coordination, we propose to assume Shared Access licensees can synchronise if necessary to mitigate the risk of interference between users in adjacent spectrum. Therefore, in line with our existing framework, we do not propose to carry out any adjacent channel coordination between mobile users.

### In block power and antenna modelling

10.32 We have modelled active antenna systems using [ITU-R M.2101](#)<sup>557</sup> and used this model to derive average and peak antenna gains for these systems. We used these average and peak antenna gains in both our coexistence study for the May 2022 Consultation<sup>558</sup> and new coexistence work for this consultation (see annex 16).

10.33 We propose to use either an average or peak antenna gain depending on the victim receiver. For mobile to mobile coordination we propose to use average antenna pattern for both transmitter and victim receiver. For mobile interference to other services we propose to use the peak antenna patterns as explained later in “technical coordination of new mobile users with existing users”.

10.34 In line with the existing [Shared Access framework](#),<sup>559</sup> we propose to:

- a) model the antenna of a low and medium power base station as an omni directional antenna;
- b) use a default antenna height of 5m above ground level for low power indoor, since there are no indoor height limits; and
- c) use a user specified antenna height above ground level to coordinate low power outdoor (maximum 10m) and medium power deployments.<sup>560</sup>

10.35 For the purposes of coordination, we need to convert the values to EIRP because interference calculations are not possible using TRP. We calculate this using Equation 10.1 which is valid assuming that antenna losses are negligible:

<sup>557</sup> May 2022 consultation, annex 6, paragraph A6.15

<sup>558</sup> May 2022 Consultation, annex 6, table A6.4.

<sup>559</sup> OfW 590, paragraph 3.5 and section 4.

<sup>560</sup> OfW 590, section 4.

### Equation 10.1

$$P_{t\_EIRP} = P_{t\_TRP} + G_t$$

Where:

$P_{t\_EIRP}$  is the transmit power spectral density in units of dBm / 200 MHz EIRP in a specific direction.

$P_{t\_TRP}$  is the transmit power spectral density in units of dBm / 200 MHz TRP over the whole radiation sphere of the radio equipment.

$G_t$  is the gain of the antenna in units of dBi in a specific direction.

- 10.36 We propose to model low power indoor and outdoor base stations in our coordination system using the default EIRP of 49 dBm / 200 MHz. The low power licences are area licences and we manage the location variability by adding 2 dB to the EIRP of a proxy base stations at the centre of the 50m radius licence area. This 2 dB is included in the value of 49 dBm / 200 MHz EIRP. Adding 2 dB to take location variability into account is the same approach as we have used for low power [Shared Access in sub-6 GHz bands](#).<sup>561</sup>
- 10.37 For medium power base stations, the in-block power level is specified by the applicant up to the proposed limit of 30 dBm / 200 MHz TRP as specified in the Technical Licence Conditions chapter. We propose to calculate the EIRP using Equation 10.1 with the TRP of the radio equipment to be provided by the applicant and the antenna gain to be used for coordination taken from Table 10.4.
- 10.38 Based on the coexistence analysis for the May 2022 Consultation,<sup>562</sup> for mobile to mobile coordination we propose to use the average antenna gain towards the horizon of 10 dBi and 16 dBi for low power and medium power systems respectively. For the coordination of mobile systems with non-mobile systems, we propose to use the peak antenna gain towards the horizon of 22 dBi and 28 dBi for low power and medium power systems respectively, which are 1 dB lower than boresight gains using ITU-R M.2101 to take typical downtilt into account. We have derived the maximum gains towards the horizon by considering that the base station generates a single beam which is steered towards cell-edge users for both low power and medium power deployments.<sup>563</sup>

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<sup>561</sup> Ofcom's Consultation "[Enabling opportunities for innovation](#)", published 18 December 2018, paragraphs 5.55-5.58.

<sup>562</sup> May 2022 Consultation, annex 6, table A6.4.

<sup>563</sup> May 2022 Consultation, annex 6, table A.6.1, row: Maximum antenna gain towards horizon.

**Table 10.4: Average and peak antenna gain towards the horizon used for coordination**

System types for coordination	Low power antenna gain	Medium power antenna gain
Mobile receiver	10 dBi	16 dBi
Mobile transmit to mobile receiver	10 dBi	16 dBi
Mobile transmit to non-mobile receiver	22 dBi	28 dBi

### Building entry loss

10.39 For indoor use we propose to add an attenuation of 14 dB to the interference calculation for both outgoing and incoming signals. This is 2 dB more than the loss in the sub 6 GHz Shared Access bands. We discuss building entry loss further in annex 16.

### Protection criteria

10.40 We propose to use the same protection criteria for new users as we have used for the [Shared Access bands 1.8 GHz and 2.3 GHz](#)<sup>564</sup> which we discussed in our consultation, "[Enabling opportunities for innovation](#)".<sup>565</sup> These parameters are summarised in Table 10.5.

**Table 10.5: Low and medium power noise figure and I/N**

Parameter	Low power	Medium Power
I/N	1 dB	0 dB
Noise figure	13 dB	10 dB

10.41 The noise power (N) value in the interference to noise (I/N) calculation is shown below in Equation 10.2.

### Equation 10.2

$$N = 10 \times \log_{10}(kTB) + NF + 30$$

Where:

*N* is noise power in dBm

*kTB* is the total thermal noise power (kTB) in Watts, it is a function of three quantities, 1) Boltzmann's constant "k" in Joules/°K, 2) temperature "T" is 290°Kelvin, and 3) the overall bandwidth "B" (Hz) of the channel.

<sup>564</sup> OfW 590, paragraph 3.5.

<sup>565</sup> Ofcom's Consultation "[Enabling opportunities for innovation](#)", published 18 December 2018, paragraph 5.65-5.67.

$NF$  is the noise figure in dB, which is the amount of noise power added by the electronic circuitry in the receiver to the thermal noise power from the input of the receiver.

30 is the conversion factor to convert the thermal noise term from dBW to dBm.

- 10.42 Our coordination tools currently use 50m resolution terrain data and the propagation model [ITU-R P.452-16](#) for 20% of time. We keep our coordination tools under constant review and update them as appropriate.

### How we propose to increase realism in our coordination calculations

- 10.43 In line with the approach that we initially proposed in the May 2022 Consultation,<sup>566</sup> in order to secure efficient use of spectrum we consider it appropriate to increase realism in our modelling by applying an attenuation of the interference signal of 12 dB relative to the worst case interference assumptions. In particular, we note that under the worst case assumptions the base station is modelled as an active antenna system directly facing the fixed link receiver and transmitting a single beam at maximum power towards the fixed link receiver. We believe that these conditions do not represent typical operating conditions, and therefore we consider it appropriate to introduce a “worst case reduction factor” (“ $F_{WCR}$ ”) in the interference calculation to improve realism. In annex 16, we provide further detail about why we consider 12 dB to be an appropriate value for the  $F_{WCR}$ .
- 10.44 We propose that this  $F_{WCR}$  should be applied to the calculations used for coordinating new users with: (i) Fixed Links; (ii) Fixed Satellite Services; and (iii) technically assigned Radio Astronomy.

## Proposals for coordinating Shared Access users of the 26 GHz band with existing users in the 26 GHz band

### Out-of-block emissions

- 10.45 As set out in the May 2022 Consultation,<sup>567</sup> we propose to utilise the emissions mask shown in Figure 10.1 below for coordination purposes. This is different to the mask referred to in the technical licence conditions proposed in section 13 as we have assumed for coordination that the emission levels will drop by 3 dB for every 200 MHz separation from the edge of the channel because we consider this appropriate to increase the realism of our modelling.
- 10.46 The adjacent channel leakage ratio (ACLR) of 28 dB for base stations in the 26 GHz band, has been defined in [the 3GPP documents](#).<sup>568</sup> We used this as the starting point for developing our proposed emissions mask. In addition, we have assumed that the emission levels will drop by 3 dB for every 200 MHz separation from the edge of the channel. This is in line with the approach we took to modelling base station coexistence in the

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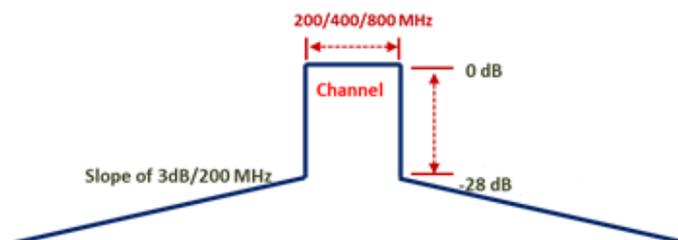
<sup>566</sup> May 2022 Consultation, paragraphs A6.42-A6.45.

<sup>567</sup> May 2022 Consultation, annex 6, paragraph A6.22 and Figure A6.3.

<sup>568</sup> [3GPP TS 38.104 V17.4.0 \(2021-12\)](#), p. 191, table 9.7.3.3-1: *BS type 2-O ACLR limit*.

[December 2021 Consultation](#) “Protecting passive services at 23.6-24 GHz from future 26 GHz uses”<sup>569</sup> and the May 2022 Consultation.<sup>570</sup>

**Figure 10.1: 26 GHz emissions mask**



10.47 We propose to coordinate low and medium power base stations in the 26 GHz band with other users in the band considering a maximum frequency separation of 2.5 times the bandwidth of the mobile system from the block edge of the mobile system. We will not coordinate low and medium power base stations with other users who are at a greater frequency separation. This is consistent with our general approach to technical assignment and we consider that it remains appropriate for 26 GHz. Table 10.6 below shows our proposed emission mask profiles for out of block coordination in relation to the channel bandwidths of 50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz that we are proposing to make available to the Shared Access applicants in the 26 GHz band (see section 14).

**Table 10.6: 26 GHz channels emission profile for coordination**

Channel Bandwidth	50 MHz	50 MHz	100 MHz	100 MHz	200 MHz	200 MHz	400 MHz	400 MHz	800 MHz	800 MHz
Rel. freq. sep.*	Freq. sep.† MHz	limit‡ dBc	Freq. sep. MHz	limit dBc						
0	0	0	0	0	0	0	0	0	0	0
0.5	25	0	50	0	100	0	200	0	400	0
0.5	25	-28	50	-28	100	-28	200	-28	400	-28
2.5	125	-29.5	250	-31	500	-34	1000	-40	2000	-52

\* Relative frequency separation from the carrier centre frequency.

† Absolute frequency separation from the carrier centre frequency. This is calculated by multiplying the relative frequency offset from the carrier centre frequency by the channel bandwidth.

‡ Emissions limit relative to the in-block power spectral density. The values for a relative frequency separation of 2.5 are calculated using an assumption that out-of-block emissions decay by 3 dB / 200 MHz from the block edge (N.B the block edge starts at a relative frequency separation of 0.5 from the carrier centre frequency).

<sup>569</sup> July 2022 Statement on protecting passive services at 24 GHz, Figure A7

<sup>570</sup> May 2022 Consultation, paragraph A6.22 and Figure A6.3.

## Fixed Links

- 10.48 We are proposing to coordinate any new Shared Access low power outdoor and Shared Access medium power deployments with all fixed link licences in the 24.5-26.5 GHz band. We propose to coordinate within a 200km radius of the Shared Access medium power location or of the site centre for Shared Access low power outdoor. As per the current framework, we would not coordinate Shared Access low power indoor with existing fixed links. The current method to protect the fixed link receivers is described in the [OfW 590 Technical Frequency Assignment Criteria for Shared Access Radio Services \(TFAC\) \(v1.2\)](#).
- 10.49 We note that our proposals to coordination of low power outdoor base stations with fixed links is different for Shared Access users than for award winners. Our proposed options for coordinating 26 GHz award winners are set out at in paragraphs 10.81-10.100 below. We consider it appropriate to coordinate Shared Access low power outdoor base stations because the marginal cost of coordinating low power Shared Access users with fixed links is low. Shared Access users will be providing us with details of their low power base stations when they apply for a licence because we need to coordinate Shared Access users with one another, so also coordinating Shared Access low power base stations with fixed links would not be significantly more onerous.
- 10.50 As shown in Table 10.7 below, for Shared Access low power outdoor and medium power applications, we propose a separation distance of 200m from a fixed link station. The proposed separation distance of 200m is consistent with the [high/low](#) protocol that we used to coordinate 26 GHz fixed links.<sup>571</sup> This distance would be used to protect against inter service FDD/TDD interference,<sup>572</sup> rejecting any frequency currently in use by existing fixed links within this distance, which is consistent with our approach for Shared Access users in the 4 GHz band.

**Table 10.7: Co-site separation radius for coordination with fixed links**

Band	Radius
24.5-26.5 GHz	200 m

- 10.51 The [current detailed technical coordination for a fixed link receiver](#) consists of two tests described below,<sup>573</sup> using propagation model ITU-R P.452-10.<sup>574</sup>
- a) Wanted/Unwanted (W/U) Test 1: where W/U is applied to the Receiver Sensitivity Level (the fully faded wanted signal) and the median interfering signal level.

<sup>571</sup> Ofcom’s Technical Frequency Assignment Criteria “[OfW 446: Technical Frequency Assignment Criteria for Fixed Point-to-Point Radio Services with Digital Modulation](#)”, paragraph 2.1.

<sup>572</sup> FDD (Frequency Division Duplex) & TDD, (Time Division Duplex) are duplex methods deployed in telecommunication networks.

<sup>573</sup> OfW 446, paragraph 2.3.

<sup>574</sup> OfW 590, p. 8.

b) W/U Test 2: where W/U is applied to the median wanted signal level (Receive sensitivity level + fade margin) and an enhanced interfering signal level exceeded for p% of time where  $p = 100 - \text{availability}$  (associated with the victim receiver).

10.52 For mobile base station coordination with fixed links, we propose to only carry out Test 1. As we said in the May 2022 Consultation,<sup>575</sup> we believe that Test 2 is not appropriate because we think short-term propagation events are not relevant to this coexistence scenario. This is because we think the risk of interference to fixed links will mainly be from base stations which are nearby (a few kilometers or less). Short-term propagation events only become relevant at much larger distances. Additionally, we propose to update our propagation model to use ITU-R P.452-16, as part our regular updates to our coordination tools.

10.53 We propose to introduce a  $F_{WCR}$  into the technical coordination method between new mobile users and fixed link incumbents to improve realism in our modelling. We consider that the value of  $F_{WCR}$  should be 12 dB and we explain why in annex 16.

### Satellite earth stations

10.54 We propose to coordinate any new Shared Access low power outdoor and medium power deployments with all satellite earth stations in the 25.5-26.5 GHz band. Currently, there is only one receive only satellite earth station using this band. However, as set out in section 5, we will continue to accept future applications for grants of Recognised Spectrum Access for satellite earth stations in the band, but only in low density areas. We propose to coordinate all satellite earth stations within a 200km radius of Shared Access medium power low power outdoor locations in the 26 GHz band. We would not coordinate Shared Access low power indoor with existing satellite earth stations, as per the current framework.

10.55 The current coordination for a satellite earth station consists of two tests described below, using propagation model ITU-R P.452-10.

a) Test 1:  $I/N = 0\text{dB}$  and for 0.005% of time

b) Test 2:  $I/N = -10\text{dB}$  and for 20% of time

10.56 We propose to only carry out Test 2. This is because, similar to coexistence with fixed links, we believe the dominant source of interference to an earth station receiver will be from nearby mobile deployments, and therefore short-term enhanced interference is unlikely to impact earth station receivers. Additionally, we propose to update our propagation model to use ITU-R P.452-16, as part our regular updates to our coordination tools.

10.57 As the earth stations in the 26 GHz band are receive only, we will not need to carry out any coordination test to protect Shared Access stations.

10.58 A worst case reduction factor of 12 dB would also be introduced into the technical coordination method between new mobile users and satellite earth station incumbents.

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<sup>575</sup> May 2022 Consultation, annex 6, paragraph A6.30.

### Radio Astronomy below the 24 GHz band

10.59 In the July 2022 Statement on protecting passive services at 24 GHz,<sup>576</sup> we decided to apply exclusion zones around the six radio astronomy sites that comprise the eMERLIN array, in which we will not allow the deployment of outdoor 26 GHz base stations, in order to protect the following 24 GHz radio astronomy (RAS) sites listed below:

- Jodrell Bank (SJ 79650 70950)
- Cambridge (TL 39400 54000)
- Darnhall (SJ 64275 62265)
- Defford (SO 90200 44700)
- Knockin (SJ 32855 21880)
- Pickmere (SJ 70404 76945)

10.60 We said that we would use exclusion zones around all six e-MERLIN sites in order to avoid harmful interference from 26 GHz mobile base stations to those sites. We reproduce the exclusion zones distances we calculated below in Table 10.8 for the period after 2024 only, because we will not be making the spectrum available before 2024. These exclusion zones will only have an impact on spectrum availability for Shared Access because none of the high density areas are close enough to radio astronomy sites for them to have an impact on spectrum availability for award winners.

**Table 10.8: Radii of exclusion zones around all six e MERLIN sites**

Radii of exclusion zones	
Frequency range 24.25 – 25.05 GHz	Frequency range 25.05 – 27.5 GHz
2.5km	1km

### Earth exploration satellite service (EESS) below 24 GHz

10.61 As set out in the July 2022 Statement,<sup>577</sup> we have decided to limit the number of outdoor 26 GHz base stations within any 300km<sup>2</sup> area which can be deployed in the lowest 800 MHz of the 26 GHz band (i.e. 24.25-25.05 GHz) in order to protect the EEES below 24 GHz. The total interference contribution from all individual base stations<sup>578</sup> operating in the lowest 800 MHz (24.25-25.05 GHz) of the 26 GHz band within any 300km<sup>2</sup> area must be equal to or lower than 0.1432 W/200 MHz. We did not consider it necessary to include an interference contribution from base stations deployed above 25.05 GHz. This means that we propose to coordinate Shared Access users in accordance with this density limit, but award winners in the 26 GHz band will not be subject to this coordination limit because we are awarding the spectrum above 25.1 GHz only.

<sup>576</sup> July 2022 Statement on protecting passive services at 24 GHz, paragraph 2.20.

<sup>577</sup> July 2022 Statement on protecting passive services at 24 GHz, paragraph 2.26.

<sup>578</sup> A base station in this context would be a single sector antenna

**Calculating the EESS limit**

10.62 We will calculate the total interference contribution from all base stations in any 300km<sup>2</sup> area and compare this with the interference limit using Equation 10.3. This equation is the same as we decided in the July 2022 Statement<sup>579</sup> but we now propose to add an apportionment term,  $I_{c\_MOD}$ , to take account of MOD deployments in 24.25-24.45 GHz.

**Equation 10.1**

$$\sum_{n=1}^N I_{c\_n} + I_{c\_MOD} \leq 0.1432 \text{ W/200 MHz}$$

Where:

$N$  is the total number of base stations in the 300km<sup>2</sup> area

$n$  is the  $n^{th}$  base station

$I_{c\_n}$  is the interference contribution from the  $n^{th}$  base station as calculated below in Equation 10.4 (in linear units W/200 MHz)

$I_{c\_MOD}$  is 0.00317 W/200 MHz for MoD use in the band

10.63 We propose that when a new Shared Access application is received, our coordination tool will count the number of existing Shared Access users in a 300km<sup>2</sup> area centred on the new applicant to check whether the new applicant would cause the deployment density limit to be exceeded.

10.64 Licensees could deploy more than one base station under the terms of each licence. We propose to take this into account in our base station density calculation by multiplying all low power outdoor and medium power licences by three. This would then be used to determine the total number of base stations within the 300km<sup>2</sup> area.

10.65 We would then calculate all emissions contributions from each base station using Equation 10.4, including the new Shared Access deployment, then add together all the individual contributions to calculate whether the overall limit has been exceeded.

**Equation 10.4**

$$I_c = 10 \left( \frac{P_{OOBE\_dB} - 2 - \left( \frac{\left( f_{centre} - \frac{Ch_{size}}{2} \right) - 24.25}{0.05} \right)}{10} \right)$$

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<sup>579</sup> July 2022 Statement on protecting passive services at 24 GHz, Equation 2

Where:

$I_c$  contribution of single base station in W/200 MHz

$P_{OOBR\_dB}$  -39 (dBW/200 MHz)

$f_{centre}$  centre frequency of assigned channel

$Ch_{size}$  channel bandwidth

- 10.66 To calculate the combined civil and MOD use and simplify coordination with MOD use, we have jointly agreed with MOD a maximum density limit of 40 MOD base stations per 300km<sup>2</sup>. We propose to add an apportionment of 0.00317 W/200 MHz<sup>580</sup> to take account of potential future MOD use. Any additional use above this limit would be captured as and when Ofcom is notified by MOD.
- 10.67 If the total calculated value is equal to or less than 0.1432 W/200 MHz, the new Shared Access deployment would pass the EESS OOB coordination.

## Coordination in the 40 GHz band

### Coordination of Shared Access users with existing users in the 40 GHz band

- 10.68 As explained in section 3 of this document,<sup>581</sup> we propose to make Shared Access licences available in the 40 GHz band in low density areas only after the end of the revocation period for existing licensees. This would reduce the co-ordination burden on existing licensees during the 5 years' notice period for revoking their licences and help manage Ofcom's internal resource.

### Fixed Links and Satellite Earth Stations

- 10.69 When the 40 GHz band becomes available for Shared Access users in low density areas, we propose to undertake coordination of Shared Access users and existing users in a similar way to the way we are proposing to coordinate these users in the 26 GHz band because we expect the technical characteristics of 40 GHz services to be similar to 26 GHz services.
- 10.70 However, we will consult on the coordination values that we consider appropriate to the 40 GHz band before Shared Access use of the 40 GHz band becomes available in low density areas.

### Radio Astronomy at Cambridge (42.5-43.5 GHz)

- 10.71 As explained in section 7, we have decided to protect radio astronomy use in Cambridge of the top 1 GHz of the 40 GHz band. We will consult on how to protect the RAS at Cambridge

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<sup>580</sup> Derived from 40 base stations operating on frequency 24.35 GHz (200 MHz channel) at the OOB limit -39 dBW / 200 MHz.

<sup>581</sup> Paragraphs 3.79-3.81.

from Shared Access licensees before we make the 40 GHz band available for Shared Access.

## Proposals for coordinating award winners in the 26 GHz and 40 GHz bands with existing users of the spectrum, during the revocation period

- 10.72 The coexistence analysis we set out in the May 2022 Consultation<sup>582</sup> shows that award winners wishing to deploy in high density areas in 25.1-26.5 GHz and the 40 GHz band before the revocation of existing users' licences has taken effect will need to coordinate with existing fixed services. We also propose to require award winners in the 40 GHz band to protect the existing radio astronomy site at Cambridge on an ongoing basis. We do not consider that other existing users operating in high density areas will require coordination.
- 10.73 At the end of the revocation period, the fixed link coordination requirements will fall away because any fixed links that cannot coexist with mobile deployments in high density areas will have been removed from the bands. We therefore propose that the only coordination required at the end of such period would be (i) the coordination of award winners and Shared Access licensees at the boundaries of high density areas, and (ii) the coordination of award winners in the 40 GHz band with the radio astronomy site at Cambridge.
- 10.74 In the May 2022 Consultation,<sup>583</sup> we explained the coexistence studies we had carried out to understand the risk of interference to existing fixed links from new low and medium power mobile base station deployments. The base stations used in these studies are equivalent to those we have used in the Shared Access framework in section 14. For example, a low power base station might be used to provide hotspot coverage, whilst medium power might be used to provide a fixed wireless access service over a wider area.
- 10.75 We have considered several options for coordination of award winners and existing fixed services in high density areas in both the 25.1-26.5 GHz and the 40 GHz bands. Below, we provide details on these options and our proposed approach for coordination in both bands.

### Risk of interference from fixed links to mobile use

- 10.76 On the basis of our coexistence analysis (detailed in annex 16), we consider that the main interference risk is from new mobile base stations to fixed links, rather than vice versa. We expect that mobile base stations will use active antenna systems which can null out interference coming from a fixed direction.<sup>584</sup> Conversely, fixed link stations cannot protect themselves in the same way because they are always transmitting and receiving between two fixed points using static antenna beams.

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<sup>582</sup> May 2022 Consultation, paragraph A6.94.

<sup>583</sup> May 2022 Consultation, paragraphs A6.92-A6.98.

<sup>584</sup> Ericsson's "[Massive MIMO Handbook: Extended version \(1st edition\)](#)", March 2022, p.13.

### Risk of interference from low power outdoor mobile use to fixed links

- 10.77 We found that low power outdoor mobile deployments were at low risk of causing interference to fixed links in the May 2022 Consultation.<sup>585</sup> Low power base stations are limited to 10m height above ground level and so will typically be below rooftops, in the clutter and usually not in line-of-sight of fixed links which are deployed above rooftop height. Our coexistence analysis showed that, except for the case of the fixed links operated by MBNL in the 40 GHz band (which is discussed below), fewer than 5% of pixels<sup>586</sup> where mobile could deploy in a high density area would be at risk of causing interference to a fixed link. Since we consider that low power outdoor mobile deployments are generally at low risk of causing interference to fixed links, we propose to address this risk by requiring licensees to cooperate when interference occurs.
- 10.78 The very high density of the fixed links operated by MBNL in the 40 GHz band means that in this case the risk of interference from low power outdoor mobile deployments is appreciably higher. Therefore, as discussed in more detail below, we think that coordination is more likely to be required in this case.

### Risk of interference from medium power mobile stations to fixed links

- 10.79 In the May 2022 Consultation,<sup>587</sup> we said that for medium power mobile base stations there was a high risk of interference when deployed in the boresight of a fixed link in the same area. This was because medium power base stations are typically deployed at a greater height than low power base stations and so are more likely to be in the line-of-sight of fixed links. Therefore, as discussed in more detail below, we think that coordination is more likely to be required also in this case.

### Cases where coordination is more likely to be required

- 10.80 As set out above, we consider that coordination is more likely to be required to mitigate the risk of interference (i) for award winners deploying medium power base stations in 25.1-26.5 GHz and 40.5-43.5 GHz bands and (ii) for low and medium power base stations using the frequencies which are currently licensed to MBNL in the 40 GHz band (40.5-40.75 GHz and 42-42.25 GHz). Coordination between award winners and fixed links is only needed during the revocation period. Coordination would cease after the revocation period, as all fixed links in and around high density areas would have been cleared and we consider that the field strength limit at the boundary of the high density areas will be sufficient to ensure coexistence with the fixed links that remain in low density areas.

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<sup>585</sup> May 2022 Consultation, paragraphs A6.92-A6.98.

<sup>586</sup> 100m x 100m square.

<sup>587</sup> May 2022 Consultation, paragraphs A6.92-A6.98.

## Proposed options

- 10.81 We have considered the following options for coordinating award winners, during the period while existing fixed services in and around high density areas would still be operating in the relevant bands:
- a) **Option 1:** Award winners expected to do detailed coordination, on the basis of coordination procedures set out by Ofcom.
  - b) **Option 2a:** Ofcom provides maps for award winners to use for coordination
  - c) **Option 2b:** Ofcom publishes fixed link locations with exclusion zone vectors.
  - d) **Option 3:** Ofcom coordinates stations for award winners.
  - e) **Option 4:** Low risk spectrum use allowed only.
- 10.82 **Option 1 (Licensees coordinate):** We would set out detailed coordination requirements and require award winners to comply with these requirements during the revocation period. This option would have the advantage of allowing award winners to start each individual new deployment without waiting for Ofcom to respond to their coordination requests. However, before starting deployment, each award winner would need to satisfy Ofcom that its coordination tool meets the coordination requirements. It is likely that award winners would need to develop or procure software capable of carrying out such detailed coordination.
- 10.83 In the 40 GHz band, award winners and the existing 40 GHz licensees may need to share relevant deployment data on a regular basis, so that the coordination is carried out with the most up to date data. Any such information-sharing would need to be consistent with competition law. The 26 GHz fixed link data is already publicly available on the [Ofcom website](#), so no further information-sharing would be necessary in this case.
- 10.84 **Option 2a (Ofcom publishes maps to aid coordination):** Ofcom would publish maps for each high density area specifying the maximum power level at a particular height which an award winner could transmit at in each pixel for every channel, without causing interference to existing fixed links. Like option 1, this could be implemented by requiring award winners to comply with detailed coordination requirements.
- 10.85 If we decide to proceed with this option, we envisage updating the maps on a regular basis (for example, every 3 or 6 months) depending on the change in the number of deployed fixed links (for example the numbers change by 5% or 10%).
- 10.86 This option would have the benefit of clearly indicating where deployments could not be made and, similar to option 1, would enable operators to deploy without needing to make coordination requests to Ofcom. However, this option would require upfront resource from Ofcom, and would require Ofcom to make a judgement about the potential mmWave base station deployment height and technical characteristics which remain uncertain. For example, we understand that the height at which base stations are deployed has a significant impact on coexistence with fixed links but it remains unclear whether small cells or macrocells will be the dominant deployment geometry.

10.87 **Option 2b (Ofcom publishes link locations and separation distance vectors):** we note that there may be ways to simplify option 2a. As medium power base stations will tend to be deployed above rooftop and within line of sight of fixed links, a simplified calculation could be made without the need to account for terrain and clutter. For example, we could provide a vector for the protection of fixed links to licensees, as illustrated in Figure 10.2 below. This vector would consist of two parts:

- (i) A short separation distance across most azimuth angles for preventing harmful interference from mobile base stations entering the back and sidelobes of the fixed link antenna.
- (ii) A longer separation distance across a narrow azimuth angle for preventing harmful interference from mobile base stations entering the boresight of the fixed link antenna.

10.88 We might require two of these vectors be applied: one for the co-channel coexistence and a much smaller one for adjacent channel coexistence.

10.89 To apply these vectors, licensees would need to know:

- (i) the frequency and bandwidth of the fixed link receiver;
- (ii) the location of the fixed link receiver; and
- (iii) the azimuth pointing direction of the fixed link receiver.

10.90 Further study would be necessary to set the values for these separation distances and the azimuth angles over which they would apply. Our initial work suggests that for co-channel scenarios the shorter of the two distances might be of the order of low hundreds of meters whilst the longer of the two distances might be of the order of low tens of kilometers. These distances would likely be much smaller for the vector in the adjacent channel.

**Figure 10.2: Diagram showing the separation distance approach that could be used to implement Option 2b**



10.91 **Option 3 (Ofcom coordinates):** Award winners would submit batches of base station coordination requests to Ofcom for coordination with the fixed links included in our database. This would be the same approach as we used for the [3.6-3.8 GHz band](#), and we would use the same tools as we would use for the Shared Access licences. This approach would require Ofcom to include the 40 GHz band within our coordination systems.

- 10.92 This option would have the advantage of allowing for coordination of a range of deployment geometries and equipment types depending on what award winners decide to deploy, without Ofcom needing to make a judgment about what mmWave deployment might look like. However, it is possible that this approach could be slower for licensees than options 1 and 2, as licensees would have to wait for Ofcom's approval before deploying spectrum. The amount of resource required under this option would scale with the number of coordination requests received by Ofcom.
- 10.93 We already hold information about the fixed links operating in the 26 GHz band, which we could use for coordination purposes. However, in order to proceed with either option 2 or 3 above to coordinate new deployments in the 40 GHz band, we would need to obtain precise data about the fixed links operated by existing 40 GHz licensees in and around high density areas. Our provisional view is that this could be achieved by requesting such information from the existing 40 GHz licensees on a regular basis (e.g. every 3 or 6 months), in accordance with the terms of their existing licences.
- 10.94 **Option 4 (low risk spectrum use only):** In this option, award winners' use of spectrum during the revocation period would be limited as follows:
- a) In the **26 GHz band**, new medium power deployments would only be allowed in the 26.5-27.5 GHz band, as this is not co-channel with fixed link users. Award winners would not be allowed to deploy at medium power in the remainder of the band. However, low power spectrum deployments would be allowed in the whole of the 26 GHz band.
  - b) In the **40 GHz band**, medium power deployments would not be allowed, and low power deployments would only be allowed in the 40.75-42 GHz and 42.25-43 GHz (i.e. the spectrum which is not currently licensed to MBNL). This is because, as explained above, our coexistence studies show that even low power deployments would be likely to cause interference to MBNL's existing fixed links.

#### How Ofcom could do the coordination at 40 GHz

- 10.95 For options 1, 2 and 3 both the existing licensees and award winners would be able to deploy new sites during the revocation period.
- 10.96 For option 2, we propose to provide maps for award winners to use for coordination, either a base station power restriction pixel map or fixed link locations with exclusion zone vectors.
- 10.97 For option 3, we would also require award winners to submit new base station requests to us for coordination, before deploying. If we receive a new coordination request from an award winner which we consider likely to cause interference to, or receive interference from, an existing user, then we would deny that coordination request.
- 10.98 For both options 2 and 3 we expect to require both award winners and existing licensees to provide us with updates on added and removed sites on an appropriately regular basis (e.g. every 3 or 6 months) and only for sites that have been deployed, not planned deployments.

10.99 We note for both options 2 and 3 that there is a chance that the award winners and the existing users might both deploy sites in the same area between updates to the coordination data. However, we expect that this is unlikely to be a common occurrence. When both an award winner and an existing user deploy in the same area and either or both of the parties suffers harmful interference, we would expect to work with both parties to resolve any interference. We do not consider existing users are likely to cause interference to award winners if they deploy new fixed links during the revocation period, as our analysis shows that interference is likely to be from 5G base stations to fixed links, rather than vice versa, see “Dominant direction of interference between fixed links and mobile base stations” in annex 16.

### Our proposed option

10.100 Our provisional view is that one of the options where we carry out the coordination (i.e. option 2 or 3) would be most likely to result in efficient use of the spectrum. We are interested in stakeholders’ views on this, including as to whether they consider option 1 would be effective and technically feasible for them, or whether they think alternative approaches to coordination would be appropriate. For implementing the option that we decide to adopt following consultation, we would notify such co-ordination procedure to licensees under the relevant terms of the award licences.<sup>588</sup>

### Radio Astronomy at Cambridge (42.5-43.5 GHz)

10.101 As explained in section 7, we have decided to protect radioastronomy use in Cambridge of the top 1 GHz of the 40 GHz band. This is currently protected by a 50km exclusion zone. We propose to change how we protect this site after the auction, in order to ensure spectrum around the site could be used efficiently by award winners.

10.102 Specifically, we propose to protect the radio astronomy site (RAS) at Cambridge (42.5-43.5 GHz) using technical assignment coordination if the following way:

- a) we propose to use a 50km coordination zone centered on NGR TL 39400 54000, which would be in line with the size and location of the existing exclusion zone;
- b) we propose to apply a [spectrum quality benchmark \(SQB\) level](#) of -207dBW/500 kHz,<sup>589</sup> which is equivalent to -181 dBW/200 MHz at 42.5-43.5 GHz. This protection level is recommended by the ITU-R RA.769-2; and
- c) in addition to the SQB level, we propose to apply a  $F_{WCR}$  of 12dB to the interference calculation. Our proposed  $F_{WCR}$  is set out at paragraph 10.43.

10.103 This would affect an award winner who won the Cambridge high density area. We note that it could affect the winners of 40.5-42.5 GHz, as well as 42.5-43.5 GHz, because all 40 GHz licensees would need to limit their emissions into 42.5-43.5 GHz in order to comply

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<sup>588</sup> See the “Co-ordination at frequency and geographical boundaries” condition in the draft award licence set out in annex 10.

<sup>589</sup> ITU, “[RECOMMENDATION ITU-R RA.769-2, Protection criteria used for radio astronomical measurements \(1992-1995-2003\)](#)”, table 2.

with the required SQB level. We would implement this proposal through a coordination notice, with which the licensee would be required to comply.

- 10.104 We would need to vary the Cambridge notification of Recognised Spectrum Access (RSA) to reflect our proposed changes. The changes would need to apply at the time of the spectrum award.

## Proposals for coordinating at the boundary of high and low density areas

- 10.105 As explained in section 3, in high density areas, we have decided to award licences to use the upper 2.4 GHz of the 26 GHz band (25.1-27.5 GHz), and we propose to award licences to use the whole of the 40 GHz band. In low density areas, we have decided to make the whole of the 26 GHz band available using our Shared Access licensing framework. This means that interference could arise at the boundaries between high density and low density areas if there is no coordination.
- 10.106 We propose to coordinate new low power Shared Access users in low density areas using a separation distance. We propose to restrict indoor and outdoor low power Shared Access base stations in the 25.1-27.5 GHz band in low density to a minimum separation distance from boundaries of high density areas, as summarised in Table 10.9. The minimum separation distances from the boundary are half the minimum station to station separations distances because this will ensure that the minimum station to station separation distances will be maintained across the boundary line.

**Table 10.9: Shared Access low power separation distance from the high density area boundary line in 25.1-27.5 GHz**

Authorisation type	Distance
low power indoor	50m
low power outdoor	100m

- 10.107 We propose that medium power base station use in the 25.1-27.5 GHz band in low density areas with a high density area boundary should comply with a field strength limit at the boundary.
- 10.108 Work is ongoing at Project Team 1 (“PT1”) within the Electronic Communications Committee (“ECC”) (ECC PT1) on 26 GHz cross-border coordination, which we expect to be finished by Summer 2023. We note that the cross-border field strength limit will result in some interference in border areas, but that mobile operators consider that the interference will result in acceptable throughput loss in these areas. We therefore consider that the same limit is likely to be appropriate for managing interference between licensees in high and low density areas. At the moment, the field strength limits being considered would allow licensees to deploy medium power base stations up to 250m from the

boundary with some site engineering.<sup>590</sup> This means that a licensee might need to downtilt base station antennas or point antenna panels away from the boundary line when deploying near the boundary. Given the high density areas which we have identified are typically several kilometers across, we believe that this field strength limit is unlikely to be a significant constraint on award winners' ability to deploy.

- 10.109 The work at PT1 is expected to conclude Summer 2023. We propose to adopt the same field strength limit as PT1 for both the 26 and 40 GHz bands, for both award winners and Shared Access users either side of the high density area boundary, as long as the finalised values do not significantly constrain use in high density areas.

## International coordination

- 10.110 Work is ongoing at PT1 within the ECC to establish the international coordination trigger levels and due to be published Summer 2023. We would then seek to establish memoranda of understanding for cross-border coordination with our neighbours which would take the border conditions recommended by ECC into account.
- 10.111 We propose to include a condition in the award licences for both the 26 GHz and 40 GHz bands, requiring licensees to comply with any such cross-border coordination and sharing procedures as may be notified to them by Ofcom from time to time, which is a standard condition in most award licences. In practice, we expect that international coordination is unlikely to be a constraint on award winners because the field strength limit at the boundary of high density areas will be a greater constraint on deployment than the field strength limit at international boundaries. This would certainly be the case if we use the same field strength limit at the boundary of high density areas as is used for international coordination, as we have proposed above.

## Next steps

- 10.112 We intend to publish a statement setting out our decisions on the coordination proposals set out in this section in later in 2023. We would then implement any decisions about coordination as appropriate, including by imposing coordination requirements in the new award licences, issuing a coordination notice and/or varying existing licences (if objectively justifiable and proportionate).

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<sup>590</sup> [ECC PT1\(23\)067](#), annex VIII-08.

## Consultation questions

**Question 7:** Do you agree with our proposed approach to coordinating Shared Access users in the 26 GHz band? If not, please give reasons.

**Question 8:** Do you agree it would be appropriate to coordinate Shared Access users in the 40 GHz band in a similar way to the 26 GHz band if we make it available in 5 years time (noting we would consult on the detail of this coordination). If not, please give reasons.

**Question 9:** Which of the proposed options for coordinating award winners and existing licensees during the (5-year) revocation period do you think would be most appropriate? Do you think alternative approaches to coordination would be more appropriate?

**Question 10:** Do you agree with our proposal to protect the radio astronomy site at Cambridge (42.5-43.5 GHz) from new mobile users using the 40.5-43.5 GHz band using technical assignment coordination? If not, please give reasons.

**Question 11:** Do you agree with our proposed approach to coordinating at the boundary of high and low density areas? If not, please give reasons.

**Question 12:** Do you agree with our proposed approach to international coordination? If not, please give reasons.

## 11. Award licences: non-technical conditions

### Summary

- 11.1 This section sets out the non-technical licence conditions which we propose to include in the award licences for the 26 GHz and 40 GHz except for the licence duration, which is discussed in section 13. In summary, most of the conditions discussed below would be in line with Ofcom's standard non-technical licence conditions for mobile licences and are the same for each of these bands.
- 11.2 Examples of the proposed licences can be found in annex 10 of this document. The draft licence shown in annex 10 would implement the proposals set out in this section, and section 12. We note that if we decide to award licences with an indefinite term, we would include additional terms and conditions in the award licences relating to payment of fees, and revocation for spectrum management reasons.

### Licence commencement

- 11.3 We propose that the award licences will commence on the date they are issued, shortly after the award. However, as noted in section 10, for the first 4-5 years (i.e. until completion of the revocation process), licensees will be required to co-ordinate their use with the use of the same frequencies by the existing licence-holders.
- 11.4 Our proposals on licence duration are set out in section 12.

### Territorial extent of licences

- 11.5 As set out in sections 2 and 3, the award licences would authorise licensees to use the relevant frequencies within the 26 GHz and 40 GHz bands in the high density areas.
- 11.6 The geographic scope of these licences would therefore be limited to high density areas. We propose to define these areas in a schedule to the licences, by listing the coordinates for the vertices of each high density area (eastings and northings, based on the British National Grid reference system). An example of this is shown in annex 10.

### The payment of licence fees

- 11.7 As set out in section 12, we propose that the award licences would have a fixed term of 15 years. As a result, we propose not to include a provision enabling us to impose ongoing fees after the end of the licence term, since these licences would expire at the end of such a term.

## The tradability of licences (including leasing)

### Trading

- 11.8 We propose to make the award licences tradable by amending the [Wireless Telegraphy \(Mobile Spectrum Trading\) Regulations 2011](#) (the “**Mobile Trading Regulations**”)<sup>591</sup> to include the relevant frequencies within the 26 GHz and 40 GHz bands.
- 11.9 This amendment would mean that licensees could trade the rights and obligations under their award licences with consent from Ofcom.<sup>592</sup> Before giving consent to a trade, Ofcom may consider whether competition is likely to be distorted as a result of the trade.<sup>593</sup> Further detail on this transfer process is provided in our [Trading Guidance Notes](#).<sup>594</sup> Including mmWave spectrum in the Mobile Trading Regulations would enable licensees to agree ‘partial’ trades.<sup>595</sup> This would mean that if a single licence authorised all high density areas (as we propose in section 9), a licensee could nonetheless trade the rights to use the spectrum in a particular high density area.
- 11.10 We plan to give formal notice of our proposals for amending the Mobile Trading Regulations, including the draft regulations that we propose to make to amend these regulations, later this year.

### Leasing

- 11.11 We do not propose to make the award licences leasable. This position is in line with our approach to other licences covered by the Mobile Trading Regulations.<sup>596</sup> In our [2016 spectrum sharing review](#),<sup>597</sup> we said that we would consider extending leasing to mobile licences if there are likely to be net benefits, including sufficient evidence of demand to lease spectrum.<sup>598</sup> The potential benefits and downsides of allowing leasing which we have considered in relation to mmWave spectrum, taking account of consultation responses, are set out below.

### Potential benefits and downsides of allowing leasing of mmWave spectrum

- 11.12 We have identified the following areas where we consider that allowing leasing could potentially be beneficial in mmWave spectrum.

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<sup>591</sup> S.I. [2011/1507](#), amended by S.I. [2013/646](#), S.I. [2015/1339](#) and S.I. [2019/951](#).

<sup>592</sup> [Mobile Trading Regulations](#), Regulations 7(3)(a) and 8.

<sup>593</sup> Mobile Trading Regulations, Regulation 8(e).

<sup>594</sup> Ofcom’s “[Trading Guidance Notes](#)”, published 12 March 2020, in particular paragraphs 2.8 and 3.34-3.43.

<sup>595</sup> Mobile Trading Regulations, Regulation 5; see also Trading Guidance Notes, paragraph 3.8.

<sup>596</sup> Trading Guidance Notes, paragraph 4.4.

<sup>597</sup> Ofcom’s “[A framework for spectrum sharing](#)”, published 14 April 2016, paragraph 6.18.

<sup>598</sup> We reiterated that position in Ofcom’s Statement “[Award of the 700 MHz and 3.6 GHz spectrum bands](#)”, published 13 March 2020, paragraphs 8.17-8.19.

### Market mechanism to enable spectrum to be used by the highest value user

- 11.13 In principle leasing is a market mechanism which has the benefit of allowing spectrum to be made available to a higher-value user than the licensee. In this case, leasing could in principle enable use of the spectrum by existing users of the bands, for example through a 'club model'.

### Existing users of the 26 GHz and 40 GHz bands in high density areas

- 11.14 As set out in sections 5 and 7, we have decided to start the statutory process for revoking some fixed link licences in the 26 GHz band and all the current licences in the 40 GHz bands. It is possible in principle that the holders of these licences could benefit from leasing, as leasing some spectrum from an award winner might enable them to continue to use these bands (e.g. by operating their fixed links) after the end of the notice period for revocation, for example to mitigate their costs of clearance.
- 11.15 However, any lessee would be required to operate within the terms of the lessor's licence<sup>599</sup> and the proposed technical conditions for citywide licences are not designed to be suitable for FDD fixed link use. In addition, as the existing users operate using separate blocks of paired spectrum, they would need to enter into lease agreements with each of the winners of the award licences for the frequencies included in each spectrum block, which could potentially require negotiations with multiple licensees, increasing the complexity of establishing such arrangements. On balance we do not consider that there are likely to be net benefits from allowing leasing, and we have not seen evidence of demand to lease spectrum.

### Club Model

- 11.16 As explained in section 3, several stakeholders<sup>600</sup> suggested we implement a form of 'club model', either to authorise the spectrum, or to enable licensees to temporarily access spectrum that is held by another operator but is unused. We recognise that one way operators might be able to implement a club model, without involvement from Ofcom, would be through leasing. However, as explained in section 3 (paragraphs 3.77-3.81), we are making over 6 GHz of mmWave spectrum available, and we therefore do not expect spectrum sharing to be necessary in order to enable operators to access as much mmWave spectrum as they might need. In addition, we do not consider that the club model would give rise to significant additional benefits compared with those available under the Local Access licensing framework or the mobile spectrum trading scheme, which are already available.

### Ofcom's Local Access licensing framework

- 11.17 Our provisional view is that the potential benefits of leasing described above could be achieved through use of Ofcom's [Local Access licensing framework](#). In particular, we consider that existing spectrum users might find it easier to access spectrum using a Local Access licence because we deal with each request for a Local Access licence on a case-by-

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<sup>599</sup> Trading Guidance Notes, paragraph 4.1.

<sup>600</sup> Vodafone, VMO2, Professor Stephen Temple and techUK. See paragraphs 3.77-3.81

case basis.<sup>601</sup> Therefore, in appropriate cases, the existing fixed link users might be granted access to the relevant spectrum for fixed link services through a Local Access licence. We also consider that leasing can give rise to difficulties relating to enforcement of licence terms (as explained below).

### **Burden of risk and enforcement**

11.18 In a lease arrangement, the licensee remains ultimately responsible for all obligations under the licence and is normally expected to act as first port of call to resolve complaints from its own leaseholders. As a result, the burden of compliance would continue to fall primarily onto the licensee.<sup>602</sup>

### **Our provisional view**

11.19 Based on the above, on balance we do not consider that leasing would give rise to net benefits over and above what can already be achieved by trading licences or through our existing Local Access licensing framework.

## **Non-technical restrictions on use**

11.20 We do not propose to include any non-technical restrictions in the licences which would limit the use to which the spectrum could be put (such as specifying the type of service that should be offered, the technology that should be deployed or the equipment that should be used). In our view imposing such restrictions would be contrary to our policy objectives for mmWave spectrum, particularly our objective of encouraging investment and innovation.

## **Spectrum sharing**

11.21 We note that the award licences will not guarantee exclusive use of the spectrum awarded. In the future, we may grant additional authorisations to allow the use of all, or part, of the spectrum, including the spectrum that is the subject of this consultation and statement. In particular, we propose to allow other users to access the 26 GHz and 40 GHz spectrum as part of our Local Access licensing<sup>603</sup> framework.

## **Local access licensing**

11.22 We propose to allow access to spectrum in the 26 GHz and 40 GHz bands following award, using our Local Access licensing framework.

11.23 Our Local Access licensing framework provides a way for other users to access spectrum which has already been awarded, in locations where the award licensee is not using the spectrum.

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<sup>601</sup> Ofcom's Guidance Document "[Local Access Licence](#)", paragraph 2.2

<sup>602</sup> Training Guidance Notes, paragraphs 4.13 - 4.19.

<sup>603</sup> Local Access Licence Guidance.

- 11.24 Local Access licensing allows access to spectrum without the need to enter into a commercial agreement with the existing licensee. Rather, following the process set out in Ofcom's [Local Access Licence Guidance](#), the potential user makes an application to Ofcom to access the spectrum held by someone else for up to three years.<sup>604</sup> This is a further mitigation against the potential risk of spectrum lying fallow for periods of time, if it is not being used by the licensee in particular areas.

## Roaming

- 11.25 We do not propose to include any roaming obligations in licences for mmWave spectrum because although there may be a case for roaming obligations where they would enable more consistent coverage of traditional voice/data mobile services, it is less clear at this stage whether such obligations would be appropriate for innovative services which may emerge using mmWave spectrum, particularly given that the specific characteristics of mmWave spectrum mean it is not suitable for providing wide area coverage.
- 11.26 However, we do not rule out the possibility of looking to impose roaming conditions, as appropriate, in these licences in the future. Any future proposals would be subject to analysis and consultation at the time, in line with our general approach.

## Roll-out obligations (“use it or lose it”)

- 11.27 We have considered whether to include roll-out obligations and/or a ‘use it or lose it’ clause in the award licences. Such obligations would require licensees to make use of the relevant spectrum (or deploy specified services) within a specified time period, or risk revocation of the licences if these obligations are not met (i.e. ‘use-it-or-lose-it’).
- 11.28 In theory, such conditions could help to ensure efficient use of spectrum. However, we do not currently propose to include such conditions, because:
- a) There may be entirely legitimate reasons for spectrum remaining unused – the licensee may be waiting for a suitable commercial opportunity or until the technology it wishes to use is ready;
  - b) Imposing such an obligation has the potential to distort and/or chill the incentives to invest in the spectrum, and so reduce the benefits for consumers and citizens which the award would otherwise create; and
  - c) Such conditions might also be difficult to make workable in practice because of the problem of defining what constitutes ‘use’ and therefore what the trigger for a licence revocation would be.
- 11.29 In addition, we note that we are minded to award 15 year fixed term licences, which would enable us to reallocate the spectrum to ensure it is efficiently used at the end of the licence term. This would reduce the need to include a power for us to take back the

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<sup>604</sup> With the licensees’ consent, this period of three years can be extended.

spectrum if it is unused. Given the above, we do not propose to include roll-out obligations or use-it-or-lose-it conditions in the award licences.

## Access and inspection

- 11.30 In accordance with our standard spectrum licence conditions, we propose that licensees would be required to permit any person authorised by Ofcom to have access to and to inspect the radio equipment specified in the licence at all reasonable times.

## Modification, restriction and closedown

- 11.31 In line with our standard spectrum licence conditions, we propose a licence provision which would enable Ofcom to require that the radio equipment (or any part of it) be modified, restricted in use or temporarily or permanently closed down if: (i) a licensee breaches the terms of its licence; (ii) the use of radio equipment is or may be causing or contributing interference to the operation of other authorised radio equipment; or (iii) it appears necessary or expedient in the event of a national or local state of emergency.

## Record-keeping and provision of information to facilitate optimal spectrum use

- 11.32 In line with our duty to ensure optimal use of spectrum, we propose to include a condition in the licences requiring licensees: (i) to compile and maintain accurate written records of certain details relating to the radio equipment (specified in the licence), (ii) to produce these records if requested by Ofcom and (iii) to provide, on request, such general information regarding their equipment and use of frequencies, or the roll-out of their network, as Ofcom may reasonably request.
- 11.33 We note that we have powers under both the [Communications Act 2003](#) (section 135 to 146) and the [Wireless Telegraphy Act 2006](#) (sections 32 to 34) to require the provision of information in certain circumstances. However, we consider that there remains a benefit in requiring licensees to compile and maintain basic details relating to the radio equipment that they are using pursuant to the licence so that it is readily available in the event that it is needed, for example, in cases of alleged interference.

## Consultation question

**Question 13:** Do you agree with the non-technical conditions that we propose to include in the award licences to be issued following the award of the 26 GHz and 40 GHz bands? If not, please give reasons.

## 12. Award licence duration

### Summary

12.1 When determining the appropriate duration of spectrum licences, we aim to strike an appropriate balance between ensuring licensees have sufficient long-term certainty for investment and maintaining ongoing optimal use of spectrum.<sup>605</sup> Having considered stakeholders' responses to the May 2022 Consultation, we are minded to award fixed term licences with a 15 year term in our auction of mmWave spectrum. We are seeking views from stakeholders on this revised proposal.

### Our initial proposals

12.2 The spectrum licences we have previously awarded by auction<sup>606</sup> for mobile bands have:

- a) an indefinite term (i.e. they continue in force until revoked by Ofcom, subject to a notice period, or surrendered by the licensee); and
- b) an initial term of 20 years during which Ofcom cannot revoke the relevant licences for spectrum management reasons or charge additional licence fees.

12.3 In the May 2022 Consultation,<sup>607</sup> we noted that the still emerging potential of new uses for mmWave spectrum gives rise to a risk that the initial allocation of citywide mmWave licences would not reflect the most efficient allocation of mmWave spectrum in the longer term. In light of this risk, we set out our provisional view that it may be appropriate to adopt alternative approaches to the duration of the new licences we would award via auction in the 26 GHz and 40 GHz bands. We said that alternatives could involve the following high-level options:

- a) A fixed term licence with a 20-year term.
- b) A fixed term licence with a shorter term, e.g. 5, 10 or 15 years.
- c) An indefinite licence with a shorter initial term, e.g. 5, 10 or 15 years (with annual licence fees potentially being imposed under [section 12 of the Wireless Telegraphy Act 2006](#) after the initial term).

12.4 We said that we were minded to adopt fixed term licences with a term between 10 and 15 years and sought early views from stakeholders on all possible alternative options.<sup>608</sup>

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<sup>605</sup> [May 2022 Consultation](#), paragraph 10.1.

<sup>606</sup> These auctions include the [2021 award](#) (700 MHz and 3.6-3.8 GHz), the [2018 award](#) (2.3 GHz and 3.4-3.6 GHz) and the [2013 award](#) (800 MHz and 2.6 GHz).

<sup>607</sup> May 2002 Consultation, paragraph 10.4.

<sup>608</sup> May 2002 Consultation, paragraph 10.8.

## High-level summary of consultation responses

### Responses concerning fixed vs indefinite term licences

- 12.5 Of those stakeholders who responded to this question, BT/EE, Vodafone,<sup>609</sup> MLL Telecom, Ericsson, Qualcomm and techUK<sup>610</sup> all expressed a preference for indefinite term licences over fixed term licences.<sup>611</sup> MLL stated that this would provide a “foundation for innovation, technology development and business continuity”.<sup>612</sup> BT/EE, Vodafone, Ericsson, and techUK considered that any allocation inefficiencies, for example where the licensee is not the highest value user, could be resolved through trading and leasing. Vodafone also noted the “threat of revocation” following the end of the initial term would be a further incentive to resolve such inefficiencies.<sup>613</sup>
- 12.6 VMO2 supported Ofcom awarding fixed term licences in the mmWave bands.<sup>614</sup> It considered that, given the uncertainty of the business case for mmWave, an alternative licensing regime may be appropriate and that there is a risk that “an auction now could lock in an allocation that turns out not to be fully efficient”. In addition, it noted that equipment in mmWave bands is likely to span large blocks of spectrum, so a small change in frequency on reallocation at the end of a fixed term should not be costly.<sup>615</sup>
- 12.7 Cellnex, Wildanet, UKWISPA and ITS UK did not express a specific preference for fixed or indefinite term licences.<sup>616</sup> However, all of their responses indicated that they expected Ofcom to proceed with fixed term licences.

### Responses relating to duration of fixed term licences

- 12.8 BT/EE, Vodafone, Ericsson, Qualcomm, and techUK expressed a preference for a 20 year licence term (as an initial term of an indefinite licence).<sup>617</sup> Ericsson described the 20 year term as “a period of certainty” which Ericsson felt was “needed for operators to invest, expand and upgrade networks”. According to Ericsson,<sup>618</sup> even 15 years would not be

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<sup>609</sup> Vodafone’s overall preference was for a club model, which we have addressed in paragraphs 3.77-3.81. However, it expressed a preference for indefinite licence should a club model not be possible ([Vodafone response to the May 2022 Consultation](#), p. 19).

<sup>610</sup> techUK noted that some of its members “have a preference towards an indefinite licence...” ([techUK response to the May 2022 Consultation](#), p. 8).

<sup>611</sup> [BT/EE response to the May 2022 Consultation](#), p. 35; Vodafone, p. 19; [MLL Telecom response to the May 2022 Consultation](#), p. 12; [Ericsson response to the May 2022 Consultation](#), p. 4; [Qualcomm response to the May 2022 Consultation](#), p. 9; techUK, p. 8.

<sup>612</sup> MLL Telecom, p. 12.

<sup>613</sup> BT/EE, p. 35; Vodafone, p. 19; Ericsson, p. 4; techUK, p. 8.

<sup>614</sup> VMO2, p. 25.

<sup>615</sup> VMO2, p. 27.

<sup>616</sup> [Cellnex response to the May 2022 Consultation](#) p. 19; [Wildanet response to the May 2022 Consultation](#) p. 10; [UKWISPA response to the May 2022 Consultation](#) p. 4; [ITS UK response to the May 2022 Consultation](#) p. 4.

<sup>617</sup> BT/EE, p. 35; Vodafone, p. 19; Ericsson, p. 4; Qualcomm p. 9; techUK noted that some of its members “have a preference towards ... an initial 20-year term” (techUK p. 8).

<sup>618</sup> Ericsson, p. 4.

- enough. BT/EE noted that in Italy and Finland mmWave spectrum was awarded through licences with 19 and 23 year durations respectively.<sup>619</sup>
- 12.9 VMO2, Cellnex, Wildanet and ITS UK indicated that a 15 year licence duration would be sufficient<sup>620</sup> and, as noted by VMO2, in line with most countries that have issued mmWave licences.<sup>621</sup> VMO2 also said that if licences are awarded in 2024, then “not less than 15 years” would be appropriate.
- 12.10 BT/EE referred to Article 49 of the European Electronic Communications Code (the “EECC”), which requires Member States to provide a minimum duration of 15 years for harmonised spectrum and “ensure regulatory predictability for the holders of the rights over a period of at least 20 years”.<sup>622</sup> BT/EE said that the UK Government had expressly confirmed its preference “not to specify minimum durations in UK legislation on the basis that, in practice, existing arrangements are consistent” with the EECC.<sup>623</sup>
- 12.11 There was a general agreement amongst BT/EE, Vodafone, Ericsson, Qualcomm, and techUK that, regardless of the type of licence, a duration of less than 15 years was likely to be incompatible with “any practical network deployment and investment cycles and would therefore not secure optimal use of the spectrum”<sup>624</sup> and could result in reduced investment towards the end of the licence term.<sup>625</sup>
- 12.12 Vodafone said a 10 year licence duration would make it “all but impossible” to invest in the award, in part because “much of the band won’t be available for usage until 5 years after the award”.<sup>626</sup> Wildanet agreed that 10 years would not be long enough, highlighting that the rising costs of equipment meant that operators would expect it to depreciate over a longer period of time.<sup>627</sup> VMO2 also requested that the auction be delayed until 2026/27 and said that, if Ofcom were to offer 10-year fixed term licences in 2024, it would be unlikely to bid.
- 12.13 In contrast, Airwave was in favour of a 10 year licence duration.<sup>628</sup> This was linked to its recommendation that Ofcom should reserve a paired block of 200 MHz in the 26 GHz band for the continued operation of fixed links and for low power shared use nationwide. It felt that the 10 year term “would enable Ofcom to reassess the status of the spectrum utilisation, deployment, economic value and the spectrum requirements for the fixed links

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<sup>619</sup> BT/EE, p. 38.

<sup>620</sup> [VMO2 response to the May 2022 Consultation](#), p. 26; Cellnex p. 19; Wildanet p. 10; ITS UK noted that “most intelligent transport communication systems are designed and tendered for 10+5 year contracts”, making 15 years a reasonable timeframe (ITS UK p. 4).

<sup>621</sup> VMO2, p. 26.

<sup>622</sup> BT/EE, p. 37; See Article 49(2) of [Directive \(EU\) 2018/1972 of the European parliament and the council of 11 December 2018 establishing the European Electronic Communications Code](#).

<sup>623</sup> BT/EE, p. 36. See Section 4.5 of the [Government response to the public consultation on implementing the European Electronic Communications Code](#).

<sup>624</sup> BT/EE, p. 36; Qualcomm also argued that this incompatibility would be compounded the revocation notice period, noting that “it will be 5 years before licenses are useable in some places due to existing fixed links” (Qualcomm, p. 9).

<sup>625</sup> Vodafone, p. 19; Cellnex, p. 19; techUK, p. 8.

<sup>626</sup> Vodafone, p. 19.

<sup>627</sup> Wildanet, p. 10.

<sup>628</sup> [Airwave response to the May 2022 Consultation](#), p. 8.

and other users” and allow it to consider awarding this block and aligning the licensing conditions for the adjacent 26 GHz blocks.

12.14 Respondents also suggested alternative options.

- a) To reduce the risk of fixed term licences resulting in lower investment towards the end of the licence term, techUK and Cellnex suggested that licences might be autorenewed.<sup>629</sup>
- b) techUK also suggested that “upfront fees [could] be ‘refunded’ based on deployment” to ensure continued investment.<sup>630</sup>
- c) BT/EE outlined an alternative option of a 15-year duration, with a right to extend it to 20 years.<sup>631</sup> While it did not recommend this option, BT/EE considered it preferable to Ofcom’s proposals.
- d) VMO2 proposed that Ofcom makes “clear that the band may be subject to replanning at the end of the initial term and that this may require incumbent licensees to change frequencies, so as to accommodate other users.”<sup>632</sup>

## Our revised proposals

### Fixed term licences

12.15 We have considered stakeholders' responses and are minded to conclude that fixed term licences are more likely to support our objectives for this award than indefinite licences.

12.16 Given the particular characteristics of mmWave spectrum and the uncertainty about the spectrum requirements for future use cases, which are discussed in section 2,<sup>633</sup> we consider there is a risk that the initial allocation of citywide licences would not reflect the most efficient allocation of mmWave spectrum in the longer term. We therefore consider that auctioning indefinite licences may preclude efficient allocation of the mmWave spectrum over time. For example:

- a) the amount of spectrum required by award winners to provide effective services may change as use cases develop;
- b) any opportunity for new entrants to use the spectrum could be delayed or denied; and/or
- c) the optimum balance between spectrum available for citywide and Shared Access licences could change.

12.17 In principle, spectrum trading could help address (a) and (b). However, we have seen very little evidence of trading spectrum between mobile operators to date and none between

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<sup>629</sup> techUK, p. 8; Cellnex, p. 19.

<sup>630</sup> techUK, p. 8.

<sup>631</sup> BT/EE, p. 37.

<sup>632</sup> VMO2, pp.26-27.

<sup>633</sup> Paragraphs 2.44-2.62.

mobile operators and new entrants, and therefore consider that we cannot rely on trading to achieve a timely and efficient outcome. We note that neither spectrum trading nor a potential variation of future licences are likely to be effective in resolving (c). Conversely, awarding fixed term licences would enable us to reallocate the band at the end of the fixed term, allowing Ofcom to:

- a) review the balance of spectrum between citywide and Shared Access licences;
- b) reallocate the spectrum to secure a new optimal allocation; and
- c) provide an opportunity for new entrants into the bands.

12.18 In light of the above, we consider that fixed term licences are more likely than indefinite licences to support our objectives for this award.

### Duration of the fixed term licence

12.19 Our provisional view is that a 15 year licence term would be appropriate.

12.20 While we agree with stakeholders that the term of the licence should be long enough to provide investment certainty to operators, we also consider it important that the opportunity to reallocate the spectrum should arise soon enough to avoid any enduring inefficient allocation.<sup>634</sup>

12.21 In considering the appropriate duration of citywide licences, we acknowledge the need for sufficient time to accommodate band clearance<sup>635</sup> and the development of the mmWave ecosystems (which is discussed in section 2). This is to provide operators with adequate time to make use of the spectrum rights they will acquire in both bands, taking into account that the ecosystem for the 40 GHz band is not as advanced as in the 26 GHz band. We note that it will take time for mmWave-capable handsets to achieve a high enough penetration to yield material benefits in both bands before the licensees can begin to recoup their investments.

12.22 While we note that some stakeholders suggested that the licence duration should be aligned with deployment and investment cycles, we think it is unlikely we could achieve this effectively as licensees' cycles will differ, and we cannot predict how long it will take for ecosystems to develop.

12.23 Having considered all the factors described above in the round (including stakeholders' responses, the need for the mmWave ecosystem to develop, and the five-year revocation notice period for existing licensees), we consider that a duration of less than 10 years may

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<sup>634</sup> There is limited empirical research available on the interaction between licence duration and the MNOs' investment levels, and the available data has limitations. We have recently commissioned [analysis on this topic from Charles Rivers Associates \("CRA"\)](#) and published a Discussion Paper ("[Mobile spectrum licence duration and mobile network operators' investment decisions](#)", published 17 February 2023). As explained in more detailed in our paper, the CRA's study "did not find a statistically significant relationship between longer licence duration and higher investment levels".

<sup>635</sup> As set out in sections 5 and 7, we will consider any further representations that licensees might want to make in response to our notices of proposed revocation before making a final decision about the revocation of their licences. If our final decision is to revoke the relevant licences, we expect to issue our final revocation notices in 2023, meaning that the bands should be clear by 2028.

be too short to incentivise investment. On the other hand, we consider that a 20-year duration could delay the potential benefits of a reallocation of the spectrum. We therefore are minded to set the term of the licences to be awarded to 15 years.<sup>636</sup>

- 12.24 In relation to BT/EE's comment on Article 49 of the EEC, we note that the licensing framework under the Wireless Telegraphy Act 2006 does not specify the minimum duration of spectrum licences.<sup>637</sup> We also note that the proposed 15-year duration would be in line with the minimum duration of 15 years set out in Article 49(2) and that, as discussed below, our provisional view is that allowing for a licence renewal at the end of the fixed term would not be appropriate in this case.

## End of the licence term

- 12.25 Some respondents expressed concern about the limited degree of investment certainty provided by fixed term licences and provided suggestions to alleviate this. Specifically, they suggested that licences should be "automatically" renewed (techUK and Cellnex) or that licensees should be given the right to extend them at the end of the term (BT/EE), or that the "upfront fees" (i.e. those paid in the auction) should be refunded, based on the level of spectrum deployment (tech UK).<sup>638</sup> For the reasons set out below, our provisional view is that we do not consider it appropriate to implement these suggestions.
- 12.26 We consider that granting fixed term licences and allowing licence holders to apply to Ofcom for a renewal or extension at the end of the fixed term (or allowing for an "automatic" renewal or extension, unless certain conditions are met) would be similar in effect to awarding an indefinite licence or a licence with a longer licence duration.<sup>639</sup> We set out our reasons for proposing a 15 year fixed term licences, as opposed to an indefinite licence or a fixed-term licence with a longer licence duration, in paragraphs 12.19-12.24 above. Based on this reasoning, we do not consider that these renewal or extension options would be appropriate in this case. We would expect an operator making effective use of the spectrum to be in a strong position to reacquire it in a reallocation process at the end of the term, such as auction.
- 12.27 As regards techUK's suggestion of a refund of "upfront fees" based on deployment, we consider that such an approach would require us to determine a level of deployment that would qualify for the refund. This would require us to reach a view of the appropriate nature and level of deployment of mmWave spectrum, rather than allowing this to be determined by the market. We do not consider this would be appropriate, particularly in

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<sup>636</sup> As discussed in paragraphs 9.39-9.43, if we separate the 26 GHz band into two lot categories (the "26 GHz lower" and the "26 GHz upper" lot categories) and invite winning principal stage bidders to bid in three separate assignment stage rounds (two for assigning frequencies during the five years' revocation period and one for assigning frequencies after that period), we propose to award (i) an initial licence which would be valid until the end of the revocation period; (ii) a migration licence which would be valid for 6 months from the end date of the initial licence and (iii) a final licence which would be valid from the end date of the migration licence, for a period of 15 years minus the durations of the initial and migration licences.

<sup>637</sup> Art. 49 of the EEC was not transposed into UK law. See "[Government response to the public consultation on implementing the European Electronic Communications Code](#)", published 22 July 2020, section 4.5 (pp. 39-40).

<sup>638</sup> See paragraph 12.14 above.

<sup>639</sup> Depending on the specific terms on which renewal or extension were made available.

light of the potential for innovative uses of mmWave spectrum. We also note that Ofcom will pay the receipts from the auction to the Consolidated Fund in accordance with s.400 of the Communications Act 2003 and that Ofcom does not have general powers to make payments to the auction winners.

- 12.28 If we decide to award fixed term licences, we would expect to consult on our approach to ensuring an efficient allocation (once the licence term has expired) in advance of the end of the licence term.

## Consultation question

**Question 14:** Do you have any comments on our proposal to award fixed term licences with a 15 year term?

## 13. Technical licence conditions for award licences and Shared Access licences

- 13.1 As set out in section 3, subject to the outcome of the revocation process of existing licences which we have decided to start, we have decided to enable mobile and other new uses of the 26 GHz and 40 GHz bands by making available (i) local licences via the Shared Access licensing framework, to be issued on a ‘first come first served’ basis, and (ii) award licences, to be awarded in an auction. In this section we set out the technical conditions that we propose would apply to all these licences.
- 13.2 This section is organised as follows:
- the harmonised technical conditions for the 26 and 40 GHz bands as set out in the relevant ECC, CEPT and EC documents;
  - the general technical licence conditions that we propose to impose;
  - the technical conditions that we propose to impose for coexistence with passive services;
  - the block-assigned area boundary conditions; and
  - cross-border coordination
- 13.3 In the May 2022 Consultation,<sup>640</sup> we used similar technical licence conditions to those used for existing Shared Access licences with some modifications to make them more suited for mmWave. Below, we address stakeholders’ comments where relevant.
- 13.4 A draft copy of the proposed award licences and Shared Access licences is provided in annexes 10 and 11.

### The 26 and 40 GHz bands are harmonised for mobile broadband services

- 13.5 Harmonised technical conditions for the 24.25-27.5 GHz band have been set out in European Commission Decision 2019/784, as amended by Decision 2020/590 (the ‘**26 GHz Decision**’), which continues to have effect in domestic UK law.<sup>641</sup> The harmonised technical conditions have been established to ensure coexistence between licensees within the mmWave bands, as well as with the services that operate in adjacent bands. In particular, the conditions set out in the 26 GHz Decision include limits on out-of-band emissions from future deployments in the 26 GHz band to ensure the protection of Radio Astronomy Service and Earth Explorations Satellite Service (passive) in the 24 GHz band. In July 2022, we decided to implement those limits as well as additional protective measures consisting

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<sup>640</sup> May 2022 Consultation, paragraphs 8.23-8.28.

<sup>641</sup> See this [unofficial consolidated version of Decision 2019/784, as amended by Decision 2020/590](#). The UK version of this legislation is set out in S.I. [784/2019](#) and [S.I. 590/2020](#). See also annex 5, paragraph A5.8.

of a density limit on the number of outdoor base stations and exclusion zones around six radio astronomy sites.<sup>642</sup>

- 13.6 The harmonised technical conditions for the 40.5-43.5 GHz band have recently been approved in a ECC Decision (“**ECC Decision (22)06**”)<sup>643</sup> and a CEPT report (“**CEPT Report 82**”).<sup>644</sup> CEPT Report 82 specifies the out-of-block emissions required for coexistence. As set out in section 2, we consider it appropriate to authorise spectrum use of the relevant frequencies on the basis of technical conditions reflecting the CEPT harmonisation (to which the UK has contributed) because the adoption of harmonised conditions is likely to facilitate spectrum use.<sup>645</sup>
- 13.7 In addition to the out-of-band emission restriction in the 26 GHz band set out above, there is also a restriction on the elevation of active antenna systems of base stations in the 26 GHz band and in 42.5-43.5 GHz in order to protect satellite receivers.
- 13.8 In-block power levels and other deployment conditions like base station height limits are not harmonised and so we need to set the level which we consider necessary to ensure the prevention of harmful interference.

## General technical conditions

### Transmit power and height limits

- 13.9 We are proposing license two classes of base station in the mmWave bands: low power and medium power. For example, a low power base station might be used to provide hotspot coverage (e.g. of a single stadium), whilst medium power might be used to provide a fixed or mobile wireless access service over a wider area. These classes would be in line with our existing Shared Access framework.<sup>646</sup> Outdoor low power base stations would have both height and in-block power limits whereas medium power and indoor low power base stations would have in-block power limits, but no height limit.
- 13.10 We propose that the holders of award licences will be required to identify and record whether their base stations are indoor low power, outdoor low power, or medium power because we propose that different coordination rules will apply based on station type. For the avoidance of doubt, this record-keeping requirement is not necessary for Shared Access licensees because they will be required to specify which type of base station they intend to operate when they apply for their Shared Access licence.
- 13.11 Under the Shared Access framework, station power limits in sub-6 GHz bands are expressed in Effective Isotropically Radiated Power (EIRP), however we do not think that this would be appropriate for mmWave applications. As we said in the May 2022

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<sup>642</sup> Ofcom’s Statement “[Protecting passive services at 23.6-24 GHz from future 26 GHz uses](#)”, published 4 July 2022.

<sup>643</sup> [ECC Decision \(22\)06](#).

<sup>644</sup> [CEPT Report 82](#); See annex 5, para A5.13: CEPT Report 82 will form the basis of a harmonising Commission Decision, which is currently in draft form. A [draft of the Commission Implementing Decision](#), dated 7 December 2022, is available.

<sup>645</sup> Paragraph 2.16.

<sup>646</sup> Ofcom’s Guidance Document “[Shared Access Licence](#)”, published 20 September 2022, paragraphs 2.9-2.20.

Consultation,<sup>647</sup> we propose that power levels will be stated in Total Radiated Power (TRP) because 5G mmWave systems are likely to use active antenna systems (AAS) for which units of TRP are more appropriate. This approach would also be consistent with the harmonised technical conditions set out in the 26 GHz Decision as well as relevant ECC and CEPT documents, which set emissions limits in units of TRP.

### Antenna height limit for outdoor low power equipment

#### Our initial proposals for Shared Access licences

13.12 In the May 2022 Consultation we proposed to restrict the antenna height for outdoor low power equipment to a limit of 10m above ground.<sup>648</sup> We observed that this was the same height limit as we require for outdoor low power base stations in other Shared Access bands.

#### Stakeholders' comments

13.13 Intracom, Luminet and UKWISPA all raised concerns over this height restriction.<sup>649</sup> Intracom and UKWISPA said that this would create barriers for operators wanting to deploy FWA solutions as these are typically deployed at roof height or above and need line of sight. Luminet stated that such a restriction would make the spectrum unusable to provide FWA/BFWAS services.<sup>650</sup> Intracom advised that sterilisation caused by high antennas would not be a problem if licences in the adjacent areas are acquired by the same operator.<sup>651</sup>

13.14 Luminet also raised concerns over the 10m height limit on medium power licences. It proposed that FWA providers should instead be subject to a minimum height restriction. It provided some analysis to show if hot-spot users were subject to a maximum height limit while FWA providers were subject to a minimum height requirement then both sets of users would be able to use the same spectrum with no or minimal interference. Luminet submitted that such an approach would make more efficient use of the spectrum.<sup>652</sup>

#### Our updated proposals and reasoning for both Shared Access licences and award licences

13.15 We note from our previous coexistence analysis in annex 6 of the May 2022 Consultation, that antenna height is an important parameter in ensuring coexistence between outdoor base stations and other services. We are now proposing that the 10m height limit would apply to the outdoor low power base stations for both the Shared Access licences and award licences. We are not proposing any antenna height restrictions on indoor low power and outdoor medium power base stations because (i) we expect that building entry loss will mitigate the risk of interference from low power indoor base stations to other users

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<sup>647</sup> May 2022 Consultation, paragraph 8.24.

<sup>648</sup> May 2022 Consultation, paragraph 8.25.

<sup>649</sup> [Intracom response to the May 2022 Consultation](#), p. 6, response to Q.15; [Luminet response to the May 2022 Consultation](#), p. 1, paragraph 3; [UKWISPA response to the May 2022 Consultation](#), p. 4, response to Q.14.

<sup>650</sup> Luminet, p. 4, paragraph 4.1.

<sup>651</sup> Intracom, p. 7, response to Q.15.

<sup>652</sup> Luminet, section 4, pp. 4-9, and annex 1, p. 10.

and (ii) medium power licences will be coordinated to take into account the antenna height.

- 13.16 In response to the concerns raised by Intracom, Luminet and UKWISPA, we note that the 10m antenna height restriction for outdoor low power equipment is designed to ensure that we can accommodate as many Shared Access users as possible. Increasing outdoor antenna height would have the effect of increasing the interference range which may limit others' ability to deploy. We consider that the outdoor antenna height for the low power licence is consistent with typical small cell deployments and appropriate to ensure that there is enough spectrum available in an area for several users in high density areas. Those wishing to deploy citywide applications should consider participation in the award as the award licences are intended to meet this type of use case.
- 13.17 We note Luminet's proposed solution to permit medium power use in high density areas. We have considered Luminet's proposal, and while it could be viable and would lead to the efficient use of spectrum, we note that only one respondent asked for this licensing approach, and we would need to consider the proposal in detail to understand the practicalities. We therefore do not consider it appropriate to adopt Luminet's proposal in authorising Shared Access licences in the mmWave band. Nevertheless, we would encourage respondents to submit similar proposals when we review our approach to Shared Access more generally.

### In-block power limits for base stations and terminal stations

#### Our initial proposals for Shared Access licences

- 13.18 As mentioned above, in-block power levels are not harmonised, which means we need to set an appropriate in-block power limit. In the May 2022 Consultation,<sup>653</sup> we said that in order to maintain broad equivalence with the existing Shared Access licence power limits, we provisionally expected the power limit for mmWave licences to be around 25 dBm/200 MHz TRP for both indoor and outdoor low power licences and 30 dBm/200 MHz TRP for medium power licences. For terminal stations, we said that we provisionally expected the power limit to remain equal to 23 dBm TRP, in line with the current 26 GHz indoor Shared Access licence.

#### Stakeholders' comments

- 13.19 Most respondents requested that we permit high power use in Shared Access licences. Airspan, Cellnex, techUK, Wildanet and Qualcomm all requested that we reconsider the power limits proposed in the May 2022 Consultation,<sup>654</sup> especially in rural areas.<sup>655</sup> Airspan recommended a limit of 64 dBm EIRP.<sup>656</sup> Qualcomm stated that setting the maximum TRP levels for a medium power base station at 30 dBm/200MHz would be only 5dBm higher

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<sup>653</sup> May 2022 Consultation, paragraphs 8.25-8.26.

<sup>654</sup> May 2022 Consultation, paragraphs 8.25-8.26.

<sup>655</sup> [Airspan response to the May 2022 Consultation](#), p. 6, response to Q.15; [Cellnex response to the May 2022 Consultation](#), p. 16, response to Q.14; [techUK response to the May 2022 Consultation](#), p. 4, response to Q.4; [Wildanet response to the May 2022 Consultation](#), p. 11, response to Q.5; [Qualcomm response to the May 2022 Consultation](#), p. 8, response to Q.14.

<sup>656</sup> Airspan, p. 6, response to Q.15.

than for low power ones, and therefore may not be particularly attractive. It explained that the propagation characteristics of the mmWave spectrum will result in higher path loss compared to sub-6 GHz Shared Access bands, so allowing higher power in mmWave bands would not risk sterilising large areas for other users.

### Our updated proposals and reasoning for both Shared Access licences and award licences

- 13.20 The in-block power limits that we are proposing in this consultation are the same as those we used for coexistence modelling with fixed links in Annex 6 of the May 2022 Consultation.
- 13.21 For low power base stations, we propose a maximum TRP of 25 dBm/200 MHz. This remains consistent with the TRP for the IMT-2020 Outdoor hotspot BS used in ECC Report 307,<sup>657</sup> which is the same as our definition of low power base stations.
- 13.22 For medium power base stations, we propose a maximum TRP of 30 dBm/200 MHz. As set out in Table A6.1 of the May 2022 Consultation,<sup>658</sup> we calculated this TRP value on the following basis:
- Early stakeholder engagement highlighted that EIRP in the range of 44 to 70 dBm may be required.
  - We chose a representative value of 65 dBm/800 MHz EIRP to represent the radiated power for medium power deployment.
  - Assuming a 16x16 antenna array, a 5 dBi gain per antenna element gain, the boresight gain using ITU-R M.2101 is 29 dBi.
  - This leads to the transmit power of 30 dBm TRP/200 MHz based on Equation 13.1 below.<sup>659</sup>

#### Equation 13.1

$$P_{t\ EIRP}(\text{dBm}/800\ \text{MHz}) = P_{t\ TRP}(\text{dBm}/200\ \text{MHz}) + G_t + BW_f$$

Where:

$P_{t\ EIRP}$  (dBm/800 MHz) is the transmit power spectral density in units of dBm / 800 MHz EIRP in a specific direction

$P_{t\ TRP}$  (dBm/200 MHz) is the transmit power spectral density in units of dBm / 200 MHz TRP over the whole radiation sphere of the radio equipment

$G_t$  is the gain of the antenna in units of dBi in a specific direction

$BW_f$  is the bandwidth adjustment factor to convert from 800 MHz to 200 MHz

- 13.23 Since the limit that we are proposing would allow up to 65 dBm/800 MHz EIRP, we note that this limit would be broadly in line with Airspan’s response, which recommended a limit of 64 dBm EIRP. We also note that similar TRP values for medium power base stations

<sup>657</sup> [ECC Report 307](#), approved 6 March 2020, p. 12, table 2.

<sup>658</sup> May 2022 Consultation, annex 6, p. 9, table 6.1, row: “transmit power”.

<sup>659</sup>  $P_{t\ TRP}$  (dBm/200 MHz) = 65 dBm / 800 MHz EIRP – 6 dB bandwidth adjustment factor – 29 dBi antenna gain) = 30 dBm/200 MHz.

can be found in current ECC working documents,<sup>660</sup> as well as in specification sheets and test reports for existing mmWave equipment.<sup>661</sup>

- 13.24 While our proposed medium power limit aligns with existing mmWave equipment, we are aware that some equipment currently under development may be able to use a higher TRP.<sup>662</sup> We consider that the proposed limit for medium power stations remain appropriate for mmWave deployments in the UK but would welcome any new evidence justifying a different power level to that which we are proposing.
- 13.25 We have received no comments on terminal power limits. We propose a maximum power of 23 dBm TRP for all terminal stations including mobile, nomadic, fixed and installed terminals. We consider that keeping fixed or installed terminal powers at these levels is important to avoid the risk that terminals (the locations of which we are not specifically coordinating) cause interference to other authorised uses, such as fixed links. We consider that this power level is likely to be sufficient because the power limit for handset terminals in the 3GPP specifications is 23 dBm TRP for both 26 and 40 GHz.<sup>663</sup>

### Out-of-block power limit

- 13.26 Block edge masks define the out-of-block emission limits for a given frequency range relative to the edge of a block of awarded spectrum to ensure coexistence with other licence holders in the band. A block edge mask consists of the emission limits for a transitional region, which is the spectrum adjacent to the assigned block, and a baseline region, which is the spectrum within the operating band (i.e., 24.25-27.5 GHz or 40.5-43.5 GHz) excluding the assigned block and the transitional regions. These block edge mask elements are illustrated in Figure 13.1.

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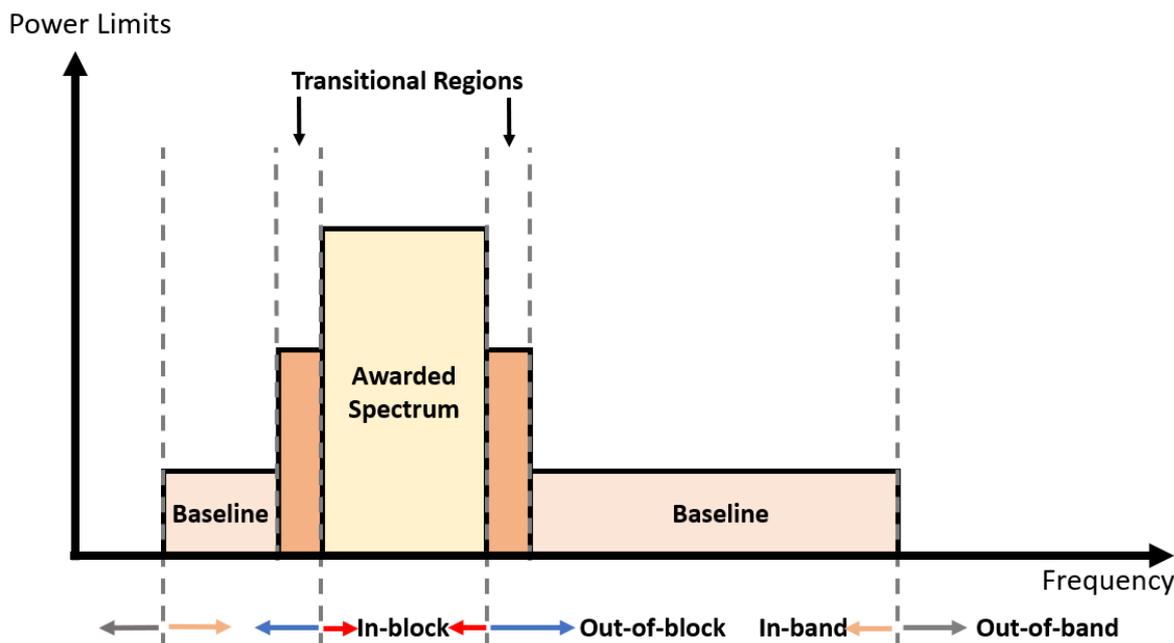
<sup>660</sup> A value of 30.6 dBm is used in “Temporary working doc on 26 GHz x-border\_rev2”, CG Cross Border Coordination #36, ECC PT1, 1 December 2022.

<sup>661</sup> EIRP of 54 dBm/Path minus 24 dBi antenna gain = 30dBm TRP (“[Samsung 5G NR HRU Installation Manual](#)”, published August 2018); Total EIRP of 55 dBm minus 25 dBi antenna gain = 30 dBm TRP (“[Nokia product evaluation: AWEUC/D 5G AirScale 24 GHz mmWave Radio](#)”, published 17 November 2020).

<sup>662</sup> Fierce Wireless, “[Is it time for mmWave 2.0?](#)”, published 20 December 2022.

<sup>663</sup> 3GPP, “[TS 38.101-2 V18.0.0 \(2022-12\)](#)”, table 6.2.1.3-2: UE maximum output power limits for power class 3.

Figure 13.1: Block edge mask elements



13.27 The out-of-block emission limits that we propose for the 26 GHz and the 40 GHz bands are shown in Table 13.1 below.

Table 13.1: Out-of-block power limits for 26 and 40 GHz

Frequency Range	Maximum TRP	
	26 GHz	40 GHz
Transitional regions 0 to 50 MHz below or above an assigned block	12 dBm/50 MHz	12 dBm/50 MHz
Baseline region	4 dBm/50 MHz <i>within 24.25 – 27.5 GHz</i>	4 dBm/50 MHz <i>within 40.5 – 43.5 GHz</i>

13.28 These proposed limits are in line with those set out in the 26 GHz Decision<sup>664</sup> for the 26 GHz band, which are also reflected in the ECC Decision (22)06 for the 40 GHz band.<sup>665</sup>

13.29 We note that under the 26 GHz Decision and the ECC Decision (22)06 the maximum out-of-block TRP values presented in the table above are only applicable when the base station transmissions are synchronised.<sup>666</sup> Our proposed approach to synchronisation is described below.

<sup>664</sup> [26 GHz Decision](#), annex, tables 2 and 3.

<sup>665</sup> [ECC Decision \(22\)06](#), annex 2, tables 2 and 3.

<sup>666</sup> See Explanatory Notes under tables 2 and 3 of the annex to the 26 GHz Decision and the note preceding table 2 in the ECC Decision (22)06, which specifies that “For Table 2 and Table 3 synchronised operation is assumed”.

## Synchronisation

- 13.30 Synchronisation is a mitigation technique which helps to reduce the interference between different time division duplex (TDD) networks which are not isolated from each other. When networks are synchronised, all base stations are either transmitting or receiving at the same time, so there are no simultaneous uplink and downlink transmissions. When there is no synchronisation, one base station may be receiving whilst a nearby base station may be transmitting, resulting in interference at the receiving base station.
- 13.31 Frame structures are used to synchronise networks by enabling licensees to agree on specific time periods to allocate for uplink and downlink transmissions.
- 13.32 We propose two options for synchronisation, and we are minded to adopt option 2 for both award winners and Shared Access licensees. Regardless of the option chosen, we would coordinate on the basis that all licensees are synchronised because we believe that this would allow us to pack users closer together and ensure we achieve efficient use of spectrum. For option 2, this means that licensees may not need to synchronise at first but may need to synchronise later on when mmWave spectrum becomes more heavily used in an area.

### Option 1

- 13.33 Similar to other TDD bands that we have awarded, for example the 2.3 GHz, 2.6 GHz, and 3.4-3.8 GHz bands, we could mandate synchronisation in the technical licence conditions. For example, we might specify the DDSU frame structure which is 5G compatible<sup>667</sup> and has been used by Qualcomm in its mmWave tests.<sup>668</sup>

### Option 2

- 13.34 An alternative approach would be for us to not mandate synchronisation. This option might be preferable for the following reasons:
- *Use case uncertainty*: in addition to enhancing existing services, the versatility of 5G also enables numerous new use cases.<sup>669</sup> As a result, the most appropriate downlink to uplink ratio will differ depending on the use cases.<sup>670</sup> For example, current mobile networks use downlink for 75% of the time and the remaining 25% is for uplink, but industrial use cases might have higher uplink usage requirements, whilst FWA might require higher downlink usage.
  - *Lower propagation distance with mmWave*: the risk of interference becomes more localised than for lower frequency spectrum, particularly for low power base stations

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<sup>667</sup> GSMA's Guidelines and Recommendations "[5G TDD Synchronisation](#)", published April 2020, p. 7.

<sup>668</sup> Qualcomm's webpage "[Qualcomm Achieves Critical 5G Standalone mmWave Milestone in China](#)", published 10 November 2022.

<sup>669</sup> Ofcom's Discussion Document "[Enabling 5G in the UK](#)", published 9 March 2018, p. 16, Figure 4.

<sup>670</sup> UK5G's webpage, "[Uplink/Downlink balance in 5G private networks](#)", published 14 January 2022.

deployed in the clutter in urban areas. The topic of separation distances is covered in more detail in section 10 and annex 16 for coordination and coexistence.

- 13.35 If harmful interference occurred and licensees were not able to agree appropriate measures to mitigate the interference between their networks (e.g., by agreeing on a common frame structure), we would consider whether it would be appropriate to impose additional technical conditions by issuing a coordination notice. We would implement this option by including in both the award licences and Shared Access licences a condition reflecting the “Synchronisation requirement” condition included in our standard Shared Access licences.<sup>671</sup>

## Antenna elevation

### Shared Access Licences

- 13.36 We propose to include the following condition in all Shared Access licences in the 26 GHz and 40 GHz bands:

*"When deploying Active Antenna System (AAS) outdoor base stations, licensees transmitting in either 24.45-27.5 GHz or 42.5-43.5 GHz, shall ensure that each antenna is normally transmitting only with main beam pointing below the horizon and in addition the antenna shall have mechanical pointing below the horizon except when the base station is only receiving."*

### Award licences

#### 26 GHz

- 13.37 In line with the [26 GHz Decision](#) (for the 26 GHz band), which is now part of UK law, to ensure coexistence with space station receivers, we are proposing to include the condition set out above, which would require licensees authorised to use any of the frequencies within the whole of the 26 GHz band (24.25-27.5 GHz) to ensure that, except when the base station is only receiving, each (5G) active antenna system of outdoor base stations:

- a) is normally transmitting only with main beam pointing below the horizon and
- b) has mechanical pointing below the horizon.

- 13.38 However, we understand that a restriction on antenna pointing could restrict licensees' ability to use the spectrum for integrated access and backhaul (“IAB”), which could be an important use case for mmWave spectrum.<sup>672</sup> To the extent that we can enable this type of use while ensuring compliance with the relevant framework and appropriate protection of satellite services, we would consider making an exception to this restriction on antenna

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<sup>671</sup> See the [draft Shared Access licences](#) annexed to Ofcom's Statement, "[Enabling wireless innovation through local licensing](#)", published 25 July 2019.

<sup>672</sup> We note in this regard BT/EE's comment that “while support for IAB varies considerably between equipment vendors, we are keen to ensure that any future spectrum regulations enable this use case. To facilitate this, it will be necessary to allow above the horizon transmissions in the same manner as that implemented today for point to point links in the 26 GHz and 40 GHz bands.” (BT/EE, p. 7).

pointing for IAB, in line with our proposals for the 42.5-43.5 GHz band (see below). In this regard, we note that the [Retained EU Law \(Revocation and Reform\) Bill](#) is currently going through Parliament and might result in a change to the legal status of the 26 GHz Decision. We also note that, as discussed in more detail below, our initial view is that applying a less stringent requirement to UK licensees where they use the relevant spectrum for providing backhaul between fixed stations, including in IAB configurations, could enable this type of use while ensuring appropriate protection of satellite services.

#### 40.5-42.5 GHz

- 13.39 We do not propose to include any restrictions on antenna pointing in licences authorising use of 40.5-42.5 GHz, because we do not consider this is necessary to protect any satellite services.

#### 42.5-43.5 GHz

- 13.40 ECC Decision (22)06 (for the 40 GHz band)<sup>673</sup> recommends that a similar condition on antenna pointing to the one discussed in paragraph 13.37 above should be included in licences authorising use of 42.5-43.5 GHz.
- 13.41 Our initial view is that applying a less stringent requirement on UK licensees where they use the relevant spectrum for providing backhaul between fixed stations, including in IAB configurations, could enable this type of use while ensuring appropriate protection of satellite services.
- 13.42 In particular, we are considering whether it would be beneficial to include a requirement of the following nature in licences authorising use of 42.5-43.5 GHz (and the 26 GHz band, should there be a change to the legal status of the 26 GHz Decision):
- “Except in relation to a main beam used to provide backhaul between fixed stations only, when deploying Active Antenna System (AAS) outdoor base stations, licensees transmitting in either 24.45-27.5 GHz or 42.5-43.5 GHz, shall ensure that each antenna is normally transmitting only with main beam pointing below the horizon and in addition the antenna shall have mechanical pointing below the horizon except when the base station is only receiving.*
- In relation to a main beam used to provide backhaul between fixed stations only, licensees transmitting in the [24.45-27.5 / 42.5-43.5] GHz range shall ensure that the direction of maximum radiation of the main beam used to provide backhaul is not within [ +/- X] degrees of the GSO orbit”*
- 13.43 We intend to consult on technical analysis in order to refine our proposals for the appropriate restriction on the maximum permissible antenna elevation angle (i.e. [ +/- X] highlighted above), and we welcome engagement from interested stakeholders on this point.

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<sup>673</sup> [ECC Decision \(22\)06](#), annex 2, table 4.

## Provisions relating to electromagnetic fields (EMF)

- 13.44 A number of consultation respondents set out views that mmWave spectrum could be harmful to humans or other life forms, and suggested that we should not make the spectrum available until we are certain it is safe.
- 13.45 In the UK, the UK Health and Security Agency (“**UKHSA**”)<sup>674</sup> takes the lead on public health matters associated with EMF and has a statutory duty to provide advice to Government on any health effects that may be caused by exposure to EMF. UKHSA’s main advice is that EMF exposure should comply with the internationally agreed limits in the ICNIRP Guidelines. UKHSA’s view is that “the overall exposure [from all mobile network EMFs, including 5G] is expected to remain low relative to [the ICNIRP] guidelines and, as such, there should be no consequences for public health.”<sup>675</sup>
- 13.46 Whilst we note these respondents’ concerns, Ofcom believes that it is appropriate for us to take into account the advice of UKHSA in relation to EMF in our management of the radio spectrum. It is worth noting that Ofcom has been measuring EMF levels for many years and we publish the results of these measurements on our website. Our measurements,<sup>676</sup> in busy publicly accessible areas near to mobile phone masts where we can expect to see high levels of mobile phone use, have consistently shown that EMF levels are well within the internationally agreed levels in the ICNIRP Guidelines. Ofcom has also worked with the UK Government to produce a guide to 5G<sup>677</sup> which provides further information on the technological advances of 5G, such as use of higher frequencies, advanced antenna technology and small cells.
- 13.47 We therefore propose to include our standard licence condition requiring licensees to comply with the ICNIRP general public limits. Ofcom’s [Update of 1 March 2021](#) provides further detail about our standard EMF licence condition.

## Technical licence conditions for coexistence with passive services

- 13.48 As explained in our July 2022 Statement,<sup>678</sup> we are required to implement the following limits on out-of-band emissions from use of 26 GHz spectrum, in order to protect the passive services operating in the 23.6-24 GHz band from interference from wireless deployments in 24.25-27.5 GHz.

**Table 13.2: Maximum emissions into the 23.6-24.0 GHz band**

Frequency range	Station Type	Maximum TRP
Within 23.6-24.0 GHz	Base Station	-39 dBW/200 MHz

<sup>674</sup> [UKHSA took over these responsibilities from Public Health England \(PHE\) on 1 October 2021.](#)

<sup>675</sup> UK Government’s webpage “[5G technologies: radio waves and health](#)”, published 3 October 2019.

<sup>676</sup> Ofcom’s webpage “[Electromagnetic field measurements near mobile base stations](#)”.

<sup>677</sup> Ofcom and UK Government’s guide “[5G mobile technology: a guide](#)”.

<sup>678</sup> Ofcom’s Statement “[Protecting Passive Services at 23.6-24 GHz from future 26 GHz uses](#)”, published 4 July 2022, paragraphs 2.14-2.19.

Frequency range	Station Type	Maximum TRP
	Terminal Station	-35 dBW/200 MHz

13.49 Note that the table above only considers the out-of-band emission limits which will be applicable from 2024 onwards, since we do not anticipate awarding the licences before 2024.

## Block-assigned area boundary conditions

13.50 Block-assigned area boundary conditions are given as a power flux density limit which licensees must not exceed. More details on this are set out in section 10.

## Cross-border coordination

13.51 The licence conditions we are proposing contain a clause requiring licensees ensure that the Radio Equipment is operated in compliance with such cross-border coordination and sharing procedures as may be notified to the Licensee by Ofcom from time to time. We discuss our proposals for cross-border coordination in more detail in section 10.

## Consultation questions

**Question 15:** Do you agree with the proposed technical licence conditions for award licences and local access licences in the 26 GHz and 40 GHz bands? If not, please give reasons.

**Question 16:** Do you have any comments on our proposed licence conditions relating to antenna elevation?

## 14. Shared Access licences

### Summary of our approach

- 14.1 In section 8 of the May 2022 Consultation, we sought stakeholders' views on our high-level proposal to extend the Shared Access licensing framework to the 26 GHz and 40 GHz bands. In particular, we proposed to apply the same standard non-technical licence conditions<sup>679</sup> and the same overall approach to setting the annual fee,<sup>680</sup> and to make for mmWave spectrum some modifications to the technical licence conditions applying to the Shared Access licences for the sub-6 GHz bands.<sup>681</sup> We also sought views on our proposed high-level approach to coordination between existing users and new Shared Access licensees,<sup>682</sup> specifying that we would be consulting on the full details of coordination procedures in our next consultation, alongside detailed proposals for technical licence conditions.
- 14.2 As discussed in more detail below, having considered stakeholders' responses, we are minded to make low and medium power Shared Access licences available in both the 26 GHz and 40 GHz bands and to apply the same standard non-technical licence conditions as the Shared Access licences available in other bands. In this section, we discuss this high-level approach and seek stakeholders' views on our detailed proposals for the channel bandwidths we will make available and the proposed level of licence fees. Our proposals relating to the technical licence conditions for the proposed award licences and Shared Access licences are set out in section 13. Our proposals for coordination of existing users and new Shared Access licensees are set out in section 10.
- 14.3 In summary, under our revised proposals the Shared Access licences would be:
- a) available in:
    - i) high density areas, where 650 MHz of the 26 GHz band (24.45-25.1 GHz) would be available for low power use; and
    - ii) low density areas, where in the 24.45 to 27.5 GHz and 40.5 to 43.5 GHz bands would be available for low power and medium power use on a coordinated basis with incumbent users.
  - b) subject to the same non-technical licence terms and conditions as existing Shared Access licences;
  - c) subject to a proposed annual fee of £320 per 400 MHz (pro rata for different bandwidth options);
  - d) offered in channels sizes from 50 to 800 MHz, in increments of 50 MHz;

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<sup>679</sup> [May 2022 Consultation](#), paragraph 8.22.

<sup>680</sup> [May 2022 Consultation](#), paragraphs 8.29-8.31.

<sup>681</sup> [May 2022 Consultation](#), paragraphs 8.23-8.28.

<sup>682</sup> [May 2022 Consultation](#), paragraphs 8.32-8.37.

- e) available from:
    - i) early 2024 for the 26 GHz band (24.45-27.5 GHz); and
    - ii) once existing 40 GHz licences have been revoked after having been given five years' notice in the 40 GHz band.
- 14.4 As discussed in section 13, we propose the new Shared Access licences would have a maximum total radiated power (“**TRP**”) transmission limit per cell of:<sup>683</sup>
- a) 25 dBm per carrier for carriers up to 200 MHz for low power base stations;
  - b) 30 dBm per carrier for carriers up to 200 MHz for medium power base stations; and
  - c) 23 dBm TRP for terminal stations.

## Background

### The Shared Access licensing regime

- 14.5 In 2019 we introduced our Shared Access licensing regime in response to demand for increased use of localised mobile deployments. The Shared Access licence is part of [Ofcom’s framework for enabling shared use of spectrum](#). This framework was set up to support innovation and enable new use of spectrum by providing localised access to spectrum bands. Currently, the licence is available in four bands (the “**Shared Access bands**”).<sup>684</sup>
- 14.6 The licence allows users to apply to Ofcom for coordinated, local access to the Shared Access bands on a first come, first served basis. Successful applicants have the right to use their designated frequency and bandwidth in a specific location and must pay a licence fee that reflects the costs of issuing the licence. There are two types of Shared Access licence, distinguished primarily by permitted power levels, to cater for different types of potential uses: **low power** and **medium power** licences.

### Low power licences

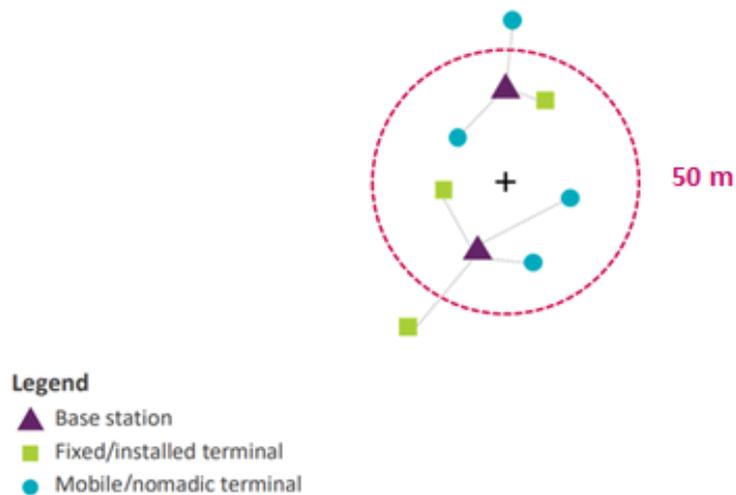
- 14.7 Low power Shared Access licences authorise multiple base stations, in an area with a 50m radius around a given point provided to Ofcom by the user, as set out in Figure 14.1. In current Shared Access bands, users may add or move base stations within the area without informing Ofcom of the changes and there is no limit to the number of base stations that can be deployed per low power licence. Connected terminals may be located outside the licensed area.

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<sup>683</sup> Paragraphs 13.21, 13.22 and 13.25.

<sup>684</sup> At present these are 1800 MHz (specifically 1781.7-1785 MHz paired with 1876.7-1880 MHz); 2390-2400 MHz; 3.8-4.2 GHz; and 26 GHz (indoor only).

Figure 14.1: Low power Shared Access licence

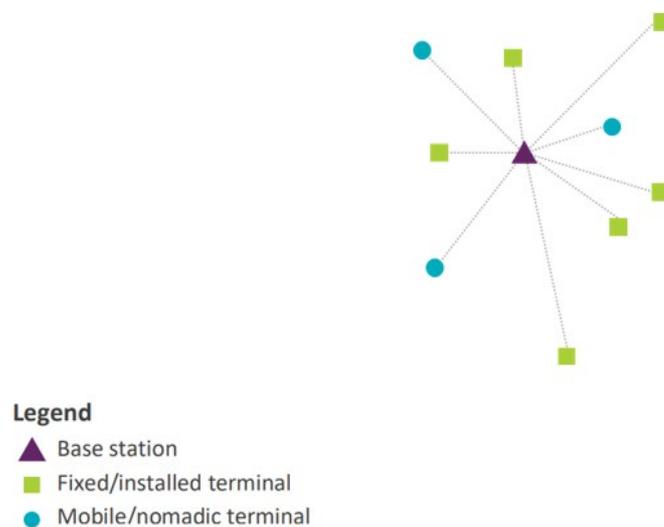


14.8 For large sites, users can apply for multiple licence areas to achieve the required coverage area, which can be contiguous and overlapping, or spaced out around a larger site. Each licence would be subject to an individual fee. Applications are assessed on a case-by-case basis.

## Medium power licences

14.9 Medium power licences are issued on a per base station basis as they have a larger potential interference area than low power licences, as shown in Figure 14.2. This is because medium power licences have higher power limits and are not subject to antenna height restrictions. Users can also apply for overlapping licences in a similar way to low power licences.

Figure 14.2: Medium power Shared Access licence



## Provisional conclusions on extending the Shared Access licences and applying their standard non-technical conditions

### Availability of Shared Access licences in the 26 GHz and 40 GHz bands

#### Consultation proposals in the May 2022 Consultation

- 14.10 Access to the 24.25-26.5 GHz range is currently available under Ofcom's low power Shared Access licence for indoor use only. In section 8 of the May 2022 Consultation, we proposed to extend the Shared Access licensing regime in the 26 GHz band by extending it from 24.25-26.5 GHz to 24.25-27.5 GHz and permitting outdoor and higher power use.
- 14.11 We proposed that we would look to extend the Shared Access licensing framework in the 26 GHz band to the following **indoor and outdoor** uses:
- a) in high density areas, in the bottom 850 MHz of the band (24.25-25.1 GHz), only for low power use; and
  - b) in low density areas, in the full 24.25-27.5 GHz band, for low power and medium power use.
- 14.12 We proposed that medium power Shared Access deployments would not be available in high density areas. We stated that since these deployments would sterilise large areas, they would deny the opportunity for other users to deploy spectrum in those areas. We advised that stakeholders interested in deploying medium power equipment would therefore need to participate in the proposed auction for citywide licences to deploy in high density areas.
- 14.13 In the May 2022 Consultation,<sup>685</sup> we said that we were minded to adopt a similar approach to authorising new uses in the 40 GHz band.

#### Stakeholders' comments on the licensing approach and Ofcom's response

- 14.14 While most respondents (including Wildanet, Virgin Media O2 and Intelligent Transport Systems (ITS) UK)<sup>686</sup> supported the use of Shared Access licensing, Dense Air queried why Ofcom considered that users self-defining their coverage areas is not practicable<sup>687</sup> and stated that the current Shared Access process does not meet its business needs.<sup>688</sup>
- 14.15 We note the overall support for extending the Shared Access licensing framework to the 26 GHz band. As set out in the May 2022 Consultation,<sup>689</sup> we have considered other options for enabling local licensing in the 26 GHz band, including the self-defined areas option mentioned by Dense Air. The inclusion of self-defined areas would likely require a wider

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<sup>685</sup> May 2022 Consultation, paragraph 8.4.

<sup>686</sup> [Wildanet response to the May 2022 Consultation](#), p. 14, response to Q.14; [VMO2 response to the May 2022 Consultation](#), p. 8 and p. 34; [ITS UK response to the May 2022 Consultation](#), p. 3, response to Q1.4; [Vodafone response to the May 2022 Consultation](#), p. 6, response to Q.3.

<sup>687</sup> [Dense Air response to the May 2022 Consultation](#), p. 6, response to Q.14.

<sup>688</sup> Dense Air, p. 3, response to Q.5.

<sup>689</sup> May 2022 Consultation, paragraph 8.8.

change in the fees policy for these licences. For example, in Germany, where this approach has been introduced, licensees are not only charged by bandwidth but also by the surface area covered by the licence. This would require further detailed consideration of the charging regime and fee levels, for example whether fees should be the same in urban and rural areas.

- 14.16 We remain of the view that it is more appropriate to extend the current Shared Access regime than to create a new licence product or fundamentally change the existing licensing approach. This is because Ofcom's existing Shared Access licensing framework contributes to our objectives for making mmWave spectrum available: it is a local licence which enables us to coordinate new and incumbent users, and promote innovation. In addition, we can implement it more quickly than a new framework, especially as Shared Access licences are already partially available in this band for indoor use. Using our existing framework would also minimise disruption to existing 26 GHz indoor Shared Access licensees.
- 14.17 In conclusion, we believe our current approach is an appropriate way to license this spectrum, since it would contribute to our objectives without giving rise to the additional complexity and cost that a new approach would incur. We are not planning on making changes to our Shared Access licensing framework as part of this consultation. However, as we indicated in our 2023/24 plan of work consultation, we plan to undertake a separate review of our Shared Access framework through the course of 2024 and will consider the comments made here as part of that work.<sup>690</sup> We expect to issue an initial publication on this work in the Spring 2023.

### Stakeholders' comments on the licensing process and Ofcom's response

- 14.18 BT/EE,<sup>691</sup> Cellnex,<sup>692</sup> Dense Air<sup>693</sup> and Wildanet<sup>694</sup> all had concerns about the time it currently takes to obtain a Shared Access licence. They all advised that Ofcom should look to automate or semi automate the process to make it more responsive and better suited to their needs. Vodafone said that the application process should not be an administrative barrier to deployment. BT/EE raised concerns about the potential need to obtain several licences simultaneously to cover large areas, for example roads or railways.<sup>695</sup> Vodafone also said that Ofcom should make available a batch model, to enable operators to apply for multiple licences at once.<sup>696</sup>
- 14.19 We acknowledge the need to automate the licensing process to reduce the time taken to obtain a licence. As set out in [Ofcom's proposed plan of work](#),<sup>697</sup> we are currently in the

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<sup>690</sup> Ofcom's Consultation "[Ofcom's proposed plan of work 2023/24](#)", published 14 December 2022, paragraph 2.29.

<sup>691</sup> [BT/EE response to the May 2022 Consultation](#), p. 30.

<sup>692</sup> [Cellnex response to the May 2022 Consultation](#), p. 16.

<sup>693</sup> Dense Air, p. 6, response to Q.15.

<sup>694</sup> Wildanet, p. 14, response to Q14.

<sup>695</sup> BT/EE, p. 30, response to Q.14.

<sup>696</sup> Vodafone, p. 16, response to Q.14.

<sup>697</sup> Our Licensing Platform Evolution programme will explore ways to further automate our processes and provide clearer information on spectrum availability.

process of updating our spectrum licensing platform as part of our Licensing Platform Evolution (“LPE”) programme. The work is initially intended to provide an online application and batch process to allow applicants/licensees to manage their own applications. Later, we intend to integrate an automated coordination functionality, where possible. Each stage of these upgrades should significantly reduce the time taken for applicants to receive their licence(s). We expect Shared Access licences issued from the new platform to be available in 2024.

- 14.20 However, it is possible that we will still be in the process of transitioning between systems for a short period of time between mmWave Shared Access licences becoming available and the new system being implemented. We would be interested in understanding the extent of operators’ plans to rollout networks using Shared Access spectrum as soon as the spectrum becomes available. In the meantime, we continue to look at ways to improve the current licensing process.
- 14.21 In relation to BT/EE and Vodafone’s concerns regarding batch processing of licences, this functionality is already in place today and licensees can apply for multiple locations as part of a single application.

#### **Provisional conclusions on making Shared Access licences available in the 26 GHz and 40 GHz bands**

- 14.22 Having considered stakeholders’ comments, we have provisionally decided to extend the Shared Access licensing framework in the 26 GHz and 40 GHz bands.
- 14.23 However, as set out in section 3,<sup>698</sup> since we published the May 2022 Consultation, we have decided to implement a nationwide safeguard in the bottom 200 MHz of the 26 GHz band (i.e. 24.25-24.45 GHz) for Ministry of Defence (“MOD”) access, supporting future defence demands which will require the use of mmWave spectrum. This means that Shared Access licences will only be available from 24.45 GHz, instead of 24.25 GHz as we initially proposed in the May 2022 Consultation.<sup>699</sup>
- 14.24 In line with our initial proposals<sup>700</sup> and subject to consideration of any further comments which stakeholders might have, we are also minded to allow the use of low and medium power Shared Access licences of the 40 GHz band in low density areas. However, these Shared Access licences would not become available until the revocation of the existing 40 GHz licences has taken effect. Further information on this is set out in section 3.
- 14.25 As shown in Figure 14.3, the new Shared Access licences would enable the following **indoor and outdoor** uses of mmWave spectrum on a Shared Access basis:
- a) in high density areas, in the 650 MHz of the 26 GHz band (24.45-25.1 GHz), for low power use only;

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<sup>698</sup> Paragraphs 3.7-3.12.

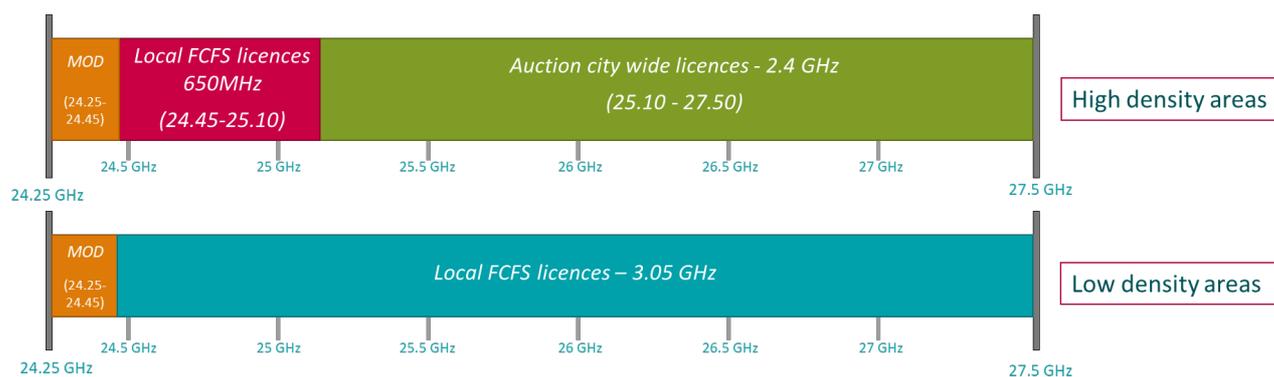
<sup>699</sup> May 2022 Consultation, paragraph 8.2.

<sup>700</sup> May 2022 Consultation, paragraph 8.4

- b) in low density areas, in the 24.45-27.5 GHz band, for low power and medium power use; and
- c) in low density areas, in the entire 40.5-43.5 GHz band.

14.26 While the Shared Access licences in the low density areas would only become available from the date the revocation of the existing 40 GHz licences takes effect, the Shared Access licences in the 26 GHz band (in the portions where they are not already available) would become available from early 2024.

**Figure 14.3: 26 GHz band plan**



## Stakeholders’ comments on our proposed non-technical licence conditions

14.27 In the May 2022 Consultation,<sup>701</sup> we proposed to apply the same standard non-technical licence conditions for Shared Access licences that we will make available in 26 GHz and 40 GHz bands as the Shared Access framework (which are described in our [guidance document](#)).<sup>702</sup> Below, we set out these standard conditions in more detail and discuss stakeholders’ comments on these, where relevant.

### Licence duration

14.28 In the May 2022 Consultation,<sup>703</sup> we proposed to apply the standard licence duration for Shared Access licences. Shared Access licences are issued for an indefinite duration, subject to the payment of an annual licence fee and a revocation period of one month. Short-term licences for less than one year are permitted and would be charged on a pro-rata basis subject to a minimum fee of £32 per licence. Cellnex was supportive of the indefinite nature of the licences.<sup>704</sup> Based on the limited comments on this proposed licence condition, we are minded to proceed with it.

<sup>701</sup> May 2022 Consultation, paragraph 8.22.

<sup>702</sup> Ofcom’s Guidance Document, “[Shared Access Licence](#)”, published 20 September 2022, paragraphs 5.7-5.23.

<sup>703</sup> May 2022 Consultation, paragraph 8.22(a).

<sup>704</sup> Cellnex, p. 16, paragraph 14.3.

### Revocation for spectrum management reasons

- 14.29 In the May 2022 Consultation,<sup>705</sup> we proposed that, in line with the current Shared Access licensing framework, Ofcom’s power to revoke a licence for spectrum management reasons would be subject to a minimum notice period of one month. Cellnex said that Ofcom should set a revocation period of years and provide certainty to accessing the spectrum for at least 15 years.<sup>706</sup> Ericsson commented that “the ability to revoke at short notice could be prohibitive when considering the business case for investment”.<sup>707</sup> Wildanet also disagreed with a one month revocation period.<sup>708</sup> For the reasons set out below, having taken account of stakeholder’ comments, we are minded to proceed with our initial proposals.
- 14.30 As set out in the July 2019 Spectrum Access Statement, “[Enabling Wireless Innovation through Local licensing](#)” (the “**July 2019 Statement**”),<sup>709</sup> given the uncertainty about how use of the relevant frequencies may develop, we consider it is appropriate to maintain discretion and flexibility to deal with unforeseen circumstances that might arise and enable us to make and give effect to any future spectrum management decisions in an efficient manner. We consider a one-month notice period is appropriate to allow us to revoke licences more quickly than the standard five years’ notice, to enable more efficient use of spectrum, for example where the user fails to transmit as required under the licence. We also consider that a shorter notice period would reduce the risk of hoarding of spectrum.<sup>710</sup>
- 14.31 We recognise that investment cases require a degree of certainty about spectrum availability. For that reason, as we said in the May 2022 Consultation<sup>711</sup> and in line with our Shared Access licensing framework,<sup>712</sup> should we consider repurposing the band for alternative uses, we will take account of the impact of this decision in determining a reasonable notice period. This will be longer than one month and will not occur without us first conducting a formal consultation.

### ‘Use it or lose it’ clause

- 14.32 In the May 2022 Consultation,<sup>713</sup> we proposed that, in line with the current Shared Access licensing framework, licensees will be required to start transmission within six months of the issue of their licence and remain operational thereafter (i.e., that we would include a ‘use it or lose it’ clause). In response, Intracom requested that Ofcom have rules in place to require licensees to use or lease the spectrum they have or lose it.<sup>714</sup> On the other hand, Ericsson was concerned about the current ‘use it or lose it’ clause in the Shared Access

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<sup>705</sup> May 2022 Consultation, paragraph 8.22(b).

<sup>706</sup> Cellnex, p. 16, response to Q.14.

<sup>707</sup> Ericsson, p.4.

<sup>708</sup> Wildanet, p. 14, response to Q.14.

<sup>709</sup> Ofcom’s Statement, “[Enabling Wireless Innovation through Local licensing](#)”, published 25 July 2019, paragraph 3.206.

<sup>710</sup> July 2019 Statement, paragraph 3.177.

<sup>711</sup> May 2022 Consultation, paragraph 8.22.

<sup>712</sup> July 2019 Statement, paragraph 3.206(b).

<sup>713</sup> May 2022 Consultation, paragraph 8.22(c).

<sup>714</sup> [Intracom response to the May 2022 Consultation](#), p. 4, response to Q.5.

licence. It said this is exceptionally challenging given the time it takes to obtain the appropriate planning and access approvals.

14.33 In line with the current Shared Access licensing framework,<sup>715</sup> we consider it appropriate to include such a clause because it will reduce the risk of hoarding and ensure that spectrum is only used by those who continue to need it, and is available to others if no longer required by existing users. In response to Ericsson's concern, we note that in accordance with the statutory process for revoking spectrum licences,<sup>716</sup> Ofcom will consider any representations made by the relevant licensees to determine whether a failure to transmit within six months should result in the revocation of the licence.

14.34 Therefore, having considered stakeholders' comments, we are minded to include a 'use it or lose it' clause in mmWave Shared Access licences, consistent with the current Shared Access framework.

## Other non-technical conditions

14.35 We are also minded to include the technical conditions set out below, which no stakeholders commented on.

### Access and inspection

14.36 In accordance with our standard spectrum licence conditions, the new Shared Access licences would include a condition giving Ofcom the power to access and inspect the licensee's radio equipment. This is so we can check the licensee's compliance with the terms of its licence, if necessary.<sup>717</sup>

### Modification, restriction and closedown

14.37 The new Shared Access licences would also include a condition that gives Ofcom the power to require the licensee to modify, restrict or close down the use of its radio equipment, should we have reasonable grounds to believe that the licensee has breached the terms of its licence, or we consider this necessary in the event of a national or local state of emergency being declared.<sup>718</sup>

### Geographical boundaries

14.38 We plan to allow use of equipment within the United Kingdom and territorial seas. The new authorisation could also extend to the Channel Islands and the Isle of Man, subject to further discussions with the relevant authorities. Low power licensees would be able to deploy any number of base stations within a 50m radius from the licensed location.

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<sup>715</sup> July 2017 Statement, paragraphs 3.177 and 3.187(b).

<sup>716</sup> See, in particular, section 7 of Schedule 1 to the [Wireless Telegraphy Act 2006](#).

<sup>717</sup> September 2022 Guidance Document, paragraph 5.19.

<sup>718</sup> September 2022 Guidance Document, paragraphs 5.19-5.21.

### Provision of information and record-keeping condition

14.39 The new Shared Access licences would include standard conditions to require licensees to provide us, on request, with general information regarding their equipment and use of frequencies, or the rollout of their network. Licensees would be required to maintain a record of the address and certain transmitter parameters for all base station or fixed terminal deployments.<sup>719</sup>

### Changing transmission frequencies

14.40 Licensees could also be required to change their transmission frequency, as notified by Ofcom from time to time. Licensees should ensure their equipment can operate using a range of frequencies when requesting channels in the relevant band.<sup>720</sup>

### Trading

14.41 In line with our Shared Access licensing framework,<sup>721</sup> we are also minded to allow licensees to trade their spectrum rights under the Shared Access licences for the 26 GHz and 40 GHz bands. We would only permit trades of the entire licence, either outright or concurrently with another party. Partial trades of spectrum would not be permitted.

### Provisional conclusions on non-technical licence conditions

14.42 Having considered stakeholders' responses to the May 2022 Consultation, we are minded to apply the standard non-technical licence conditions for the Shared Access framework (which are described in our guidance document)<sup>722</sup> to the Shared Access licences that we will make available in 26 GHz and 40 GHz bands. We will consider any further comments that stakeholders might have on these proposed terms and conditions before making a final decision.

## Further proposals on channel bandwidths, outdoor base station limits and fee limits

### Channel bandwidth and allocation policy

14.43 In the May 2022 Consultation,<sup>723</sup> we proposed to offer bandwidths of 50 MHz, 100 MHz and 200 MHz, and invited comments on whether any further bandwidth option would be useful for applicants, to cover anticipated uses.

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<sup>719</sup> September 2022 Guidance Document, paragraphs 5.16-5.18.

<sup>720</sup> September 2022 Guidance Document, paragraphs 5.22-5.23.

<sup>721</sup> September 2022 Guidance Document, paragraphs 5.14-5.15.

<sup>722</sup> September 2022 Guidance Document, paragraphs 5.7-5.23.

<sup>723</sup> May 2022 Consultation, paragraph 8.27.

### Stakeholders' comments on the proposed bandwidth availability and Ofcom's response

- 14.44 While Intracom suggested that frequency resources of 200 MHz are sufficient to support ultrahigh broadband fixed services,<sup>724</sup> Qualcomm recommended that Ofcom provide channel bandwidths larger than 200 MHz, given the bandwidth requirements needed for future services.<sup>725</sup>
- 14.45 We note Qualcomm's response, and as a result, we now propose to allow the use of a range of unpaired channel sizes, 50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz in the 26 GHz and 40 GHz bands, for Time Division Duplex (TDD) operation. We note that most users are likely to deploy multiples of 200 MHz channel sizes. However, if new use cases emerge, then there may be greater demand for larger channel sizes and therefore, we propose to enable these.
- 14.46 Applicants that wish to deploy continuous bandwidth should apply for the bandwidth and number of channels they require (for example, four 200 MHz channels rather than a single 800 MHz channel). This is because when we carry out the interference calculation, as set out in paragraphs 10.45-10.47, we propose to set the maximum offset at 2.5 times the bandwidth from the block edge, meaning that there is a greater chance of successful coordination where applicants request a smaller channel size.

### Allocation policy

- 14.47 For the **26 GHz** band, we will allocate channels based on the following order, which we consider is the most spectrally efficient method, taking into account the desire to allow (i) citywide auction licensees to access the same frequencies in low density areas as they are authorised to use in high density areas, and (ii) MOD's potential need to access spectrum which is contiguous to its 200 MHz safeguarded spectrum in high and low density areas.
- In both **high and low density areas** we would allocate shared access licences starting with the first available channel from 25.10 GHz, and going down the band to 24.45 GHz, unless the prospective licensee requests specific frequencies; and
  - In **low density areas**, once 25.10 -24.45 GHz is full, we would start allocating additional Shared Access licences at the first available channel above 25.10 GHz, and work up the band, unless the prospective licensee requests specific frequencies.
- 14.48 For the **40 GHz** band, we propose to allocate the first available channel from 43.5 GHz down the band to 40.5 GHz.

### Proposed outdoor base station deployment limit

- 14.49 As set out in Ofcom's July 2022 statement, "Protecting passive services at 23.6-24 GHz from future 26 GHz uses" (the "**July 2022 Statement on protecting passive services at**

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<sup>724</sup> Intracom, p. 4, response to Q.5.

<sup>725</sup> [Qualcomm response to the May 2022 Consultation](#), p. 8, response to Q.14.

24 GHz”),<sup>726</sup> we have decided to limit the number (within any 300km<sup>2</sup> area) of outdoor 26 GHz base stations which can be deployed in the lowest 800 MHz of the 26 GHz band (i.e. 24.25-25.05 GHz), in order to protect the EESS. The total interference contribution from all individual base stations operating in the lowest 800 MHz (24.25-25.05 GHz) of the 26 GHz band within any 300km<sup>2</sup> area must be equal to or lower than 0.1432 W/200 MHz.<sup>727</sup> We did not consider it necessary to establish a contribution limit from base stations deployed above 25.05 GHz. This means that award winners in the 26 GHz band will not be subject to this coordination requirement because we are awarding the spectrum above 25.1 GHz only.

14.50 In the May 2022 Consultation, we proposed to comply with this provision by limiting the number of outdoor base stations that could be deployed under each low power outdoor Shared Access licence in the bottom 800 MHz of the 26 GHz band.<sup>728</sup> Our initial proposal in the May 2022 Consultation was that this would be set as a limit of two base stations.<sup>729</sup> We explained that, for coordination purposes, we would assume that every user is operating at the maximum deployment density permitted per licence to avoid exceeding the overall limit. We said this would enable us to monitor deployment density while offering flexibility to licensees, as they would not have to inform us if they wish to deploy an additional base station, as long as they stay within the limit of their licence.

14.51 We proposed to take a measured approach weighing up the needs of Shared Access licensees, having a simple authorisations approach and ensuring that there is sufficient spectrum still available for users in the future. An alternative approach would be for each licensee to state how many outdoor deployments they will have as part of the application process. Without measures, such as a fee per transmitter, there would be little incentive for users to restrict the numbers asked for. This could lead to a relatively small number of licensees using up the allowance so that no others can deploy in that area. In addition, if licensees wish to deploy more outdoor base stations than stated in their licence, they will need to vary their licence. This places an administrative burden on licensees and Ofcom. We did not receive any comments on these proposals.

14.52 Since publication of these proposals and the publication of the July 2022 Statement on protecting passive services at 24 GHz, we have considered the proposed restriction on outdoor base stations further. Since we published our initial proposals, there have been two important changes which would impact on our proposed deployment density limit for outdoor base stations in 24.45-25.05 GHz:

- We are proposing to make larger channel bandwidths available than we originally anticipated, as set out above in paragraph 14.45. We expect that there will be greater use of bandwidths of 200 MHz and above for Shared Access than we originally anticipated. The result of this would be a lowering of the overall density of outdoor

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<sup>726</sup> Ofcom’s Statement “[Protecting passive services at 23.6-24 GHz from future 26 GHz uses](#)”, published 4 July 2022, section 1.

<sup>727</sup> Paragraph 10.61.

<sup>728</sup> A base station in this context would be a single sector antenna.

<sup>729</sup> May Consultation 2022, paragraph 8.18.

base stations across the 24.45-25.05 GHz band in the EESS coordination area compared the use of smaller bandwidths, as the overall number of transmitters would be lower across the whole band.

- The bottom 200 MHz of the band (24.24-24.45 GHz) is to be made available for use by the MOD and not for outdoor Shared Access deployments. This is important, as the impact on EESS is not uniform across the 24.25-25.05 GHz band (the closer to the EESS frequency the greater the impact) so therefore has a greater impact on the EESS coordination calculation. We also do not expect the MOD deployment density would be as much as Shared Access across a 300km<sup>2</sup> area. This should enable us to permit a greater number of deployments in the 24.45-25.05 GHz band.

14.53 Given these changes, we are proposing to increase the number of permitted outdoor base stations from two to three in the 600 MHz (24.45-25.05 GHz) of the 800 MHz that is constrained by the EESS protection density limit. We believe that the increase to three outdoor base stations should enable low power outdoor licensees to deploy a number of transmitters whilst also allowing for the deployment of a three-sector antenna for those that wish to do so.

14.54 We note that this provision would only apply to licensees operating in 24.45-25.05 GHz. Any stakeholders wishing to deploy greater numbers of outdoor transmitters would be able to do so in the rest of the band. We do acknowledge that in high density areas this restriction would apply to all outdoor low power licensees other than those using the 50 MHz between 25.05-25.1 GHz. If licensees need to have more outdoor transmitters in high density areas, they would be able to do so by getting an additional Shared Access licence for that location.

14.55 Given the uncertainties surrounding the future deployments densities in the band, we will keep this under review and, if necessary, will ask licensees for the number of outdoor base stations that they have deployed. If we find that the outdoor deployment densities are significantly lower than we have proposed or that licensees are only deploying a low number of transmitters, then we will look to review the limit.

## Licence fees

14.56 In the May 2022 Consultation,<sup>730</sup> we proposed to adopt the same cost-based approach to setting licence fees as we have done for the other Shared Access bands, where we take the amount of spectrum allocated into account in the fee calculation.<sup>731</sup> This was based on there being no excess demand for the bands. As there is substantially more spectrum available in the 26 GHz and 40 GHz bands than in the other Shared Access bands, we said that if we used the same baseline bandwidth limit of £80 per 10 MHz this would lead to over-recovery of costs. We stated that the exact fee structure would be set out in our next

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<sup>730</sup> May 2022 Consultation, paragraphs 8.29-8.31.

<sup>731</sup> In the 1800 MHz, 2300 MHz and 3.8-4.2 GHz bands, fees are charged by spectrum allocated. In the 26 GHz band, there is currently a standard annual fee of £320 per licence, regardless of spectrum requested up to the 200 MHz limit.

consultation and welcomed initial views from stakeholders on our proposed high-level approach.

### Stakeholders' comments on the proposed approach to fees and Ofcom's response

- 14.57 BT/EE agreed that the fees should be based on costs of managing the spectrum.<sup>732</sup> Vodafone said that the proposed fee mechanism is too simplistic.<sup>733</sup> Cellnex stated that organisations were willing to pay a higher licence fee for accessing higher power spectrum.<sup>734</sup>
- 14.58 Vodafone stated that the linear way the fee for Shared Access licences currently increases in proportion to the number of locations cannot represent Ofcom's administrative costs. It argued that scale users should not be subsidising costs of new entrants. Vodafone argued that the initial fee would be higher than any subsequent annual fee due to the costs of processing the application and issuing a licence. It agreed that the fee should include a bandwidth element, but disagreed that this should be linear with 200 MHz costing double that of a 100 MHz licence. Instead, it proposed that where requests go beyond an agreed sensible amount of bandwidth that would constrain the amount of spectrum for others, then the fees should increase significantly (for example, a 1 GHz licence should cost 50% more than an 800 MHz licence).<sup>735</sup>
- 14.59 As set out in the July 2019 Statement,<sup>736</sup> we consider it appropriate to have a simple pricing structure that helps to keep licences affordable, incentivises innovation and provides the opportunity for efficient use of spectrum. In particular, we noted the following principles:<sup>737</sup>
- in aggregate, fees should cover our spectrum management costs;
  - each fee should cover the notional variable cost of issuing the licence; and
  - all fees should contribute towards common and specific fixed costs, but we consider it reasonable and appropriate for higher bandwidth licences to make a greater contribution towards these costs.
- 14.60 We recognise that under our proposed pricing structure each licence fee will not perfectly reflect its associated administrative costs. However, we consider that this pricing structure is consistent with the principles summarised above. This would be in line with our overall authorisation objective of making it simple and straightforward for users to access spectrum at the location they intend to provide a service, and with a choice of bands to suit their needs.
- 14.61 Vodafone proposed a non-linear pricing structure where at some points (100 MHz to 200 MHz) the marginal price would be lower than the average price, while at other points (800 MHz to 1 GHz) it would be greater than the average price. We consider that determining

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<sup>732</sup> BT/EE, p. 30.

<sup>733</sup> Vodafone, pp. 14-15.

<sup>734</sup> Cellnex, p. 16, paragraph 14.2.

<sup>735</sup> Vodafone, pp. 14-15.

<sup>736</sup> July 2019 Statement, paragraph 3.166.

<sup>737</sup> July 2019 Statement, paragraph 3.160.

the appropriate parameters of such a pricing structure would be an unduly complex exercise. Moreover, according to Vodafone, the purpose of such a pricing structure would not simply be to better reflect the administrative costs of licences – it would also attempt to reflect the opportunity cost of the spectrum, as we do when setting AIP-based fees.<sup>738</sup>

- 14.62 As set out in the May 2022 Consultation,<sup>739</sup> our provisional view, providing there is no clear evidence of excess demand, is that it is appropriate to set cost-based fees for these Shared Access licences, rather than to set AIP-based fees. However, we do not believe that the current flat fee of £320 per licence, independent of the amount of spectrum assigned, for current Shared Access licences in the 26 GHz would be appropriate. Therefore, in line with other Spectrum Access licences, we are proposing that the fee would vary in proportion to the amount of spectrum requested by the applicant.

### Proposed approach to determining fees in 26 GHz and 40 GHz

- 14.63 The July 2019 Statement set out the framework for setting fees that we would follow for the Shared Access licences.<sup>740</sup> We concluded that the most appropriate approach was to use the actual per-licence costs associated with a similar licence product. Specifically, we proposed to use the costs associated with the Business Radio Technically Assigned licence product as the reference product. This was because: (i) the process of issuing the licence for this product is very similar to the proposed new product, namely that applications have to be run through a coordination system before licences are issued, and (ii) the ongoing costs of managing interference etc. were likely to be similar.
- 14.64 In the July 2019 Statement, we set a fee of £80 per 10 MHz for most bands based on an average bandwidth of 40 MHz.<sup>741</sup> As we currently expect that the average bandwidth of users in the 26 GHz and 40 GHz bands would be greater than 40 MHz, our current fees per 10 MHz of spectrum used in other Shared Access bands would lead to over-recovery of costs and would also impose a significant cost to licensees. We are therefore proposing a different fee rate for Shared Access licences in these two bands.
- 14.65 There is some uncertainty over what Shared Access licences in the 26 GHz and 40 GHz band will be used for. As set out in section 2, we expect that citywide operators could require 1 GHz or more of spectrum in high density areas. It is possible that citywide licensees will want to provide similar services in low density areas using Shared Access licences. For smaller /more localised operators, such as FWA providers, the bandwidth requirements are less clear.
- 14.66 As with setting the initial fees for Shared Access, we recognise that forecasting future demand is uncertain. We therefore need to make some assumptions about the distribution of licences by bandwidth. Some bandwidth distributions will lead to under-recovery, some will lead to full cost recovery and others will lead to over-recovery. Based on the limited

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<sup>738</sup> Vodafone, pp. 14-15.

<sup>739</sup> May 2022 Consultation, paragraph 8.29.

<sup>740</sup> July 2019 Statement, paragraphs 3.157 to 3.170.

<sup>741</sup> July 2019 Statement, paragraph 3.243.

information currently available for these bands, we have provisionally assumed that the average bandwidth would be 400 MHz. Based on this assumption, we propose to set the fee for 400 MHz of 26 GHz and 40 GHz spectrum at £320 per year. Table 14.1 below sets out the proposed fees by bandwidth.

**Table 14.1: Proposed cost-based fees per annum by bandwidth**

Bandwidth	Fee
50 MHz	£40
100 MHz	£80
200 MHz	£160
400 MHz	£320
800 MHz	£640

14.67 Using these figures, we illustrated in Table 14.2 below what this would mean for various deployment scenarios.

**Table 14.2: Illustration of costs based on the volume of licences and spectrum assigned spectrum**

	1 licence	5 licences	10 licences	50 licences	200 licences	500 licences
50 MHz	£40	£200	£400	£2,000	£8,000	£20,000
100 MHz	£80	£400	£800	£4,000	£16,000	£40,000
200 MHz	£160	£800	£1,600	£8,000	£32,000	£80,000
400 MHz	£320	£1,600	£3,200	£16,000	£64,000	£160,000
800 MHz	£640	£3,200	£6,400	£32,000	£128,000	£320,000

14.68 In the July 2019 Statement, we noted that we would expect to only review these cost-based fees if we considered there was a significant misalignment with costs in the future or there was evidence of excess demand.<sup>742</sup> We are in the process of reviewing aspects of our Shared Access licensing approach and will consider any evidence that comes from this work. If we do find that there is a need to amend the fee level for the Shared Access licences, we will consult on revised fees for 26 GHz and 40 GHz alongside any other proposed changes to the fees in the other Shared Access bands.

<sup>742</sup> July 2019 Statement, paragraph 3.148.

## Conclusions and next steps

14.69 In summary, having considered stakeholders' comments, we are minded to make low and medium power Shared Access licences available in both the 24.25-27.5 GHz band (with effect from January 2024) and the 40.5-43.5 GHz band (from the date the revocation of the existing 40 GHz licences will take effect) and to apply the same standard non-technical licence conditions as the Shared Access licences. Taking into account the proposals relating to the technical licence conditions (section 13) and coordination requirements (section 10) we have summarised the revised licence conditions which we are proposing for Shared Access licences for the 26 GHz (Table 14.3) and 40 GHz (Table 14.4) bands. A draft copy of the proposed Shared Access licences is provided in annex 11.

**Table 14.3: Proposed high-level conditions for Shared Access in the 26 GHz band**

Parameters	Low power	Medium power
<b>Non-technical terms and conditions</b>	Same as existing Shared Access licences issued in other frequency bands.	Same as existing Shared Access licences issued in other frequency bands.
<b>Frequency</b>	24.45-27.5 GHz	24.45-27.5 GHz
<b>Permitted locations</b>	Low density areas  High density areas only in 24.45-25.1 GHz	Low density areas only
<b>Permitted deployment</b>	24.45-27.5 GHz Indoor / Outdoor	24.45-27.5 GHz Indoor / Outdoor
<b>Authorised channel sizes</b>	50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz	50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz
<b>Fees</b>	£80 per 100 MHz	£80 per 100 MHz
<b>Maximum device power (TRP)</b>	Base station: 25 dBm/200 MHz Terminal station: 23 dBm	Base station: 30 dBm/200 MHz Terminal station: 23 dBm
<b>Maximum TRP out of band limits</b>	Up to 50 MHz below or above an assigned block 12 dBm/50 MHz  Within 24.45-27.5 GHz 4 dBm/50 MHz  Within 23.6-24.0 GHz -39 dBW/200 MHz (Base station) -35 dBW/200 MHz (Terminal station)	Up to 50 MHz below or above an assigned block 12 dBm/50 MHz  Within 24.45-27.5 GHz 4 dBm/50 MHz  Within 23.6-24.0 GHz -39 dBW/200 MHz (Base station) -35 dBW/200 MHz (Terminal station)
<b>Other conditions</b>	When deploying Active Antenna System (AAS) outdoor base stations, Licensees transmitting in	When deploying Active Antenna System (AAS) outdoor base stations, Licensees transmitting in

<p>24.25-27.5 GHz shall ensure that each antenna is normally transmitting only with main beam pointing below the horizon and in addition the antenna shall have mechanical pointing below the horizon except when the base station is only receiving.</p> <p>Deployments in 24.45-25.05 GHz restricted to 3 outdoor base stations (sector antenna equates to a base station)</p> <p>Outdoor antennas limited to 10m height above ground.</p>	<p>24.25-27.5 GHz shall ensure that each antenna is normally transmitting only with main beam pointing below the horizon and in addition the antenna shall have mechanical pointing below the horizon except when the base station is only receiving.</p>
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**Table 14.4: Proposed high-level conditions for Shared Access in the 40 GHz band**

Parameters	Low power	Medium power
<b>Non-technical terms and conditions</b>	Same as existing Shared Access licences issued in other frequency bands.	Same as existing Shared Access licences issued in other frequency bands.
<b>Frequency</b>	40.5-43.5 GHz	40.5-43.5 GHz
<b>Permitted locations</b>	Low density areas only	Low density areas only
<b>Permitted deployment</b>	Indoor or outdoor	Indoor or outdoor
<b>Authorised channel sizes</b>	50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz	50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz
<b>Fees</b>	£80 per 100 MHz	£80 per 100 MHz
<b>Maximum device power (TRP)</b>	Base station: 25 dBm/200 MHz Terminal station: 23 dBm	Base station: 30 dBm/200 MHz Terminal station: 23 dBm
<b>Maximum TRP out of band limits</b>	Up to 50 MHz below or above an assigned block 12 dBm/50 MHz  Within 40.5-43.5 GHz 4 dBm/50 MHz	Up to 50 MHz below or above an assigned block 12 dBm/50 MHz  Within 40.5-43.5 GHz 4 dBm/50 MHz
<b>Other conditions</b>	When deploying Active Antenna System (AAS) outdoor base	When deploying Active Antenna System (AAS) outdoor base

stations, Licensees transmitting in 42.5-43.5 GHz shall ensure that each antenna is normally transmitting only with main beam pointing below the horizon and in addition the antenna shall have mechanical pointing below the horizon except when the base station is only receiving.

Outdoor antennas limited to 10m height above ground.

stations, Licensees transmitting in 42.5-43.5 GHz shall ensure that each antenna is normally transmitting only with main beam pointing below the horizon and in addition the antenna shall have mechanical pointing below the horizon except when the base station is only receiving.

## Consultation questions

**Question 17:** Do you agree with our proposal to make available channel sizes of 50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz? If not, please give reasons.

**Question 18:** Do you have any further comments on the proposal to limit low power outdoor deployments in 24.45-25.05 GHz to three base stations in any 300km<sup>2</sup> area order to comply with the EESS protection requirements?

**Question 19:** Do you have any further comments on the proposed level of fees for the Shared Access licences in the 26 GHz and 40 GHz bands?

**Question 20:** Do you have any further comments on the proposed extension of the Shared Access licensing framework (including its standard non-technical licence conditions) to the 26 GHz and 40 GHz bands?

# A1. Responding to this consultation

## How to respond

- A1.1 Ofcom would like to receive views and comments on the issues raised in this document, by 5pm on 22 May 2023.
- A1.2 You can download a response form from <https://www.ofcom.org.uk/consultations-and-statements/category-1/mmwave-spectrum-for-new-uses>. You can return this by email or post to the address provided in the response form.
- A1.3 If your response is a large file, or has supporting charts, tables or other data, please email it to [mmwave.allocation@ofcom.org.uk](mailto:mmwave.allocation@ofcom.org.uk), as an attachment in Microsoft Word format, together with the [cover sheet](#).
- A1.4 Responses may alternatively be posted to the address below, marked with the title of the consultation:
- Enabling mmWave spectrum for new uses  
Ofcom  
Riverside House  
2A Southwark Bridge Road  
London SE1 9HA
- A1.5 We welcome responses in formats other than print, for example an audio recording or a British Sign Language video. To respond in BSL:
- send us a recording of you signing your response. This should be no longer than 5 minutes. Suitable file formats are DVDs, wmv or QuickTime files; or
  - upload a video of you signing your response directly to YouTube (or another hosting site) and send us the link.
- A1.6 We will publish a transcript of any audio or video responses we receive (unless your response is confidential)
- A1.7 We do not need a paper copy of your response as well as an electronic version. We will acknowledge receipt of a response submitted to us by email.
- A1.8 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.
- A1.9 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 4. 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.
- A1.10 If you want to discuss the issues and questions raised in this consultation, please contact Lara Singer on 020 7981 3000, or by email to [mmwave.allocation@ofcom.org.uk](mailto:mmwave.allocation@ofcom.org.uk)

## Confidentiality

- A1.11 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 responses on [the Ofcom website](#) at regular intervals during and after the consultation period.
- A1.12 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.
- A1.13 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.
- A1.14 To fulfil our pre-disclosure duty, we may share a copy of your response with the relevant government department before we publish it on our website. This is the Department for Business, Energy and Industrial Strategy (BEIS) for postal matters, and the Department for Culture, Media and Sport (DCMS) for all other matters.
- A1.15 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 in our [Terms of Use](#).

## Next steps

- A1.16 Following this consultation period, Ofcom plans to publish a statement in Q3 of FY 2023/24.
- A1.17 If you wish, you can [register to receive mail updates](#) alerting you to new Ofcom publications.

## Ofcom's consultation processes

- A1.18 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in annex 2.
- A1.19 If you have any comments or suggestions on how we manage our consultations, please email us at [consult@ofcom.org.uk](mailto: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.

A1.20 If you would like to discuss these issues, or Ofcom's consultation processes more generally, please contact the corporation secretary:

Corporation Secretary

Ofcom

Riverside House

2a Southwark Bridge Road

London SE1 9HA

Email: [corporationsecretary@ofcom.org.uk](mailto:corporationsecretary@ofcom.org.uk)

## A2. Ofcom's consultation principles

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

#### Before the consultation

- A2.1 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

- A2.2 We will be clear about whom we are consulting, why, on what questions and for how long.
- A2.3 We will make the consultation document as short and simple as possible, with an overview of no more than two pages. We will try to make it as easy as possible for people to give us a written response.
- A2.4 We will consult for up to ten weeks, depending on the potential impact of our proposals.
- A2.5 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.
- A2.6 If we are not able to follow any of these seven principles, we will explain why.

#### After the consultation

- A2.7 We think it is important that everyone who is interested in an issue can see other people's views, so we usually publish the responses on our website at regular intervals during and after the consultation period. 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.

## A3. 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? \_\_\_\_\_

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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 aims to publish responses at regular intervals during and after the consultation period. 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)

## A4. Consultation questions

We invite responses to the questions listed in this annex. We also welcome any other comments on our proposals set out in this consultation.

**Question 1** (section 3): Do you have any further comments on the approach we are minded to take to authorising the 40 GHz band?

**Question 2** (section 5): Do you agree with the method that we have outlined in annex 16 for identifying which licences authorising the use of fixed links around high density areas will be subject to revocation on the basis that the authorised links would be likely to suffer interference from new users in the high density areas? If not, please give reasons.

**Question 3** (section 7): Do you agree that the licence fee for fixed links that we allow to remain in the 40 GHz band should be the same as the fee in place for the 26 GHz band? If not, please give reasons.

**Question 4** (section 9): Do you have any comments on the proposed rules of our auction?

**Question 5** (section 9): Do you have an interest in bidding for specific high density areas in this award? If so, please provide evidence that you have a credible intention to do so.

**Question 6** (section 9): Do you consider it appropriate to have one or two 26 GHz lot categories?

**Question 7** (section 10): Do you agree with our proposed approach to coordinating Shared Access users in the 26 GHz band? If not, please give reasons.

**Question 8** (section 10): Do you agree it would be appropriate to coordinate Shared Access users in the 40 GHz band in a similar way to the 26 GHz band if we make it available in 5 years time (noting we would consult on the detail of this coordination). If not, please give reasons.

**Question 9** (section 10): Which of the proposed options for coordinating award winners and existing licensees during the (5-year) revocation period do you think would be most appropriate? Do you think alternative approaches to coordination would be more appropriate?

**Question 10** (section 10): Do you agree with our proposal to protect the radio astronomy site at Cambridge (42.5-43.5 GHz) from new mobile users using the 40.5-43.5 GHz band using technical assignment coordination? If not, please give reasons.

**Question 11** (section 10): Do you agree with our proposed approach to coordinating at the boundary of high and low density areas? If not, please give reasons.

**Question 12** (section 10): Do you agree with our proposed approach to international coordination? If not, please give reasons.

**Question 13** (section 11): Do you agree with the non-technical conditions that we propose to include in the award licences to be issued following the award of the 26 GHz and 40 GHz bands? If not, please give reasons.

**Question 14** (section 12): Do you have any comments on our proposal to award fixed term licences with a 15 year term?

**Question 15** (section 13): Do you agree with the proposed technical licence conditions for award licences and local access licences in the 26 GHz and 40 GHz bands? If not, please give reasons.

**Question 16** (section 13): Do you have any comments on our proposed licence conditions relating to antenna elevation?

**Question 17** (section 14): Do you agree with our proposal to make available channel sizes of 50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz? If not, please give reasons.

**Question 18** (section 14): Do you have any further comments on the proposal to limit low power outdoor deployments in 24.45-25.05 GHz to three base stations in any 300km<sup>2</sup> area in order to comply with the EESS protection requirements?

**Question 19** (section 14): Do you have any further comments on the proposed level of fees for the Shared Access licences in the 26 GHz and 40 GHz bands?

**Question 20** (section 14): Do you have any further comments on the proposed extension of the Shared Access licensing framework (including its standard non-technical licence conditions) to the 26 GHz and 40 GHz bands?