# Enabling mmWave spectrum for new uses

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

Enabling mmWave spectrum for new users – Welsh overview

**CONSULTATION:**

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## Section



## Annex

# 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 are proposing to make a large amount of millimetre wave (mmWave) spectrum available across the 26 GHz and 40 GHz bands for use of mobile technology, including 5G. We recognise that mass market applications for mmWave spectrum are still at an early stage worldwide, but believe this spectrum has the potential to deliver significant benefits by enabling large increases in wireless data capacity and speeds.

We therefore want to take a proactive approach in making mmWave spectrum available for new uses, to enable investment in faster broadband, better quality mobile services, and innovation in services. We believe making the 26 GHz and 40 GHz bands available for new uses will maximise the benefits of this spectrum for people and businesses.

## What we are proposing – in brief

We want to enable opportunities for a wide range of users and applications across the country to access mmWave spectrum for new uses.

To do this in the **26 GHz band** (24.25-27.5 GHz), we are proposing to make a combination of citywide and local licences available:

- In the major towns and cities, where we expect the highest volume of mmWave deployment ('**high density areas**'), we propose to:

  i) assign **local licences on a first come, first served basis** in the lowest 850 MHz of the band, using our Shared Access licensing framework;[1] and

  ii) **auction city/townwide licences** for upper 2.4 GHz of the band.

- Elsewhere in the UK, we expect deployments to be sparser ('**low density areas**'), and so we propose to assign **local licences on a first come, first served basis** for all of the 26 GHz band through the Shared Access licensing framework.

Existing fixed point-to-point links which currently operate in the 26 GHz band could receive interference from new uses, and this would likely constrain deployments of these uses in high density areas. Noting that these fixed links could be accommodated in other spectrum bands, we propose to **revoke fixed link licences for the 26 GHz band in and around high density areas**, giving five years' notice of revocation. Fixed links that operate elsewhere in low density areas would remain in the band. We expect that other existing users of the 26 GHz band would be able to coexist with new uses.

For the **40 GHz band** (40.5-43.5 GHz), we are consulting on options to make spectrum in this band available. The 40 GHz band is already 'block assigned',[2] and currently licensed to Hutchinson 3G UK Limited (H3G), Mobile Broadband Network Limited (MBNL), and MLL 40 GHz Limited (MLL). However, the terms of their licences do not permit mobile use. We are seeking stakeholders' views on the following options: (a) varying existing licences to allow current licensees to deploy mobile services in the band, (b) revoking existing licences and re-allocating the spectrum alongside the 26 GHz band, and (c) combinations of variation and revocation.

[1] The Shared Access licensing framework was set up to support innovation and enable new use of spectrum by providing localised access to spectrum bands. See Ofcom's website for more detail. Shared Access licences are already available in a portion of the 26 GHz band for indoor-use only. Our proposals would enable both indoor and outdoor use.
[2] Block assigned means licensees manage their own deployments in their licensed frequencies. This is unlike the 26 GHz band, which is 'Ofcom managed', where Ofcom issues individual licences for each fixed link that operates in the band.

# Our policy objectives for mmWave

1.1 Our objectives for this project, which derive from our duties, are:

- Achieve an efficient allocation of spectrum
- Sustain strong competition in mobile markets
- Encourage investment and innovation
- Ensure timely availability of spectrum.

# Our proposals

## Authorising mmWave spectrum for new uses

1.2 We expect that new uses of mmWave spectrum will be mostly concentrated in areas with high levels of data traffic such as towns and cities. Spectrum in the mmWave range can carry large amounts of data, but is typically limited to short distances as it is easily blocked by obstacles such as buildings and trees. This spectrum is therefore not well-suited for providing 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'. We refer to the rest of the country as 'low density areas', which comprises around 97% of the UK landmass.

1.3 In high density areas, we propose to make the 26 GHz band available through a combination of auctioned citywide licences, and local first come, first served Shared Access licences. This is because wide area users (e.g. Mobile Network Operators (MNOs) and other potential citywide operators) are likely to require wide area licences to facilitate investment and network planning. However, other prospective users' requirements (e.g. local industrial users) are likely to be better met by local licences.

1.4 In low density areas, we propose to make the entire 26 GHz band available for new uses through local first come, first served licences, using our Shared Access licensing framework. This is because we expect deployments of new uses to be sparser and more highly localised in these areas, and so local licences to be sufficient to satisfy all users' requirements.

1.5 We consider that this approach would enable efficient allocation of spectrum and support investment in new uses of mmWave spectrum from both wide area users and local users across the country. New citywide and local Shared Access licences would allow for both indoor and outdoor deployments.

1.6 To identify which towns and cities should be classified as high density areas, we propose to rank major UK towns and cities by peak mobile data traffic and base station density. We are consulting on defining high density areas as either the top 20, 40 or 80 towns and cities in this ranking, and are minded towards adopting 40 high density areas.

1.7 We set out more detail on our authorisation proposals in section 3, and our proposed approach to identifying 'high density' areas in section 4.

## Our approach to existing 26 GHz users

1.8 Existing uses of the 26 GHz band include fixed point-to-point links, one satellite earth station, level crossing radar used by Network Rail, ultra-wideband (UWB) radar, and a range of different licence-exempt short-range devices (SRDs). There is also an allocation for programme-making and special events (PMSE) from 24.25-24.5 GHz. The Ministry of Defence (MOD) has access to the band, though currently has no uses.

1.9 We propose that most existing uses would remain in the band, as we believe managing coexistence between new services and existing uses (other than fixed links) would be straightforward. We are however proposing to close the 26 GHz band for future PMSE use, giving five years' notice of closure, noting that there have been no PMSE licences allocated in this band since 2014.

1.10 Ofcom individually licenses and coordinates each fixed link that operates in the 26 GHz band. Our coexistence analysis indicates that the protections necessary to keep current fixed links in the band (without them suffering interference from new wireless services) could impose a material constraint on spectrum availability for new uses in high density areas. This constraint could lead to less optimal use of the spectrum, and reduced benefits to people and businesses from new uses. We also expect there to be sufficient spectrum available in other spectrum bands to accommodate the fixed links currently operating in the 26 GHz band.

1.11 We are therefore proposing to clear fixed links in and around high density areas only. Affected users would have five years' notice of the revocation, in line with the conditions outlined in their licences, to move their fixed links to alternative spectrum. In other areas of the UK, we propose that fixed links would remain in the band. We consider that this approach would be likely to meet our objectives for authorising mmWave spectrum without imposing disproportionate costs on existing users.

1.12 We set out our proposals on existing users in the 26 GHz band in full in section 5 and section 6.

## Our approach to existing 40 GHz licensees

1.13 We propose to enable the 40 GHz band for new uses on the same or similar timescale to 26 GHz. We think 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.

1.14 There are three existing licensees in the band – H3G, MBNL, and MLL – who hold block assigned national licences. These licences were allocated by auction in 2008. At the time of the 2008 award, 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, the 40 GHz licences are used for fixed links.

1.15 As existing licences are already block assigned, we can enable the 40 GHz band for new uses (including mobile use) either by varying existing licences, revoking them and re-allocating the relevant spectrum, or a combination of both. We have carried out an initial assessment of each of these options against our objectives.

1.16 Our provisional view is 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. Under certain scenarios, it is possible that we could achieve our objectives by re-allocating part of, but not all, the 40 GHz band. However, this would depend on how much mmWave spectrum operators are likely to require for delivering quality services.

1.17 We are seeking stakeholders' views on this initial assessment to inform our decision on how we proceed. If we were to revoke licences, we would be minded to auction citywide licences for the 40 GHz band via auction, at the same time as for the 26 GHz band.

1.18 We set out our full proposals in section 7.

## Other issues under consideration

1.19 We are also seeking early stakeholder feedback on our initial thinking on issues specific to the proposed auction.

### Auction design

1.20 Section 9 sets out our early thinking on aspects of auction design, specifically seeking views on the following:

a) **Lot structure**: We are proposing to have geographic lot categories for each high density area, so that bidders can reflect potential differences in demand in different high density areas. We are also considering whether to have one or two frequency lot categories in the 26 GHz band. Two frequency lot categories would allow bidders to more easily reflect any differences in value for different parts of the band, which may arise due to the presence of fixed links in the bottom of the band.

b) **Auction format**: We are currently minded towards adopting a clock auction format for the principal stage. This auction format is simpler and would allow for a faster auction compared to alternative auction formats.

### Duration of auction licences

1.21 In light of the still-emerging potential of new uses for mmWave, 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 our most recent approach of awarding indefinite licences with a 20-year initial term could result in an allocation of mmWave spectrum which could become inefficient over time.

1.22 We are seeking early views from stakeholders on alternative options for the duration of any new licences we would award for the 26 GHz or 40 GHz bands. These alternatives

would involve either a fixed licence term (instead of an indefinite term) or an indefinite term with an initial term of less than 20 years. We are currently minded towards fixed term licences with a duration between 10 to 15 years.

### Potential competition measures in an award

1.23 We have considered the potential competition concerns that might arise in the context of the proposed auction of new 26 GHz licences in high density areas, which might also include new 40 GHz licences if both bands were re-allocated on the same timeframe. Our analysis includes the potential competition measures we might include in an award to address those concerns. Our provisional view is that there are unlikely to be competition concerns if we were to revoke all or the majority of licences in the 40 GHz band, and re-allocate the spectrum alongside the 26 GHz band.

1.24 Conversely, there may be competition concerns in the longer term if we were to vary licences in the 40 GHz band to enable new uses (including mobile use), such that H3G would start the award process with a significant holding of mmWave spectrum. In this case, to avoid any competition issues, it may be appropriate to place a 'precautionary cap' on the amount of 26 GHz spectrum that H3G could acquire in the auction.

## Next steps

1.25 We invite responses to this consultation by **18 July 2022**.

1.26 Following responses to this consultation, we plan to publish a statement in Q3 2022/2023 on our high level authorisation approach, including our approach to defining high density areas and to existing licensees in the 26 GHz band. This statement will also include our provisional conclusion in relation to existing licences in the 40 GHz band. If we are minded to revoke licences (in the 26 GHz and/or 40 GHz bands) following this consultation, we will give licensees a notification of the proposed revocation and allow an opportunity to make representations.

1.27 In addition to this statement, we intend to also publish a further consultation on the detail of our authorisation approach. This consultation will include our detailed proposals on licence conditions for Shared Access and auction licences; coordination between existing and new users; auction design; any measures we might include in the award to address potential competition concerns; and any licence variations within the 40 GHz band.

1.28 At present, we are aiming to make mmWave spectrum available for new uses by 2024.

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

# 2. Ofcom's approach to mmWave

2.1 One of Ofcom's strategic priorities is enabling wireless services in the broader economy. We therefore want to ensure that spectrum is made available in an appropriate and timely way to facilitate investment, innovation and competition in the development of wireless services to benefit UK people and businesses.

2.2 We are now proposing to make millimetre wave (mmWave) spectrum available in the 26 GHz and 40 GHz bands for mobile technology, including 5G.[3] Our proposals would enable new uses of this spectrum, including mass-market mobile, gigabit fixed broadband and innovation in 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 our proposals would enable.

2.3 The 26 GHz and 40 GHz bands comprise 6.25 GHz spectrum in combination, and 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 offers 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. Mobile bands below 6 GHz, by contrast, can enable coverage over a wide area, but have much smaller bandwidths than mmWave bands.

2.5 As demand for data continues to grow, mmWave spectrum will therefore be an important component in mobile operators' ability to meet future growth in demand for mobile broadband.[4] 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 mmWave spectrum has been harmonised and is being made available for new uses across the world, business 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 and Finland), with more planned for the next few years, though commercial deployments have been limited to date.

[3] We refer to the range of spectrum above 24 GHz (but below 100 GHz) as mmWave spectrum

[4] See *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.

2.7 While we recognise that the commercial development of mmWave spectrum for new uses is still at a relatively early stage worldwide, we want to provide industry with certainty of access to this spectrum to enable timely investment and innovation. In particular, making around 6 GHz of spectrum across the 26 GHz and 40 GHz bands available for new uses will help to ensure that spectrum availability is not a barrier to innovation.

2.8 Below we give the background to both the 26 GHz and 40 GHz bands, and further detail on our objectives in enabling these bands for new uses. We then summarise early indications of use cases and demand for mmWave spectrum.

# mmWave bands under consideration

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

2.9 We have indicated over the years that we intend to open up the 26 GHz band for use of mobile technology, including 5G. 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.[5] In July 2017, we published a call for input, seeking feedback from stakeholders on making the 26 GHz band available for 5G.[6] 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 be become important for 5G, many suggested that it was too early to say how the band will be used, and for what purposes.[7] 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.[8]

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 adopted as a pioneer band for 5G in Europe with harmonised technical conditions set out in the "**26 GHz Decision**",[9] which are now part of UK law.[10]

2.11 Equipment manufacturers already offer products for 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

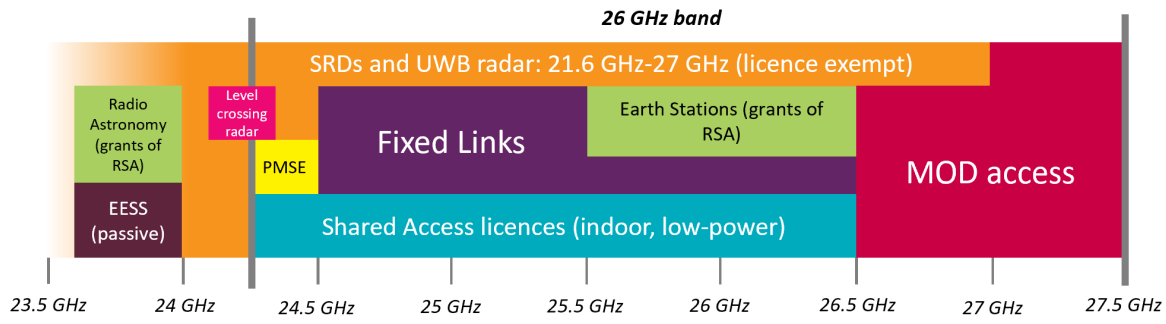
[5] *Update on 5G spectrum in the UK*, published 8 February 2017.
[6] *5G spectrum access at 26 GHz and update on bands above 30 GHz*, published 28 July 2017.
[7] Paragraph 1.16 of *Enabling 5G in the UK*, published 9 March 2018.
[8] *Review of spectrum used by fixed wireless services*, published 5 July 2018, see paragraph 3.79. This statement followed a consultation document that we published on 7 December 2017.
[9] 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.
[10] 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.

band is also supported in US models of mainstream consumer devices such as the Apple iPhone 13, 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.[11]

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.[12] 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.

**Figure 2.1 – 26 GHz band current use**




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

2.14 The wider 39-40 GHz band (37-43.5 GHz) was identified globally for IMT at WRC-19, with Europe identifying 40.5-43.5 GHz as a priority band for 5G. Work is ongoing to develop harmonised technical conditions for 5G in the European Conference of Postal and Telecommunications Administrations (CEPT), and is expected to conclude in late 2022.[13]

2.15 The 40 GHz band has not yet been made available for mobile use in other countries in Europe, and there are currently no devices or equipment available on the market for new uses of the 40 GHz band. However, the neighbouring 39 GHz band was made available in the US for new uses by auction in 2020 and is supported by equipment manufacturers such

[11] *Closure of 26 GHz band to new fixed link licence applications and technical variations*, published 18 January 2022.
[12] *Enabling wireless innovation through local licensing*, published 25 July 2019, section 5.
[13] Subsequently, an EC decision on harmonisation is expected in 2023. See the European Commission's mandate to CEPT, which is annexed to CEPT Report 78.

as Ericsson. The 39 GHz band is also supported in US models of mainstream handsets such as the Apple iPhone 13, Samsung Galaxy S20 Plus and Google Pixel 6.

2.16 We expect equipment for 40 GHz may become available for deployments of new uses to begin around 2024. Typically, subject to demand, we expect vendors to begin producing equipment shortly after harmonised technical standards have been developed. The availability of mobile technology equipment and devices in the adjacent 39 GHz band, which has similar technical properties to the 40 GHz band, may facilitate the development of 40 GHz equipment for new uses.

2.17 There are three existing licensees in the band – H3G, MBNL, and MLL – who hold block assigned national licences.[14] The band is arranged with a duplex split, with H3G holding 2 GHz (2x1 GHz), and MBNL and MLL each holding 500 MHz (2x250 MHz). These licences were assigned by auction in 2008 on a service and technology neutral basis.[15] The 40 GHz licences are currently used for fixed links.

2.18 At the time of the 2008 award, there was no general expectation that the 40 GHz band would be used for future mobile services.[16] 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. [17] This requirement prevents licensees from 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.[18] The current technical licence conditions are also not optimal for 5G, noting that harmonised technical conditions are currently in development in CEPT for new 40 GHz wireless communications services.

2.19 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 are limited.[19] Since February 2018, Ofcom has been able to revoke these licences, with five years' notice, for spectrum management reasons.[20]

2.20 There is also one grant of Recognised Spectrum Access (RSA) for radio astronomy at 42.5-43.5 GHz. An exclusion zone of 50 km applies around the radioastronomy site at Cambridge for these specific frequencies.

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[14] 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 licences are published on Ofcom's website.

[15] 10 GHz, 28 GHz, 32 GHz and 40 GHz Award page on Ofcom's website.

[16] 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.

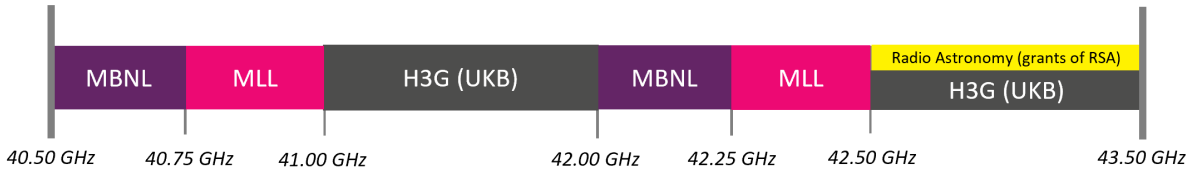
[17] See paragraph 3(a) of Schedule 1 to the 40 GHz licences.

[18] We note that in addition to varying Schedule 1 of the 40 GHz licences, we would also need 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.

[19] 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.

[20] See Condition 3(f) of the 40 GHz licences.

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




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

### 28 GHz

2.21 We do not currently 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.[21]

2.22 The 28 GHz band is currently used for satellite services, in addition to fixed terrestrial services.[22] 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.[23] The 28 GHz is therefore unlikely to be suitable for mobile services in the future.

### 66-71 GHz

2.23 The 66-71 GHz band was 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.[24] In April 2021, 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.[25]

[21] We note however that the US definition of the 28 GHz band (26.5-29.5 GHz) does have a 1 GHz overlap with the bottom of our 26 GHz band (specifically 26.5-27.5 GHz).
[22] Licences covering the frequencies 27.8285-28.4445 GHz paired with 28.8365-29.4525 GHz were awarded by auction in 2008.
[23] As set out in our March 2022 Space Spectrum Strategy, there are a number commercial NGSO systems currently being deployed or planned using the Ka band, which typically use 27.5-30 GHz for uplink. See Table 5.
[24] *Decision to make the Wireless Telegraphy (Exemption and Amendment) (Amendment) (No.2) Regulations 2018,* published 8 November 2018.
[25] Decision on changes to the licence exemption for wireless telegraphy devices and on licensing equipment in 57 to 71 GHz, 29 April 2021.

## Our policy approach and objectives for mmWave

2.24 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 are proposing to authorise for new uses.

2.25 As discussed 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.[26] 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.[27] We consider that, in general, the optimal use of spectrum is most likely to be secured for society if spectrum is used efficiently, that is if it delivers the maximum benefits (or value) for society.[28]

2.26 Our principal duty also includes furthering the interests of consumers in relevant markets, where appropriate by promoting competition,[29] 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.[30]

2.27 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 factors include, in particular, the desirability of encouraging (i) investment and innovation in relevant markets,[31] (ii) the development of innovative services[32] and (iii) the availability of high speed data transfer services throughout the United Kingdom.[33]

2.28 Our main policy objectives for enabling mmWave spectrum for new uses are:

a) Achieve efficient allocation of spectrum

b) Sustain strong competition in mobile markets

c) Encourage investment and innovation in new uses

d) Ensure timely availability of spectrum.

2.29 We discuss these objectives in more detail in the context of mmWave spectrum below.

[26] Section 3(1)(a) of the 2003 Act.
[27] Section 3(2)(a)-(b) of the 2003 Act.
[28] *Spectrum management strategy*, published October 2013, paragraph 2.5.
[29] Section 3(1)(b) of the 2003 Act.
[30] Section 3(2)(d) of the Wireless Telegraphy Act 2006.
[31] Section 3(4)(d) of the 2003 Act
[32] Section 3(2)(c) of the Wireless Telegraphy Act 2006.
[33] Section 3(4)(e) of the 2003 Act.

## Achieve efficient allocation of spectrum

2.30 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 that will use the spectrum to provide the most value to society.

2.31 In the case of new uses of mmWave spectrum, we believe the users that would deliver the highest value to society are likely to be a combination of wide area operators and local operators. Due to its technical characteristics, mmWave spectrum is more suited for providing localised services requiring very high capacities and/or speeds, than for 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.

2.32 In addition to authorising new uses in the 26 GHz band, we also aim to support coexistence with existing uses where feasible, including fixed links, radioastronomy, and short-range devices. Where we are considering clearing existing uses, we expect that these uses could be accommodated in alternative spectrum bands. We note that the MOD also may require access to a portion of the 26 GHz band. Our intention is to continue to enable the MOD's access to the 26 GHz band for future Defence requirements, when and where these arise.[34]

## Sustain strong competition in mobile markets

2.33 The mobile sector has delivered good outcomes to date, with competition among MNOs driving investment and improvements in quality.[35] In light of this, our aim in authorising mmWave spectrum for new uses is to ensure people and business continue to benefit from strong competition in the provision of mobile services. [36]

## Encouraging investment and innovation in new uses

2.34 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. Similarly, innovation will support the development of new services to the benefit of people and businesses, and lead to ongoing benefits from the spectrum in the future.

2.35 There is particular potential for investment and innovation in new uses of mmWave spectrum by a diverse set of users. This spectrum will 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.

[34] Our approach to 26 GHz existing users and the Ministry of Defence is set out in section 6.
[35] Paragraph 1.8-1.10 of *Ofcom's future approach to mobile markets*, published 9 February 2022.
[36] 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 [refer to section 11].

### Ensure timely availability of spectrum

2.36 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. [37]

2.37 We believe 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 under development, 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 is most likely to deliver positive outcomes for people and businesses, given we expect the two bands will become functionally substitutable. This point is discussed in more detail at the end of this section.

## mmWave use cases and deployment scenarios

### Potential demand and use cases

2.38 As the landscape for new uses of mmWave spectrum is still in a relatively early stage of development, we treat early indications of levels of demand from industry with caution. Indications of demand at this stage are likely to be speculative, given longer-term use cases for mmWave spectrum are still developing, though we think the potential benefits of new uses are high.

2.39 We do, however, expect 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 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 national coverage. Elsewhere, we expect any mmWave deployments for new uses to be sparser.

2.40 From initial engagement with prospective mmWave spectrum users, we understand 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.[38] We strongly expect new uses cases to develop over time, beyond these current known applications. Reports from the mobile industry suggests that mmWave spectrum could also support applications such as augmented and/or virtual reality, remote object manipulation, and intelligent transport

[37] *Supporting the UK's wireless future*, published 19 July 2021.

[38] In addition to pre-consultation engagement with prospective operators of mmWave spectrum, the following reports mention these as mmWave use cases: Analysys Mason report *Status, costs and benefits of 5G 26GHz deployments in Europe*, published May 2021; 5G America's report *5G Services Innovation*, published November 2019; GSMA report on *The economics of mmWave 5G*, published January 2021.

systems, which require very high data rates.[39] We therefore expect a range of potential users of mmWave spectrum, including nation-wide players such as the MNOs, regional FWA providers, and highly localised industrial users.

2.41 Current estimates of the amount of mmWave spectrum operators may require for new uses have a wide range, indicating that the estimates are likely imprecise at this stage. Initial evidence from industry and early engagement with prospective users suggest operators may want to use somewhere between around 200 MHz to over 1 GHz in the longer term. It is also likely that operators would be interested in acquiring larger amounts if the price of that mmWave spectrum was sufficiently low.

a) **Prospective new users:** Early engagement with the MNOs suggest that each MNO may be interested in using between 400-800 MHz of mmWave spectrum. In addition, non-MNO FWA operators have indicated that 100-200 MHz would be required for an FWA service delivering 1 Gbit/s or more.

b) **Mobile industry bodies and vendors:** The GSMA, which represents the mobile industry, have suggested that regulators should assign 1 GHz of mmWave spectrum per operator in a timely way, or otherwise risk creating artificial barriers to the development of 5G networks.[40] Nokia have also said that 1 GHz of contiguous spectrum should be made available per operator "to enable the real features of 5G".[41]

c) **International auctions results:** 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,[42] while in Australia Telstra won 1 GHz.[43] 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.

## Network deployment scenarios for new uses of mmWave spectrum

2.42 The technical characteristics of mmWave spectrum mean it is particularly well-suited for 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. [44]

2.43 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

[39] GSMA report, *Regional Spotlights: Impact of mmWave 5G*, published July 2019.
[40] GSMA report on *The economics of mmWave 5G*, published January 2021, which can be accessed through GSMA intelligence, page 35.
[41] Nokia's response to Ofcom draft Plan of Work for 2022/23.
[42] European 5G observatory, *5G auction in Denmark raised 2.1 billion DKK (279.1 million EUR)*, published 23 April 2021.
[43] ACMA, *26 GHz band auction results*, last updated 23 April 2021.
[44] *Mobile networks and spectrum: Meeting future demand for mobile data*, published 9 February 2022, paragraph 1.4.

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 1 km radius in urban areas and several kilometres in rural areas). [45]

2.44 In 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.

### We are seeking stakeholders' views to inform our understanding of future use of mmWave spectrum

2.45 As future use cases and deployment strategies for mmWave spectrum are still developing, we want to authorise this spectrum in a way that enables a wide range of potential users and deployment scenarios. We invite stakeholders' views and evidence on the range of scenarios that we should take into consideration to inform our authorisation approach, including likely use cases, spectrum requirements, and deployment strategies.

## Benefits of making 26 GHz and 40 GHz spectrum available on a similar timeframe by 2024

2.46 We understand from initial engagement with industry that widespread deployment of mmWave for new uses is likely to be in the mid-2020s, with deployments beginning from around 2024. We are therefore aiming to make mmWave spectrum available by 2024, to provide industry with the certainty of spectrum access to enable innovation and realise the full benefits of mmWave spectrum for new uses.

2.47 Our provisional view is that making the 26 GHz and 40 GHz bands available for new uses on the same or similar timeframe is most likely to deliver the best outcomes for people and businesses, given we expect the two bands will become functionally substitutable. 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 hold large contiguous blocks of spectrum. We also consider that making this mmWave spectrum available may provide an incentive for mobile operators to accelerate their network densification plans, to maximise the benefits of this spectrum.

2.48 We believe 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 40 GHz is slightly behind 26 GHz in ecosystem development, and has yet to be made available for mobile services in any

[45] 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.

country in Europe. However, subject to the spectrum being available for new uses, we consider 40 GHz deployments could begin on a similar timescale to the 26 GHz band i.e. from around 2024.[46] Making both bands available in the UK by 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.

2.49 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. It is possible that operators may have greater certainty of their longer-term mmWave spectrum 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.

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

2.51 Furthermore, we consider making these two functionally substitutable bands available together on the same or similar 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.[47] 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.

2.52 By contrast, authorising the two bands separately increases the risk of an inefficient allocation, potentially risking poorer services to people and businesses. For example, uncertainty in the future availability of the 40 GHz band may incentivise more operators to acquire smaller blocks of mmWave spectrum in the 26 GHz band than would be ideal. 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

[46]As set out above, we expect equipment for 40 GHz may become available for deployments to begin around 2024. Work is ongoing to develop harmonised technical conditions for 5G in CEPT, which is expected to conclude in late 2022, with an EC decision on harmonisation expected in 2023.

[47] We explain in more detail in paragraphs 7.30-7.33.

areas. This would lead to underutilisation of spectrum, and potentially hamper the quality of services.

2.53 We explore different options for enabling the 40 GHz band for new uses in section 7, which include varying existing licences, revoking them and re-allocating the relevant spectrum, or a combination of both. We have also assessed in more detail how each option might achieve an efficient allocation of spectrum across the 26 GHz and 40 GHz bands. If we were to pursue the option of varying existing 40 GHz licences to enable new uses, we would look to do so on a similar timeframe to allocating the 26 GHz band. If instead we were to revoke existing 40 GHz licences and re-allocate the spectrum by auction, our current view is that we would realise the most benefits by doing so at the same time as we award the 26 GHz band.

2.54 We are interested in views from stakeholders, together with any supporting evidence, on the timing of making the 26 GHz and 40 GHz band available for new uses. In particular, we are seeking stakeholders' comments on our initial view to make both bands available for new uses on the same/similar timescales. We discuss how we propose to authorise the 26 GHz and 40 GHz bands in sections 3 and 7 respectively.

## Impact assessment

2.55 The analysis presented in this consultation 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.[48] 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.

2.56 We have also given careful consideration to whether our proposals will have a particular impact on persons sharing protected characteristics (broadly 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 dependants and political opinion), and in particular whether they may discriminate against such persons or 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.[49] We do not consider that our proposals have equality implications under the 2010 Act or the 1998 Act.

[48] For more information on our approach to impact assessments, see the guidelines.
[49] Further detail is given in section 149 of the Equality Act 2010 and section 75 of the Northern Ireland Act 1998.

## Consultation questions

**Question 1**: Do you have any comments on our assessment of potential use cases, demand and deployment strategies for new uses of mmWave spectrum?

**Question 2:** Do you have any comments on our proposed overall approach to mmWave spectrum (including our aim to make the 26 GHz and 40 GHz bands available for new uses on the same or a similar timeframe)?

# 3. Our authorisation proposals

## Summary

3.1 In this section we set out our proposed approach to authorising new uses of mmWave spectrum. In summary, for the 26 GHz band, we propose 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) Authorise spectrum use in high density areas in a way which enables both wide area and local operators to access spectrum for new uses. Specifically, we propose to:

i) make local licences available in the bottom 850 MHz of the band (24.25-25.1 GHz) available via the Shared Access licensing framework;[50] and

ii) auction citywide licences for the top 2.4 GHz of the band (25.1-27.5 GHz).

c) Authorise spectrum use on a local basis via the Shared Access licensing framework in low density areas.

d) In line with the current Shared Access licensing framework, Shared Access licences would be granted on a first come, first served basis.

3.2 We consider that this approach would enable efficient allocation of spectrum and support investment in new uses of mmWave spectrum from both wide area users and local users across the country.

3.3 If we decide to re-allocate any spectrum in the 40 GHz band, we would propose to make this spectrum available in a similar way.

3.4 We explain how we propose to identify high and low density areas in section 4. In the remainder of this section we explain why we think it would be appropriate to take a different approach to authorisation in high and low density areas, and set out our initial views on the authorisation mechanisms that we propose for these areas.

3.5 The licences that we propose to assign through these authorisation mechanisms would allow for both indoor and outdoor deployments. In section 8 we explain how we propose to extend the current indoor-only Shared Access licences in the range 24.25-26.5 GHz to reflect these changes.

[50] 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. See Ofcom's website for more detail.

## We propose to identify high and low density areas of the UK

3.6 We expect 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 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 much sparser.

3.7 We therefore do not consider national licences to be suitable for mmWave spectrum, and instead favour a more local or sub-national licensing approach. In the past, we have tended to award national licences for mid-band and low-band spectrum that has been harmonised for mobile use. This is because we wanted to give operators flexibility to provide coverage anywhere in the country. However, it is likely that taking this approach to mmWave spectrum would result in underutilised 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.

3.8 Instead, we propose 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, primarily in larger built-up areas, where we expect there to be a greater density of mmWave deployments. In these areas we consider 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) [51] and facilitate investment by providing certainty of spectrum access for ease of network planning.

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 believe that demand for new uses of mmWave spectrum in much of the UK can be satisfied through local licences.

3.9 We propose 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. We would therefore expect to see a high density of mmWave deployments for new uses in these areas. In section 4 we explain our proposed methodology for identifying which cities and towns should be considered high density areas.

3.10 We note that spectrum regulators in several other countries have authorised new uses of mmWave spectrum in a way that varies across different types of geographic area. For example, the Australian spectrum regulator, the ACMA, took a different approach to

[51] 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.

authorising use of mmWave spectrum in towns/cities with a population of 50,000 people or more, compared to other areas.[52] Some stakeholders have also recommended a similar approach. For example, the *UK SPF recommendations resulting from Real Wireless' 26 GHz study* included defining a 'high-demand zone' covering 1-3% of the UK, outside of which local licences would be appropriate for all prospective new users.

## Authorisation approach in high density areas

3.11 In summary, in high density areas we propose to auction citywide licences for the top 2.4 GHz of the band (25.1-27.5 GHz), and to make the bottom 850 MHz of the band (24.25-25.1 GHz) available for local users by extending the Shared Access licensing framework. We consider this combination would secure an efficient allocation of mmWave spectrum, by allowing the market to determine the allocation of citywide licences for which there is likely to be excess demand (and provide wide area operators with the certainty they need to invest and plan their networks), while also enabling localised access for local users on first come, first served basis. Our reasoning for this proposed approach is set out below.

### We propose to make both local and citywide licences available in high density areas

3.12 We believe that the new users with the highest value for this spectrum are likely to be a combination of wide area operators and local operators. We also 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.

3.13 The type of spectrum licence required is likely to differ depending on the type of user.[53] Although the requirements of some users (such as local industrial users) would be best met with local licences, we believe that wide area users (such as Mobile Network Operators (MNOs), fixed wireless access (FWA) operators and other potential citywide operators) are likely to require wide area licences for the following reasons:

a) An operator's investment case may depend on its ability to deploy over a wide area, with a high level of certainty on spectrum access. [54]

b) Wide area licences would be 'block assigned', and therefore allow licensees to manage their own re-use distances and remove the need to coordinate with other users within an area. This enables an operator to invest without the risk of incurring future costs in managing potential co-channel interference to and from other users. In addition, wide

[52] This information is available on page 4 of the ACMA's document titled "Draft spectrum reallocation recommendation for the 26 GHz band in cities and regional centres", which is available under *26 GHz band draft legislative consultations and submissions (July 2020)*.
[53] As explained in our spectrum strategy statement *Supporting the UK's wireless future*, July 2021, page 21.
[54] Where this wide area encompasses several deployment targets, such as a town centre, train station, university campus, business park, residential areas, etc.

area licences would also support the potential deployment on macro cells by MNOs and FWA operators. This is because such deployments typically risk causing interference over a large area (around 800-1000 m in cities using mmWave spectrum). Offering only local licences in high density areas would make this type of deployment by multiple users much more difficult.

c) Being authorised to use the same frequencies in an area facilitates network planning and deployment. For example, operators will be able to tune their equipment to the same frequencies, rather than needing to tune to different frequencies for multiple deployments in a wide area.

3.14 We therefore propose to make two types of licence available in high density areas, in order to enable all types of users to access the spectrum that they require for new uses. One type of licence will be suitable for local deployments, and we propose to make these available through our Shared Access licensing framework. We explain this in more detail below. A second type of licence will cover a wider geographical area for more widespread deployments. We believe that citywide licences would be an appropriate size for these wide area licences. [55]

3.15 We have also considered the possibility of awarding wide area licences which cover smaller geographic areas than citywide licences (although larger than that available for Shared Access licences) such as by postcode area or a district within a city. However, we believe that such an approach would deliver fewer of the benefits outlined above, compared to citywide licences. Additionally, any boundaries within such areas would inevitably cut across important areas in some cases and increase coexistence issues.

3.16 We propose the Local Access licensing framework would apply to citywide licences.[56] Local Access licences also authorise localised access to spectrum, but are distinct from Shared Access licences. Local Access licences allow users to access licensed spectrum in locations where it is not being used by the licensee and the licensee has no plans to deploy in the near future. However, we would expect local users to apply for Shared Access licences in high density areas in the first instance, and only apply for Local Access licences if no Shared Access licences were available.

## We propose to allocate 850 MHz for local licences and 2.4-GHz for citywide licences in high density areas

3.17 We want to ensure that a reasonable amount of spectrum for new uses is available for local users, and that wide area users have the opportunity to acquire large blocks of spectrum. As such, we consider that the majority of the band should be allocated to wide

[55] Our proposals for the geographical areas where spectrum use would be authorised under these licences would be largely based on the boundaries set by the UK's statistics agencies the Office of National Statistics (ONS), National Records of Scotland (NRS) and the Northern Ireland Statistics and Research Agency (NISRA) boundaries and cover the entirety of a town/city including suburbs and residential areas. Our proposals are set out in more detail in section 4.

[56] See paragraph 2.10 of Ofcom's statement *Enabling wireless innovation through local licensing* and paragraph 2.3 of Ofcom's *Local Access Licence Guidance document*. The Local access licensing framework typically applies to any licences included in the Mobile Trading Regulations.

area users, and a smaller part of the band should be allocated primarily to local users. We note that early indications of demand for spectrum from an operator may be in the range of around 200 MHz to over 1 GHz.[57]

3.18 Our December 2021 consultation, *Protecting passive services at 23.6-24 GHz from future 26 GHz uses*, sets out proposals to limit the number of outdoor base stations (within any 300 $km^2$ area) deployed in the lowest 800 MHz of the 26 GHz band (i.e. 24.25-25.05 GHz) to protect the passive Earth Exploration Satellite Service (EESS) that operates in the adjacent 24 GHz band.

3.19 If implemented, this limit on the number of outdoor base stations would apply across both high and low density areas. If we were to award wide area licences in the lowest 800 MHz of the 26 GHz band in high density areas and offer local licences in low density areas, this would cause implementation challenges for both stakeholders and Ofcom. This is because coordination would be required between block assigned and local licensees to ensure compliance with the limit on the number of outdoor base stations. If instead the bottom 800 MHz was authorised in both high and low density areas via local licences, the implementation challenges would be reduced significantly and would only affect Ofcom.

3.20 We think that it would be appropriate to offer at least the bottom 800 MHz of the 26 GHz band in high demand areas to local users on a first come, first served basis. There are 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 citywide licences.

3.21 Our understanding is that most users will want to access the spectrum in multiples of 100 MHz or larger. If we were to allocate only the bottom 800 MHz of the band as described above, there would be a 'spare' 50 MHz in the band, which we consider could be used by some local users.[58] Making these additional frequencies available to local users on a first come, first served basis would also be more straightforward than incorporating it into an auction. We therefore propose to allocate the bottom 850 MHz of the 26 GHz band to local users and the top 2.4 GHz to wide area users.

[57] See section 2 for more detail.
[58] The 26 GHz band comprises 3.25 GHz of spectrum – allocating only the bottom 800 MHz for local licences would leave 2450 MHz in the rest of the band.

## Options for awarding citywide licences

### Auction

3.22 The key advantage of using an auction to allocate spectrum when demand exceeds supply is that it is more likely to lead to an efficient allocation than alternative approaches, by enabling the market to determine the outcome. In an auction, the spectrum would be 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. The rules for how spectrum is allocated in an auction are clear to stakeholders in advance, and the auction results can be checked by stakeholders after the fact.

3.23 A potential disadvantage of auctions is that auction processes are generally more resource intensive than some alternatives methods. In comparison, a first come, first served process (as described below) is likely to incur lower application costs for participants.

3.24 Nevertheless, we consider an auction would be an appropriate way to allocate citywide licences for 26 GHz spectrum in high density areas, given that it is an efficient, transparent and fair method.

### Comparative selection process

3.25 An alternative approach to a spectrum auction would be to use a comparative selection process (sometimes known as a 'beauty contest'). Under this approach, Ofcom would designate the spectrum licences to be made available and the relative criteria for determining their allocation. We would then invite applications for licences from interested parties, and assign licences to the applicants that in our judgement best satisfied the selection criteria.

3.26 It is difficult to envision how Ofcom would design criteria that will reliably select the highest value users of mmWave spectrum. There is a substantial risk that the selection criteria may lead to an outcome where the final allocation is inefficient, and/or licensees do not deliver on their application commitments.

3.27 It is also unclear whether such an approach would be less resource intensive for participants than an auction, or whether it would be quicker to implement.

### 'First come, first served' process

3.28 We have also considered whether a first come, first served process would be an appropriate way of allocating citywide licences. Under this approach, citywide licences in high density areas would be allocated in a similar way to local licences, i.e. to each applicant that requested a licence, until there were no spectrum licences left in that city.

3.29 A first come, first served process may be less resource intensive than alternatives. However, with this approach there is no way to ensure that the highest value users are prioritised over lower value users. If there is excess demand in a city, this could result in misallocation of spectrum as users with lower valuations may acquire licences before

others with higher valuations. This could in turn lead to less widespread deployment of mmWave spectrum, and poorer quality or more limited services to people and businesses.

3.30 There are measures that could potentially mitigate the risk of inefficient allocation associated with a first come, first served process. For example, 'use it or lose it' conditions,[59] spectrum caps (i.e. restrictions on the amount of spectrum that each applicant could acquire) and exponential pricing for acquiring a licence (i.e. requiring applicants to pay significantly more for additional amounts of spectrum). However, imposing these measures carries the risk of adding costs and complexity to the process. Given the potential future use cases for mmWave are still emerging, they may also distort or chill investment incentives, as well as accidentally favour certain types of users.

## We propose to auction citywide licences

3.31 For the reasons outlined above, we propose to use an auction approach to assign citywide licences in high density areas. In summary, we believe that an auction is more likely to lead to an efficient allocation of the 26 GHz spectrum by enabling the market to determine the most efficient outcome, compared to alternative approaches. Further detail on how we envisage such an auction process would work in practice is set out in section 9.

3.32 In the event of unsold spectrum in the auction, we propose to make those frequencies available through local licences, via the Shared Access licensing framework.

## Authorising local use in high density areas by granting Shared Access licences on a first come, first served basis

3.33 We consider that a first come, first served mechanism would be an appropriate way of allocating local licences in high density areas. While an auction is generally the most efficient way to allocate spectrum where demand exceeds supply, we do not believe that an auction is appropriate for these licences given their small coverage area and the number of licences that would be available. The number of potential lots would make an auction process complex and would likely deter participation from local prospective users.

3.34 As explained in more detail in section 8, we propose to make the lowest 850 MHz of the 26 GHz band (24.25-25.1 GHz) available for localised use by granting Shared Access licences on a first come, first served basis.[60] Two types of licence are currently available under the Shared Access licensing framework: low power and medium power licences[61]. In high density areas, we propose to make available only lower power Shared Access licences,

[59] See our *Shared Access Licence Guidance document* (paragraph 5.11), 'use it or lose it' conditions may be imposed to ensure that new users aren't prevented from deploying their equipment by (i) existing users who are no longer operational but have not surrendered their licences, or (ii) by users who acquired more spectrum than they needed in order to make it harder for other companies to compete.

[60] The Shared Access licensing framework is currently available only within the lower 26 GHz band (24.25-26.5 GHz) and only for indoor low power use. We propose to amend Shared Access licences in high density areas so that they are available for 24.25-25.05 GHz and are available for indoor and outdoor use.[61] For further information, see Ofcom's website.

[61] For further information, see Ofcom's website.

which would allow low power small cells to be deployed. We propose to not allow medium power deployments (suitable for macro cells) because they would sterilise a large area and would deny the opportunity for a number of other users to deploy spectrum in high density areas. 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.

## We propose to allow citywide licence holders to hold Shared Access licences in high density areas

3.35 It is possible that holders of citywide licences may also be interested in acquiring Shared Access licences in high density areas. For example, a citywide licensee may want access to more spectrum than it won in the auction to deliver a specific service in a particular area. However, this introduces a risk of citywide licensees 'hoarding' Shared Access licences, and potentially preventing local users from accessing the spectrum. We are proposing to set cost-based fees for 26 GHz Shared Access licences, which are likely to be relatively low (see section 8 for more detail).

3.36 We are also proposing that Shared Access licences would include a 'use it or lose it' condition, meaning that if licensees do not use the spectrum within a specified period, they will be required to return their licences to Ofcom. The inclusion of such a term would reduce but not remove the risk of spectrum hoarding. We have therefore considered whether it would be appropriate to restrict the ability of citywide licence holders (and the holders of existing 40 GHz licences, if those licences are varied to allow new uses) to acquire local licences in the high density areas in which they have already acquired citywide licences.

3.37 We have assessed the following options:

a) Allow citywide licence holders to acquire Shared Access licences on the same basis as anyone else.

b) Prevent citywide licensees from acquiring Shared Access licences if they already hold a certain amount of mmWave spectrum or more across the 26 and 40 GHz bands spectrum in the relevant city.[62]

c) Do not allow citywide licence holders in a town/city to access Shared Access licences in that town/city.

3.38 We are currently minded towards option a), where citywide licence holders can acquire Shared Access licences on the same basis as anyone else. This is on the basis that the likelihood of spectrum hoarding is low, as we consider that citywide licence holders would likely prefer to deploy spectrum in the same frequencies across a city. We consider that option c) may impose a disproportionate restriction and prevent citywide licence holders

[62] For example, we could set that amount at 850 MHz, which is the amount of spectrum available for local use in high density areas.

from acquiring additional spectrum for legitimate reasons. Option b) would likely have some practical implementation challenges that could add complexity and cause delay.[63]

## Club model

3.39 Some stakeholders have expressed an interest in a 'club model' were we to authorise any spectrum on a block assigned basis for new uses. A club model 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 is not currently being used in a particular area.[64] Users who do not have dedicated frequencies would be unable to access spectrum in this way - access would be restricted to those who have their own spectrum holdings (i.e. who are part of the 'club'). This authorisation approach was used in the 2018 Italian auction of the 26 GHz band.

3.40 Since we are proposing to authorise citywide licences in the top 2.4 GHz of the 26 GHz band (25.1-27.5 GHz), a club model approach could be used for this spectrum. This approach 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 that they can deploy in the specific areas licensed to them.

3.41 However, our initial view is that such a model could be complex to implement. It would require a licensing mechanism which would enable licensees to: (i) declare when spectrum which is licensed to them is not being used and therefore is available for use by other members of the 'club', and (ii) to use spectrum that is currently licensed to another operator where this spectrum has been declared to be temporarily available.

3.42 It is already possible to access mobile spectrum that has been licensed but is not being used through our Local Access licensing framework, which we are proposing would also apply in the 26 GHz band. In addition, the mobile spectrum trading scheme enables operators to trade (or sell) licences which they are not using. We note that one potential benefit of implementing a 'club model' could be that it may allow access to spectrum more quickly than through the Local Access licensing framework or trading. We would therefore be interested to understand from stakeholders what length of time they would seek to use spectrum through the 'club model' for i.e. would this be for a matter of hours, days, or months.

3.43 Our provisional view is that a 'club model' would be difficult to implement and it is unclear whether it would provide significant additional benefits compared with those available under the Local Access licensing framework or the mobile spectrum trading scheme. We welcome views on any benefits that a 'club model' would provide that are not available under the Local Access licence scheme or the mobile spectrum trading scheme.

[63] For example, Ofcom would have to check whether a company, and affiliated companies, held citywide licences in the relevant areas. This could add administrative processes for both stakeholders and Ofcom.
[64] For example, user A and user B acquire spectrum licences for specific, dedicated frequencies. If user B is not using their dedicated frequencies in a specific area, user A can use user B's frequencies in addition to their own. If user B then wants to deploy in that area, user A must relinquish user B's frequencies but can continue using their own frequencies.

## Authorisation approach in low density areas

3.44 We propose to categorise most of the UK as 'low density' areas. In these areas, we expect it to be possible to satisfy demand for new uses of mmWave spectrum through Shared Access licences. We consider these licences would be sufficient to meet operators' requirements because, for most of the country, we expect deployments to be highly localised and spread far apart, even though there might be pockets of more concentrated deployments in some areas.

3.45 In these areas, we therefore propose to make all of the 26 GHz band (24.25-27.5 GHz) available via our Shared Access licensing framework.

3.46 In section 8 we discuss the types of Shared Access licences which we propose to make available for using the 26 GHz band in low density areas. In summary, we propose 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.

## The 40 GHz band

3.47 We are also proposing to enable the 40 GHz band for new uses, as set out in section 7, either by varying existing licences or by revoking existing licences and reallocating some or all of the 40 GHz spectrum. Our provisional view is 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 the best positive outcomes for people and businesses, given the two bands are functionally substitutable. We would therefore look to make the 26 GHz and 40 GHz bands available around the same time.

3.48 If we were to decide to re-allocate the 40 GHz band (as discussed further in section 7), up to 6.25 GHz of spectrum would be available across the two bands (3.25 GHz in 26 GHz, 3 GHz in 40 GHz). We would need to consider how to allocate this additional spectrum, and consult on this in our next consultation.

3.49 Our provisional view is that, in this situation, we would adopt a similar approach to allocating the 40 GHz band as our proposals for the 26 GHz band. Specifically:

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 licence scheme.

b) We would only allocate citywide licences in high density areas.

3.50 If we were to re-allocate the 40 GHz band and award citywide licences for 40 GHz in high density areas, we would propose to make these licences available by auction. We recognise that there would be considerably more mmWave spectrum available in this scenario than if we were considering only the 26 GHz band, which would reduce the likelihood of excess demand. However, our initial view is that an auction would still be more likely to result in an efficient allocation (by ensuring that the spectrum goes to those users with the highest valuations) than other allocation mechanisms.

## Next steps

3.51 We welcome views from stakeholders on the proposals set out in this section. We intend to consult on further details of our authorisation approach in our next consultation. In particular, this will include more detailed proposals on authorising the 40 GHz band, in the event that we decide to re-allocate that band.

## Consultation questions

**Question 3**: Do you agree with our approach of specifying high and low density areas in the UK, and authorising new uses differently in those areas?

**Question 4**: Do you agree with our overall authorisation approach in high density areas for the 26 GHz band (i.e. to grant Shared Access licences on a first come, first served basis for the bottom 850 MHz of the 26 GHz band, (24.25-25.1 GHz), and to auction citywide licences for the rest of the 26 GHz band (25.1-27.5 GHz))?

**Question 5**: Do you agree with our overall authorisation approach in low density areas for the 26 GHz band (i.e. to grant Shared Access licences on a first come, first served basis)?

**Question 6:** Do you agree with adopting a similar approach to authorising the 40 GHz band as our proposals for the 26 GHz band, if we were to decide to re-allocate the 40 GHz band?

# 4. Identifying high density areas of the UK

## Summary

4.1 In section 3 we set out our proposals to authorise new uses of mmWave spectrum in different ways in different areas of the UK. Principally, we propose to categorise all areas of the UK as either 'high density' or 'low density' areas, where:

a) '**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

b) '**low density areas**' are the rest of the UK, outside high density areas, where we expect deployments to be sparser and more highly localised.

4.2 In this section we outline our proposed approach to identifying high density areas. Additional detail on our proposed methodology is set out in annex 7.

4.3 Our approach involves two steps:

a) Firstly, we aim to capture towns and cities with high data demand. We do this by identifying towns and cities which have either (i) a population of 75,000 or more, or (ii) notably high peak hour mobile traffic. This gives us a list of 107 potential high density areas.

b) Secondly, we rank these areas based on the level of mobile traffic they experience at peak hours and the greatest density of mobile base stations within the area. Through this, we have developed a single combined ranking of potential high density areas.

4.4 We are currently minded to classify the top 40 areas arising from our analysis as high density areas.

4.5 We invite comments from stakeholders on our proposed approach to identifying high density areas, and on where the cut-off point should be for the number of high density areas we adopt.

## Step one: identifying towns and cities with potentially high data demands, and their boundaries

4.6 We have considered how to define the boundaries of the potential high density areas (i.e. cities and towns). Having assessed the relative merits of several different options,[65] we propose to base our definitions of high density areas on pre-defined boundaries which have already been established by the UK's statistics agencies. These agencies are the Office of National Statistics (ONS) for England and Wales, National Records of Scotland (NRS) for

[65] As discussed in more detail in annex 7, we have also considered using grid squares, local authority boundaries and postcode areas.

Scotland and the Northern Ireland Statistics and Research Agency (NISRA) for Northern Ireland. We refer to these together as the 'UK statistics agencies'.

4.7 Our provisional view is that the town and city boundaries defined by the UK statistics agencies provide an appropriate starting point for the purposes of defining high density areas. This is because they were developed specifically to provide a more precise definition of towns and cities than other sources of data. They are also widely available and intuitive to use.

4.8 We have also considered how to narrow down which of these areas we should classify as potential high density areas. In this regard, we note that the ONS already categorises certain areas of England and Wales as 'major towns and cities', on the basis that they have residential or workday populations of over 75,000 people. We refer to this as the 'Major Towns and Cities' (MTaC) dataset.[66] We consider that the population of a particular town or city is highly relevant to whether or not we should categorise it as a high density area, as we expect to see new uses of mmWave spectrum to be deployed most extensively in places where there are many people, and therefore high demand for data.

4.9 However, the MTaC dataset from the ONS only relates to England and Wales, so we have replicated the approach to include Scotland and Northern Ireland (in accordance with definitions of towns and cities used by NRS and NISRA respectively).[67] In particular, we have identified which of the towns and cities in Scotland and Northern Ireland defined by the NRS and NISRA have populations of over 75,000 people.[68]

4.10 We therefore propose to use the UK statistics agencies' definitions of towns and cities which have populations of over 75,000 people as a starting point for identifying and defining high density areas. However, we consider a small number of alterations to these datasets would be necessary to make them more suitable for our needs. We explain these below.

## Incorporating additional towns and cities with high data traffic

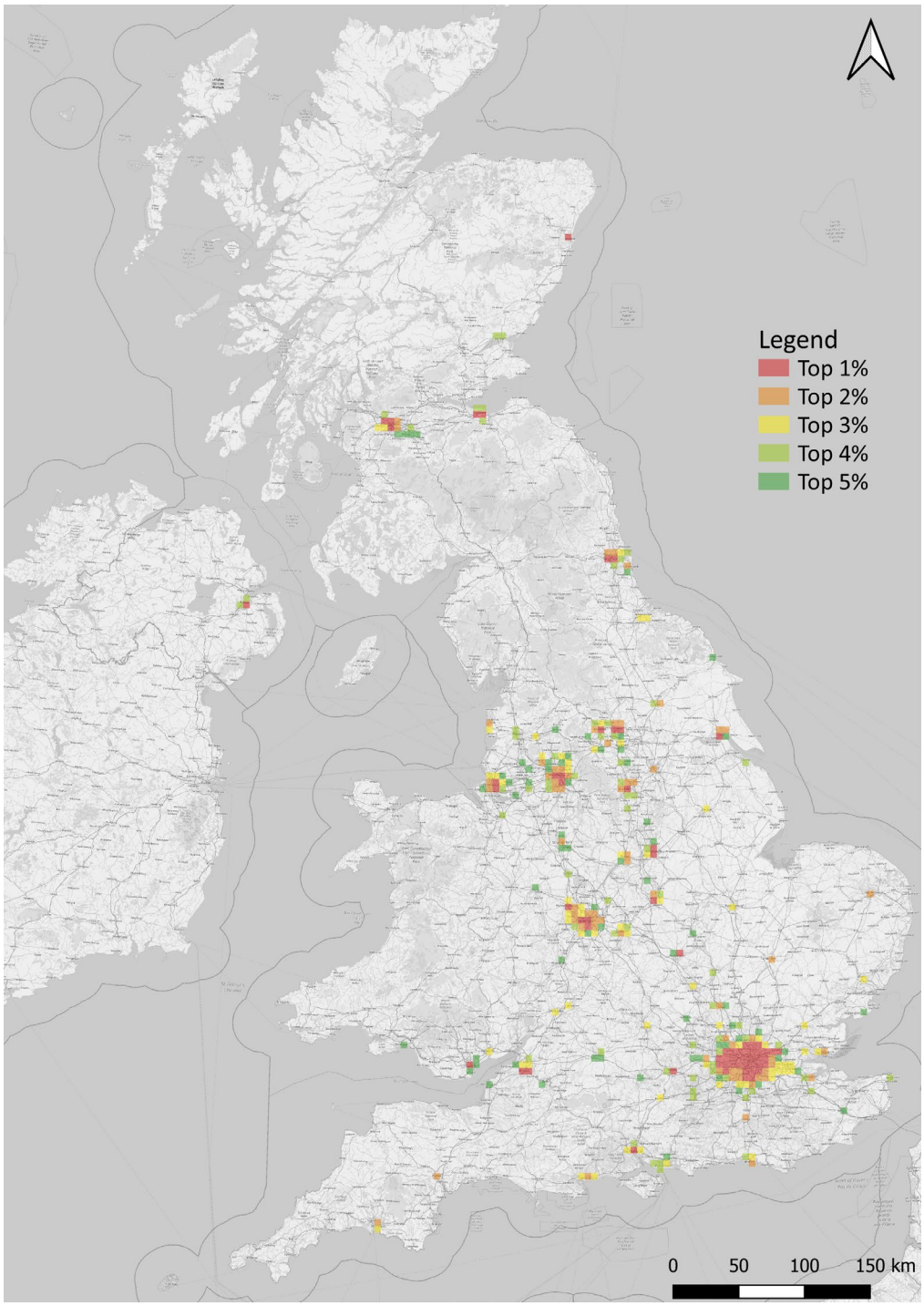
4.11 The steps set out above enable us to identify which of the UK's towns and cities have the largest populations. However, we consider that the amount of mobile data used in a town at peak times is also an important indicator of whether that town should be classified as a high density area. We have therefore identified which of the UK's towns and cities have the highest data traffic (using data obtained through Ofcom's Connected Nations report).

4.12 We have done this by analysing where mobile data traffic is the highest around the UK. Specifically, we have calculated the total peak hour mobile data downloaded across each

[66] ONS, 'Major Towns and Cities - a new statistical geography'.
[67] Full details on how we adapted the original MTaC dataset to include all four nations of the UK can be found in annex 7.
[68] For Scotland, population figures are taken from NRS' Mid-2020 Population Estimates for Settlements and Localities in Scotland; for Northern Ireland, figures are taken from Census 2011 statistics mapped to NISRA's Settlement Development Limits outlined in 2015.

5 km grid square in the UK, and mapped out the top 5% of these.[69] The result of this exercise is shown in Figure 4.1 below.

**Figure 4.1: Map showing top 5% of 5 km grid squares in the UK by total peak hour data traffic**




*Source: Ofcom; base map © OpenStreetMap contributors; N.B. Orkney and Shetland not shown as no areas there fall within the top 5% of grid squares*

[69] In annex 7 we explain why we have chosen 5% of 5 km grid squares.

4.13 We have cross-referenced the locations with high data throughput identified through this method with the list of towns and cities with populations over 75,000. While most of the locations with high data throughput we identified in this way were already included in the list of towns and cities, a small number of locations were not represented. We propose to incorporate the additional towns and cities we identified in this way into our list of potential high density areas.[70]

4.14 Full details on which additional towns and cities we have added for this reason, and our methodology, are set out in annex 7.

## Simplifying boundaries of towns and cities

4.15 We note that the boundaries of the areas identified using the methodology above are very granular and leave gaps in some cities. [71] These gaps are often caused by the presence of large parks, rivers and major roads. We consider that these granular boundaries and gaps could limit investment and network deployment, due to the need for coordination between users in high and low density areas. Specifically, gaps in high density areas could create 'dead zones'. These dead zones would technically be low density areas, where citywide licensees would not be authorised to deploy. However, applications for Shared Access licences in these areas to use the same frequencies as nearby citywide licences would also likely be rejected due to the need to keep distance between users to avoid interference.

4.16 In order to simplify and standardise the boundaries of our proposed high density areas in all nations, we are proposing to apply an overlay of 1 km grid squares over the towns and cities we have identified. Any grid square which contains any part of a town or city's boundaries would therefore be included as part of the relevant high density area. Following on from this, we also propose to use the same 1 km square grid system to fill in any gaps in the high density areas. Specifically, if a 1 km grid square not included in a town or city was encircled on three or more sides by squares which were included, that square would be added to the high density area. Additionally, any remaining gaps in high density areas which were wholly enclosed were also included (i.e. if a 2x2 km 'gap' existed within the boundaries of a high density area, this also became part of that high density area).

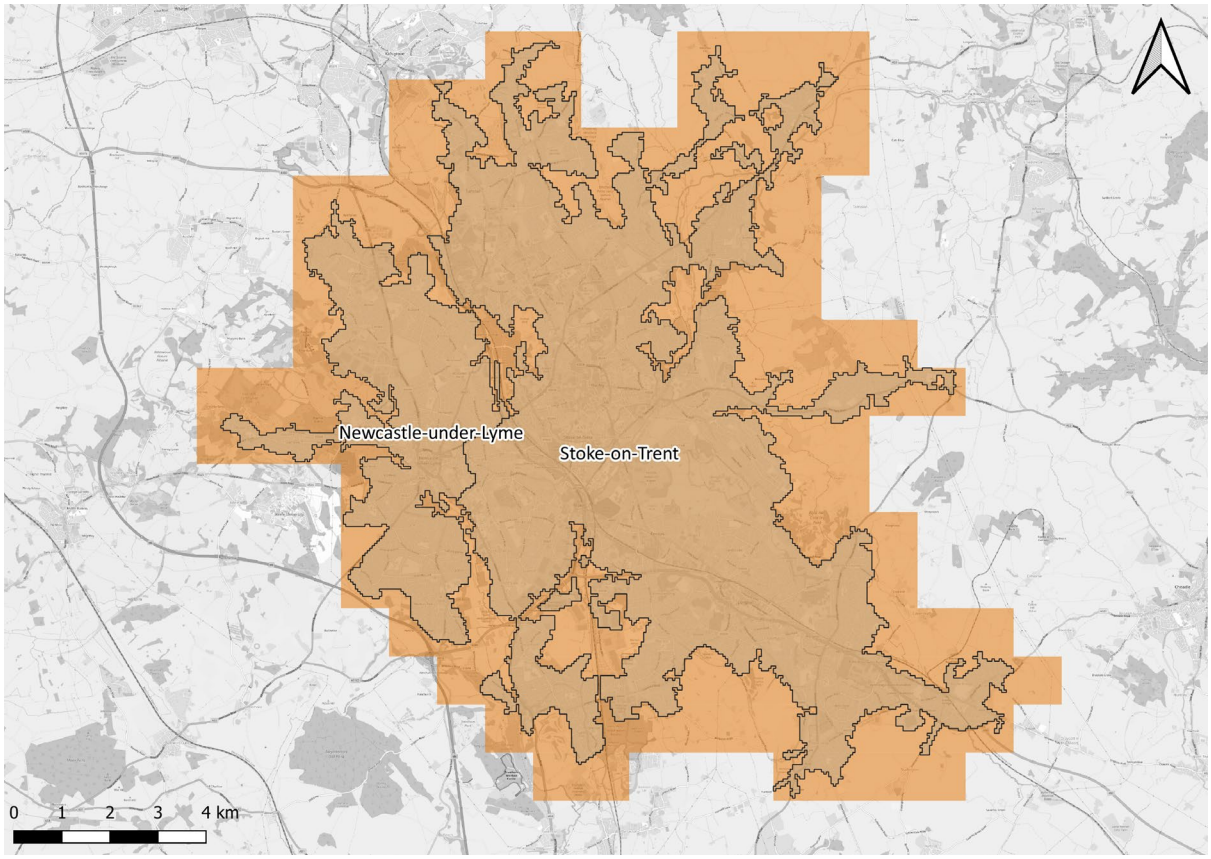
4.17 Our application of 1 km grid squares also has the effect of combining adjacent and neighbouring towns and cities into single, discrete areas. This is the case for any towns and cities which already have shared borders, as well as some of those which are within 2 km of each other. We propose that any towns and cities with contiguous borders once this overlay is applied should be treated as a single high density area, as this would remove the need to manage interference between two different block-assigned licensees in adjacent areas.

[70] We propose to do this using the same boundaries we propose to use to define the outlines of towns and cities in the four UK nations.

[71] This is particularly true for the MTaC dataset, which uses a grid square system with a resolution of 50 m.

4.18 The map below shows an example of where this methodology combines two adjacent settlements, namely Stoke-on-Trent and Newcastle-under-Lyme, which are combined into a single area. In addition, the grid square overlay simplifies the boundaries of the area and has filled in gaps within the city.

**Figure 4.2: Map of Stoke-on-Trent, showing MTaC boundaries (black outline) with 1 km grid square overlay (orange area)**




*Source: Ofcom; Office for National Statistics licensed under the Open Government Licence v.3.0; base map © OpenStreetMap contributors*

4.19 Having applied this overlay, we are left with 107 discrete potential high density areas. Please see annex 7 for a list of all 107 areas, as well as which areas are combined together by the grid square overlay.

## Step two: ranking the areas identified using metrics that indicate where mmWave spectrum is likely to be deployed most extensively

4.20 As future use cases and deployment strategies for mmWave spectrum are still developing, we consider that a degree of regulatory judgment is necessary to identify which of these 107 areas should be categorised as high density areas. In order to reduce the risk that mmWave spectrum will be underutilised, we only want to allocate citywide licences where operators are likely to deploy mmWave spectrum for new uses extensively. However,

underestimating the number of towns and cities where this may be the case runs the risk of reducing operators' potential economies of scale and incentives to invest.

## We ranked towns and cities based on mobile data and base station density

4.21 Having identified our list of potential high density areas, we propose to rank these, to better understand where mmWave spectrum will most likely be deployed extensively. We propose to use information from Ofcom's 2021 Connected Nations Report to do this, focusing specifically on the following two metrics:

a) **Base station density**, which shows us where mobile network operators have deployed their current infrastructure most intensively. This metric is comparatively stable from month to month, however it does not show, on its own, how much data traffic is being generated in a given area.

b) **Peak hour mobile data**, which tells us how much data traffic was generated on a given base station site during the busiest hour of the month (in this case, the month the data relates to is May 2021). This metric indicates the maximum mobile traffic generated at any one time, but can fluctuate from month to month. This is because events such as sports matches, festivals, or large outdoor events can drive spikes in mobile data use at a given base station or location.

4.22 We consider that these metrics are a good predictor of where mmWave spectrum is likely to be deployed most extensively for new uses. Additionally, using both of these metrics together would ensure greater reliability in ranking high density areas, ensuring that the analysis is more robust. We also think this information will be more relevant than data such as population density alone, which is not tied to mobile usage and does not, for example, reflect where people travel to or work.

4.23 Based on our understanding of how mmWave spectrum is likely to be deployed for new uses, we consider that it is more appropriate to consider both of these metrics in relation to the busiest areas within a city, rather than as an average across an entire city.[72] Therefore, we propose dividing up each of the 107 cities into 1 km squares and calculating the base station density and peak mobile traffic in each square. We would then use the highest values for each metric as the result for that city.

4.24 Calculating the highest mobile base station density and highest peak hour data gives two rankings for each of the 107 cities, which we then multiply together to determine a final ranking for each city that takes into account both metrics.[73]

4.25 To illustrate our proposed methodology using the case of Edinburgh: of the 107 potential high density areas, Edinburgh ranks 10th for peak hour data and 8th for base station density.

[72] When calculating averages across entire cities, we found that this approach gave us results with an order that did not seem logical. Some larger towns and cities were 'penalised' for having a large geographic area and appeared much further down the list than we expected given the size or population of these areas, while some small towns unexpectedly appeared towards the top of the list. We did not consider that these results reflected the likely pattern of mmWave spectrum deployment.

[73] Where there were ties, we chose the high density area with the higher base station number to be higher on the list.

Multiplying these ranks together gives a score of 80, which overall ranks Edinburgh 9th across the 107 high density areas.[74] [75]

## Our proposal to designate 40 areas as high density areas

4.26 Having identified and ranked a list of 107 potential high density areas, we then considered different options for determining an appropriate cut-off point within this ranking. In particular, we have considered the relative differences between areas based on peak hour data and base station density.

4.27 Figure 4.3 shows the 107 potential high density areas, using our peak data traffic measure. Each green dot in the figure represents a potential high density area's peak data traffic. The areas are ranked from left (area with highest peak data traffic) to right (area with lowest peak data traffic) based on highest peak hour data total for a 1 km grid square.

4.28 The figure shows:

a) The first four potential high density areas experience significantly more peak hour data traffic.

b) After the first four potential high density areas, there is steady decline in the data intensity of the following areas.

c) There are pronounced breaks in the data after around the first 10 and then 20 potential high density areas.

4.29 Figure 4.4 shows the 107 potential high density areas, using our base stations density measure. Each green dot in the figure represents a potential high density area's highest base station density. The areas are ranked from left (area with highest concentration of base stations) to right (area with lowest concentration of base stations) based on highest base station density for a 1 km grid square.

4.30 The figure shows:

a) The first two potential high density areas have significantly higher base station concentration than other areas.

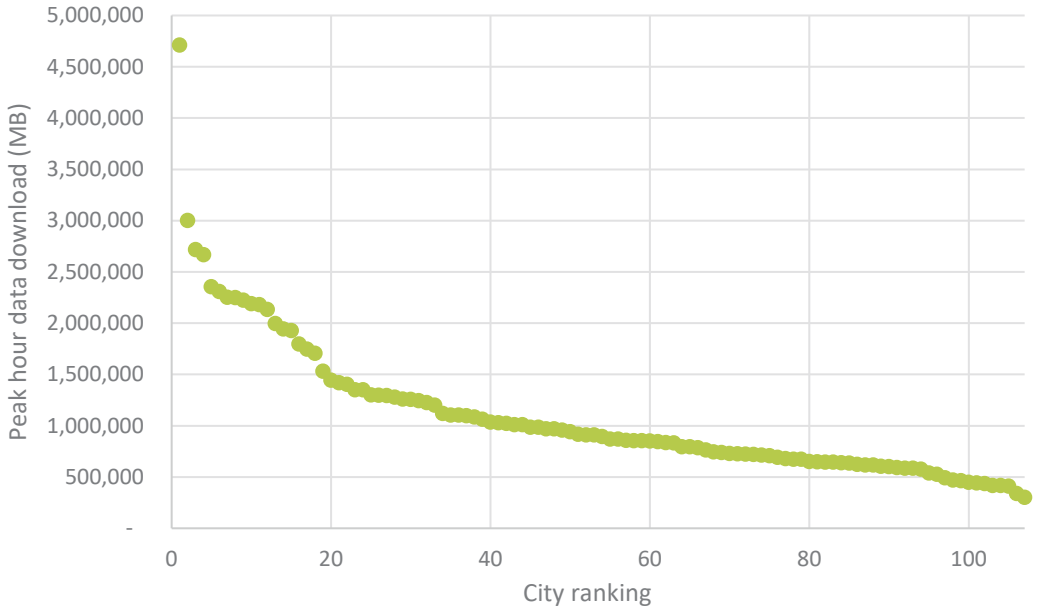
b) After the first two potential high density areas, there is a steep decline in the base station density in the subsequent areas.

c) There is a pronounced break in the data after around the first 15 potential high density areas.

[74] The full ranked list of all 107 areas can be found in annex 7.

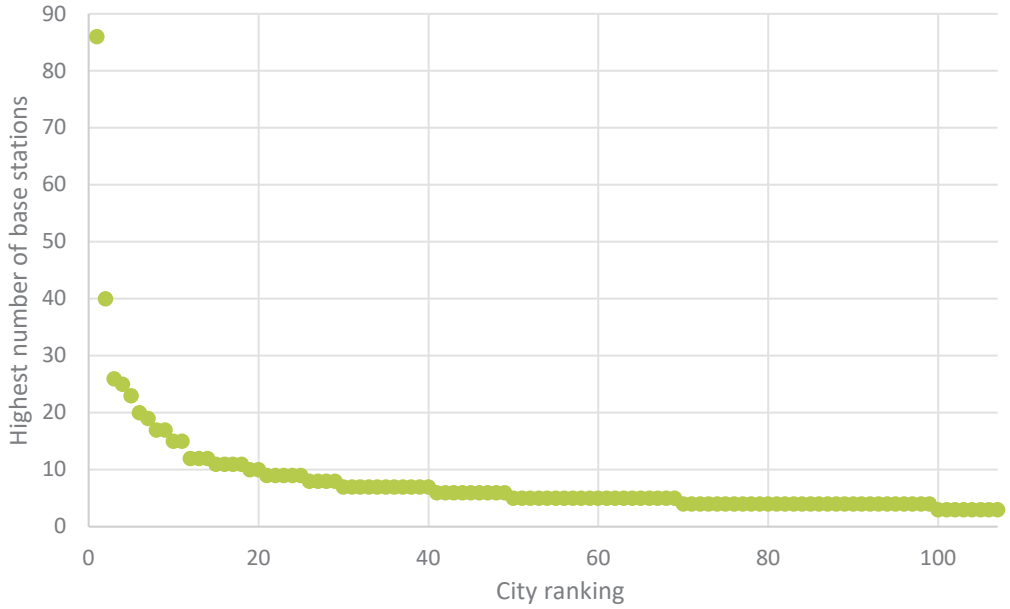
[75] We recognise that there are alternative methods of combining the ranking of individual metrics to determine a combined ranking, such as an additive approach. We have chosen a relatively straightforward multiplicative approach as we consider this is a reasonable option in this circumstance. We also note that there is relatively strong correlation in the rankings across the two metrics which means the choice of ranking methodology only has a small effect on the result.

**Figure 4.3: 107 potential high density areas ranked based on highest peak hour data total for a 1 km grid square (2021 data)**




*Source: Ofcom*

**Figure 4.4: 107 potential high density areas ranked based on highest base station density for a 1 km grid square (2021 data)**




*Source: Ofcom*

4.31 We consider, based on the analysis above, that there is a reasonably clear difference between the top 20 areas and the areas lower down the rankings. As such, we think that 20 areas would be a reasonable cut-off point for high density areas. After 20 areas there is

a steadier decline in mobile data traffic and base station density, which does not present further obvious cut-off points.

4.32 Noting that these areas still carry significant amount of data traffic, especially in the upper portions of the rankings, we consider 40 and 80 areas would be reasonable cut-off points, in addition to 20. After the top 80 areas in these rankings, we would expect deployments to be fewer and therefore local licences to be sufficient.

4.33 Table 4.1 below shows the geographical area and population of the UK that each potential cut-off represents (in absolute and relative terms). The table shows that:

a) All of the cut-offs capture a significant proportion of the UK population – the lowest cut-off, the top 20 areas, captures nearly a third of the population.

b) At the same time, the cut-off areas account for a relatively small proportion of the UK's geographic landmass – the largest cut-off, the top 80 areas, accounts for just over 4% of the UK.

4.34 We note that all three options are broadly in line with the UK Spectrum Policy Forum's (SPF) recommendation of defining a 'high-demand zone' covering 1-3% of the UK, although the SPF recommendation did not specify the particular UK geography those numbers applied to.[76]

**Table 4.1: Population and area statistics for different high density area options**

| | Area ($km^2$) | Area (% of total) | Population | Population (% of total) |
|---|---|---|---|---|
| **Top 20** | 5,736.33 | 2.37 | 20,211,520 | 32.00 |
| **Top 40** | 7,558.43 | 3.12 | 24,429,717 | 38.68 |
| **Top 80** | 10,047.67 | 4.14 | 29,677,833 | 46.99 |
| **Total UK** | **242,495.00** | **100** | **63,159,035** | **100** |

*Source: Ofcom; population statistics from 2011 UK Census*

4.35 Table 4.2 below shows the ranking for the potential high density areas in our analysis. The table segments the areas according to whether they are in the top 20, top 40, or top 80.

[76] The UK SPF recommendations are available on the techUK website.

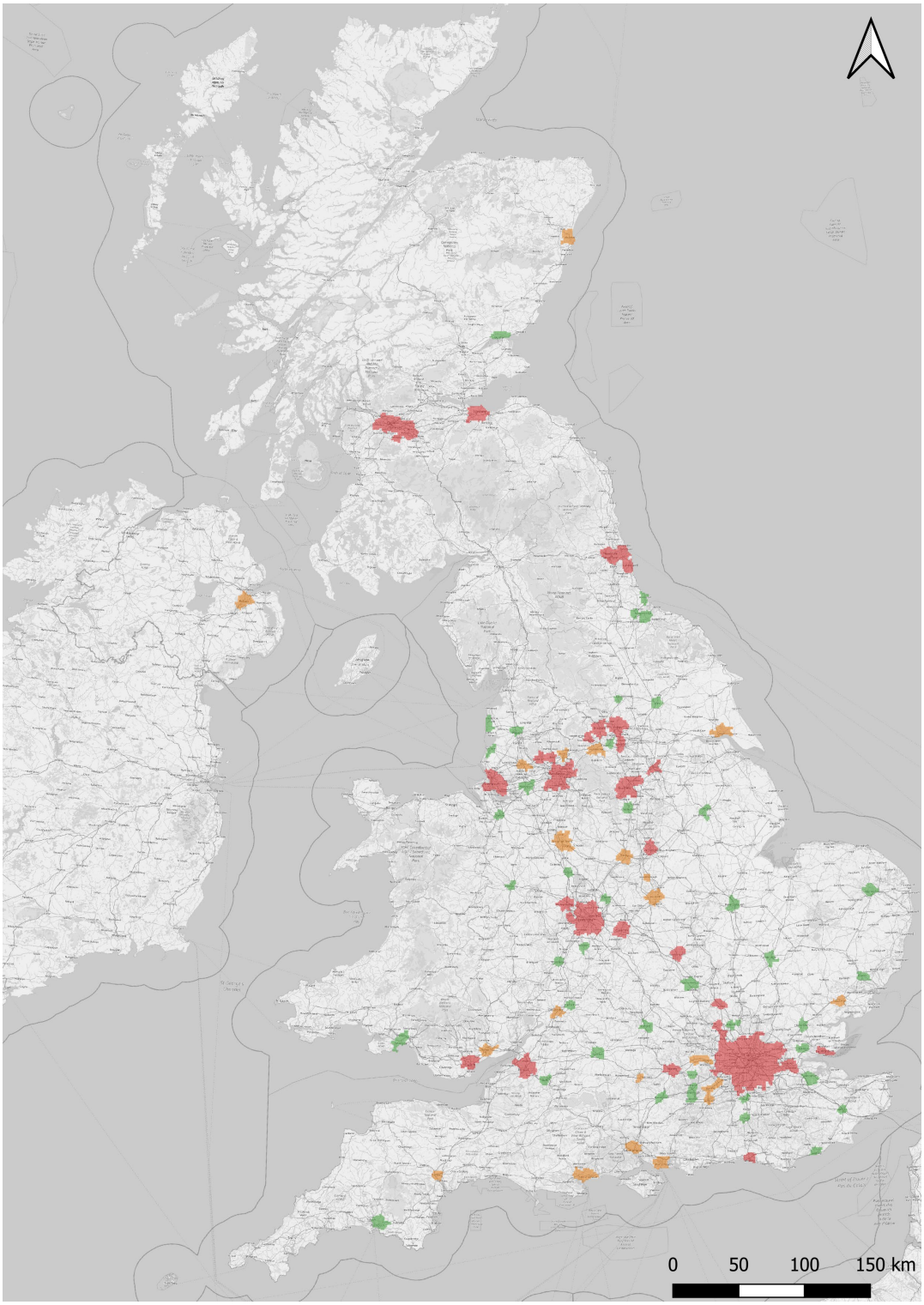
**Table 4.2: Proposed high density areas in order of ranking (colours correspond to map below)**

| Top 20 | Top 21-40 | Top 41-80 | |
|---|---|---|---|
| Greater London | Belfast | Plymouth | Blackpool |
| Greater Manchester | Aberdeen | Chester | Bath |
| Greater Glasgow | Stoke-on-Trent | York | Dundee |
| Greater Birmingham | Leicester | Oxford | Basildon |
| Cardiff | Huddersfield | St Albans & Hatfield | Farnborough & Aldershot |
| Tyne & Wear | Guildford, Woking & Weybridge | Peterborough | Tamworth |
| Bristol | Southampton | Shrewsbury | Dewsbury |
| Liverpool | Colchester | Cambridge | Swindon |
| Edinburgh | Exeter | Ashford | Lincoln |
| Leeds & Bradford Area | Hull | Norwich | Chesterfield |
| Sheffield | Bournemouth & Poole | Milton Keynes | Southport |
| Reading | Rochdale | Crawley | Ipswich |
| Nottingham | Newport | Redhill & Reigate | Harrogate |
| Wolverhampton | Derby | Medway Towns | Cheltenham |
| Northampton | Wigan | Stafford | Bracknell |
| Southend | Loughborough | Chelmsford | Basingstoke |
| Brighton | Portsmouth & Gosport | Hartlepool | Warrington |
| Doncaster | Gloucester | Preston | Redditch |
| Luton | Slough & Maidenhead | Middlesbrough | Worcester |
| Coventry | Newbury | Swansea | Hastings |

*Source: Ofcom*

4.36 Figure 4.5 is a graphical representation of Table 4.2, showing a map of the potential high density areas segmented according to whether they are in the top 20 (red), top 40 (red and amber) or top 80 (red, amber and green).

**Figure 4.5: Map of proposed top 20 (red), top 40 (red and amber) and top 80 (red, amber and green) high density areas**




*Source: Ofcom; base map © OpenStreetMap contributors; N.B. Orkney and Shetland not shown as no areas there are potential high density areas*

4.37 We are minded towards the middle option of **the top 40 areas**. We provisionally prefer this cut-off point because we think it strikes a reasonable balance between the risks associated

with 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 deployments are likely to be fewer in number as high density areas would risk underutilisation of spectrum. We invite stakeholders' comments on our proposed options, and on our current preference for 40 areas.

## Approach to potential demand hotspots outside high density areas

4.38 There are some locations outside high density areas which could also potentially be hotspots of demand for mmWave spectrum for new uses. For example, airports, train stations and sports stadia could all potentially be areas of high footfall where mmWave spectrum could be used to provide high-capacity data services. We have considered whether to create specific additional high density areas for these locations, or if we should incorporate them into the nearest existing high density area.

4.39 We have provisionally concluded this would not be necessary for two main reasons. Firstly, the majority of major sports stadia and train stations, and a significant number of major airports, would be within our proposed high density areas, as shown in Table 4.3 below.

**Table 4.3: Airports, train stations and stadia included under different high density area options**

| Which areas? | Airports included (>1m passengers, 2019) | Train stations included (>5m footfall, 2019) | Stadia included (capacity >20k) |
|---|---|---|---|
| **Top 20** | 7 | 84 | 45 |
| **Top 40** | 9 | 92 | 57 |
| **Top 80** | 9 | 104 | 63 |
| **Total UK** | **23** | **111** | **71** |

*Source: Ofcom; airport data from Civil Aviation Authority;[77] train station data from Office of Road and Rail;[78] stadium data from Wikipedia[79]*

4.40 Secondly, 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, as outlined in section 8. We consider this should be sufficient to provide spectrum access to users looking to deploy in these hot spot areas.

4.41 Therefore our initial view is that extensions or additions to our proposed high density areas are not required, and a distinct approach does not need to be established for these potential hotspots.

[77] CAA, Annual airport data 2019, Table 8: Air Pax by Type and Nat of Op, 'total terminal and transmit passengers'.
[78] ORR, Station usage 2018-19 data, sum of 'Entries & exits (2018-19)' and 'Interchanges (2018-19)'.
[79] Wikipedia, List of stadiums in the United Kingdom by capacity.

## Consultation questions

**Question 7**: Do you agree with our proposed methodology for identifying and defining high density areas?

**Question 8**: Do you agree with our proposed cut-off point of 40 high density areas?

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

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 points.

5.2 Our coexistence analysis indicates that the protections necessary to keep fixed links in the band (without them suffering interference from new wireless services) could impose a material constraint on spectrum availability for new uses in high density areas.

5.3 We have considered the following options for our approach to fixed links operating in the 26 GHz band, in light of our proposals to make the band available for new uses:

a) **Option 1**: No Ofcom-led clearance of fixed links from the 26 GHz band; new users would negotiate access to spectrum with existing users when needed.

b) **Option 2**: Clear all fixed links from the 26 GHz band, in all areas of the UK.

c) **Option 3**: Clear fixed links from the 26 GHz band in and around high density areas only.

5.4 Our initial view is that option 3 would be most likely to meet our objectives for authorising mmWave spectrum for new uses, without imposing disproportionate costs on existing users.

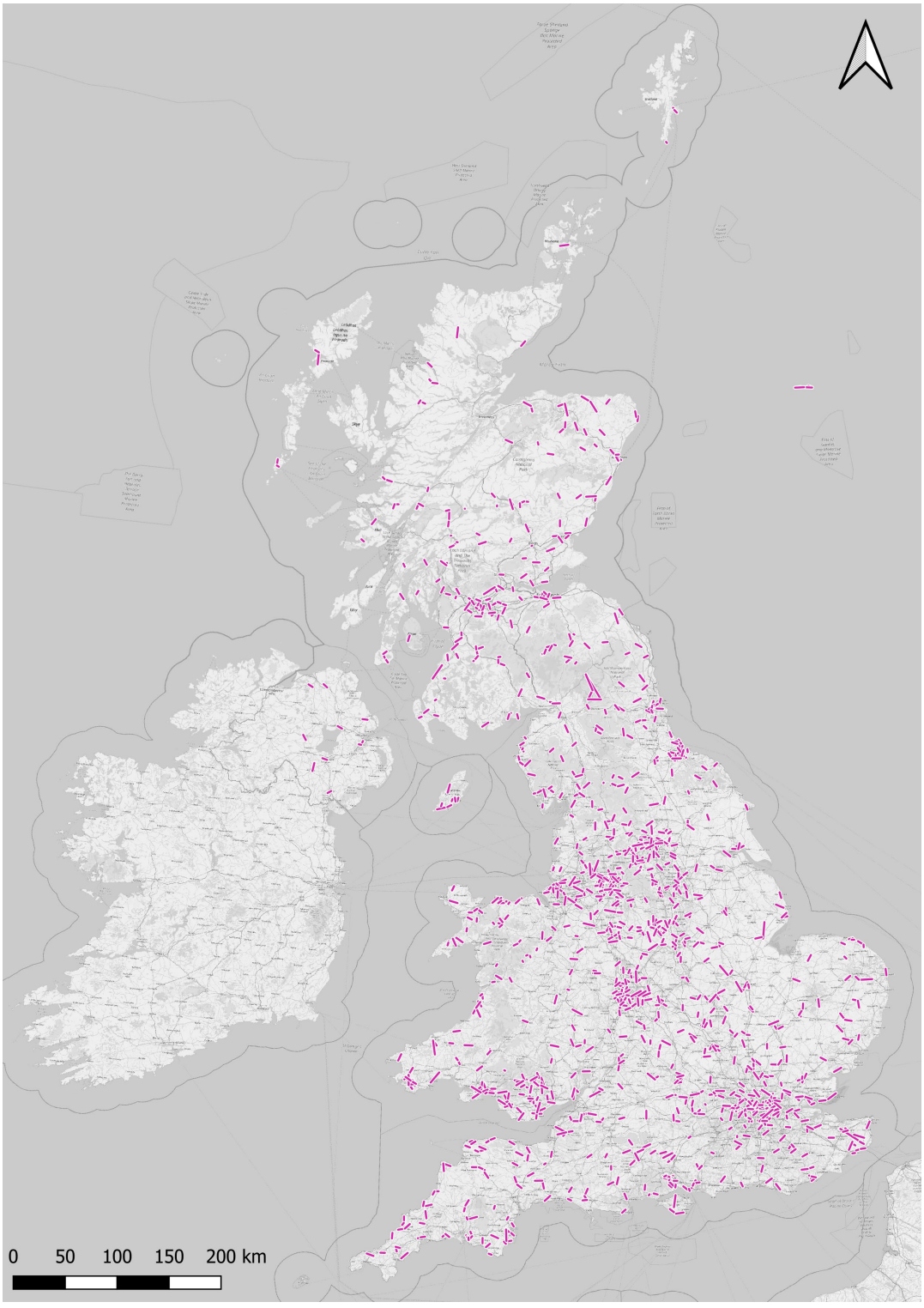
5.5 We are therefore proposing to clear fixed links in and around high density areas only, giving affected users five years' notice of the revocation in line with the conditions outlined in their licences. We expect there to be sufficient spectrum in other bands available for fixed links to accommodate the fixed links that would be cleared from the 26 GHz band. In other areas of the UK, we propose that fixed links would remain in the band.

## Current state of the 26 GHz fixed link band

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 7 February 2022, there are 1,334 fixed links in the 26 GHz band, across the frequency range 24.5-26.5 GHz. There is no spectrum available for fixed links between 24.25-24.5 GHz, or from 26.5-27.5 GHz.

5.7 The links in this band can be found all across the UK, but are more densely concentrated around the country's largest cities, as shown in Figure 5.1 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 of the UK, showing fixed links (purple) in the 26 GHz band as of 7 February 2022**




*Source: Ofcom; base map © OpenStreetMap contributors*

5.8 The 26 GHz fixed links are operated by 40 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,[80] and the top 12 users account for 93% 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 |
|---|---|
| **Airwave** | 776 |
| **Vodafone** | 131 |
| **MBNL** | 95 |
| **WPD Telecoms** | 69 |
| **M247 UK** | 54 |
| **BT** | 45 |
| **Aquila Air Traffic Management Services** | 14 |
| **New Line Networks** | 14 |
| **EE** | 12 |
| **Zycomm Electronics** | 11 |
| **Arqiva** | 10 |
| **McKay Brothers International** | 10 |

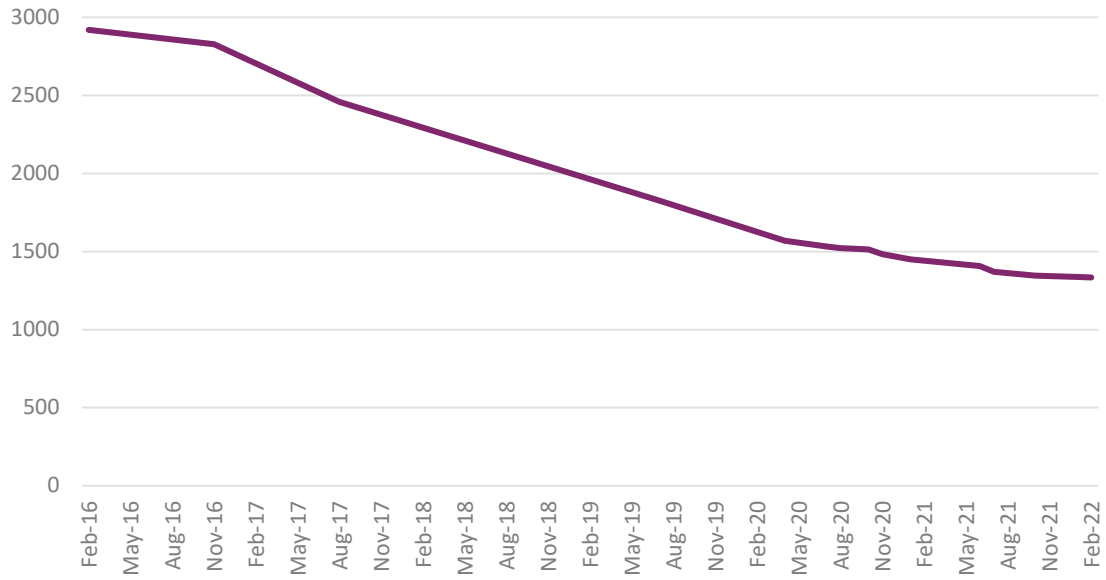
*Source: Ofcom*

5.9 In common with a number of other Ofcom-managed fixed link bands, our coordination procedure has prioritised lower frequency channels for fixed links, which means that lower frequency channels in the 26 GHz band tend to have a greater number of fixed links than the higher frequency channels.

5.10 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 that we intend to open up the 26 GHz band for the use of mobile technologies, including 5G.[81] 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.

[80] Airwave's contract to provide the current emergency services network expires in 2026.
[81] See paragraph 2.9 for full details.

**Figure 5.2: Number of fixed link licences in the 26 GHz band over time, 2016-present**




*Source: Ofcom*

## New uses are likely to be constrained by the need to avoid interference to existing fixed links

5.11 We have assessed coexistence between prospective new uses of the 26 GHz band, and existing fixed links. New uses and fixed links would need to be coordinated, in order to manage the risk of new services causing interference to fixed links.[82] As part of this analysis we have assessed how much spectrum could be available for new services in high density areas, if we were to coordinate new uses around existing fixed links. We refer to this as our 'spectrum availability analysis'. The results of this analysis inform the options that we are considering for managing existing fixed link licensees in the 26 GHz band, in enabling new uses in the band.

5.12 For this analysis, we have modelled the spectrum availability for new uses in six prospective high density areas, using our standard protection criteria for fixed links. We have considered both low power deployments (e.g. mobile hotspots) and medium power deployments (e.g. fixed wireless access (FWA) or mobile macro cell).[83]

5.13 Table 5.2 below summarises the high level results of this analysis, showing the availability of 200 MHz channels for these two types of deployments. We have shown the results separately for the portion of the band where deployments would be co-channel with fixed

[82] ECC Report 303, *Guidance to administrations for Coexistence between 5G and Fixed Links in the 26 GHz band*, approved June 2019, said "The results of all studies for the outdoor 5G network deployment scenarios show that coexistence between both services is possible but requires coordination".
[83] Specifically, we modelled low power deployments 6 m above ground and medium power deployments 15 m above ground.

links, and to the portion of the band with no fixed link use. The percentages shown are the percent of locations in high density areas where those frequencies are available. [84]

**Table 5.2: Summary of 200 MHz channel location availability for new uses in the 26 GHz band**

| | **26 GHz** | |
|---|---|---|
| ***New wireless system power level*** | Co-channel with fixed links<br>**2 GHz bandwidth**<br>24.5-26.5 GHz | Not co-channel with fixed links<br>**1.25 GHz bandwidth**<br>24.25-24.5 GHz; and<br>26.5-27.5 GHz |
| **Low power** | > 97% | > 99% |
| **Medium power** | 65-90% | > 99% |

*Source: Ofcom*

5.14 As this summary shows, the presence of existing fixed links reduces spectrum availability for new uses in the parts of the 26 GHz band where fixed links currently operate (between 24.5 GHz and 26.5 GHz). This is much more significant for medium power deployments than for low power deployments, where the spectrum is available in only 65-90% of locations. This range reflects the fact that some high density areas have more fixed links deployments than other high density areas.

5.15 We have also considered the availability of larger channel sizes, i.e. 400 MHz and 800 MHz. Our analysis shows fixed links would further reduce the location availability of these larger channel sizes for new uses, particularly for medium power deployments. This is because there is a greater likelihood that wider bandwidths will be co-channel with one or more nearby fixed links. Given operators may be looking to acquire large amounts of mmWave spectrum, potentially 1 GHz or more, we think operators could credibly want to make use of larger channel sizes.

5.16 The location availability for 200 MHz channels for new uses in the portions of the band where there is no fixed link use is greater than 99%. We note that this comprises a smaller proportion of the band (1.25 GHz out of 3.25 GHz, consisting of a 250 MHz block at the bottom of the band, and a 1 GHz block at the top of the band).

5.17 Overall, we therefore consider that fixed links in the 26 GHz band could impose a material constraint on spectrum availability for new uses. We will be conducting further work and measurements to understand the appropriate interference management approaches to protect fixed links, for the length of time they remain in the band.

5.18 The details of our technical analysis are explained in annex 6.

[84] We modelled availability in six prospective high density areas: Edinburgh, Greater Birmingham, Greater Glasgow, Greater London, Greater Manchester and Tyne & Wear.

## Options for enabling the band for new uses

5.19 Given that our coexistence analysis indicates that the presence of fixed links in the band could limit availability of spectrum for new users, we have 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 have assessed the options outlined below.

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

5.20 Under this option, we would not actively clear existing users. Instead, we would leave it up to new users to enter into commercial negotiations with operators of existing fixed links in the band to clear individual fixed links, where they pose a constraint to new deployments. We would still propose to assign both citywide licences and local Shared Access licences in high density areas, as set out in section 4.

5.21 The citywide licences would be overlay licences which would grant access to spectrum across an entire high density area, including the locations where fixed links are operating. The citywide licensee would be allowed to deploy anywhere in that high density area, provided that it did not create harmful interference to existing fixed link users.[85] Existing users would therefore have priority access to the spectrum in a given area. However, should an existing user return a licence to Ofcom, the overlay licensee would then have access to the area that has just been vacated by that particular user. Holders of citywide licences would also be able to negotiate with fixed link operators to make spectrum available in the areas where it is needed most, if the amount of spectrum available in a given location was insufficient.

5.22 All new deployments would be subject to coordination in both low and high density areas, until there were few enough fixed links that Ofcom could reconsider whether coordination remained necessary. While fixed links remain in the band, these will also have an impact on the availability of spectrum for applicants for Shared Access licences in high density areas (between 24.25-25.1 GHz).

### Option 2: Clear all links

5.23 This approach would involve revoking all fixed link licences in the 26 GHz band, across the entirety of the UK, giving five years' notice. After five years had passed, the entire 26 GHz band would be available for new users in all locations. In other words, if we were to issue licence revocation notices in early 2023, we would expect the band to be clear of fixed links by early 2028. Individual licensees may decide to hand back their licences earlier than this.

[85] Note that wide area overlay licences would only apply to citywide licences that overlap with fixed link frequencies, 25.1-26.5 GHz. Award licences in 26.5-27.5 GHz would not be affected by fixed links.

5.24 This option would require fixed link operators to move all of the fixed links that operate in the 26 GHz band to alternative spectrum bands, or otherwise cease providing the services carried on those links. We consider that there is sufficient spectrum available in other bands to accommodate fixed links migrating from the 26 GHz band. We explain this in more detail below when considering the costs of moving fixed links.

5.25 During the five-year revocation notice period, we would expect coordination with fixed links to be required in all areas of the UK.[86] Once the notice period has passed, no coordination would be needed in any part of the UK between new users and fixed links. However even in this case, as outlined in more detail in section 8, we expect that some coordination will still be needed for users applying for Shared Access licences to make sure that these new users can coexist with each other and other existing users in specific locations.

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

5.26 Under this option, we would revoke only those fixed links which overlap with high density areas, **and** those which we expect would receive interference from new users deploying within those areas. The latter would cover fixed links that are located outside of high density areas, but are in close proximity to, or are pointing in the direction of, high density areas.[87] This option would make all spectrum in the 26 GHz band available for new users to access within high density areas, after the end of the five-year revocation notice period.

5.27 As with the option of clearing all links, affected users would be given five years' notice of the revocation of their licences. This means that, assuming we issue notices of revocation in early 2023, in the relevant areas all fixed links would have left the band by early 2028. The relevant areas could be clear earlier, if licensees decided to hand back their licences before the end of the notice period.

5.28 The remaining links in the band (i.e. those in low density areas which would not receive interference from deployments in high density areas) could remain in the band, as we do not expect these to materially constrain deployments by new users. In low density areas we expect deployments by new users to be highly localised, and there should be sufficient spectrum available.

5.29 In high density areas, coordination would be needed during the revocation period, but not after this.[88] In low density areas, coordination would be required indefinitely to avoid harmful interference from new users to any existing fixed links. As described above, and in detail in section 8, we expect that some coordination would still be needed for these new users in any case.

[86] Citywide licences in high density areas would be overlay licences until fixed link licences were revoked, as described in option 1.
[87] We explain this further from paragraph 5.75 onwards.
[88] Citywide licences in high density areas would be overlay licences until fixed link licences were revoked, as described in option 1.

5.30 As we are consulting on different options for how many high density areas we should adopt, it is not possible to say at this stage precisely which fixed links would be cleared and how many. However, assuming 40 high density areas (based on our preferred option set out in section 4), we estimate that under this approach a minimum of around 30% of links **would** need to be cleared as they overlap with high density areas; up to around 60% of links **might** need to be cleared in total, taking into account links around the high density areas.

# Analytical framework for assessing options

5.31 Ofcom has a statutory power to revoke spectrum licences. However, we may not revoke a licence unless the proposed revocation 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.[89]

5.32 The factors that we have taken into account in assessing the three options outlined above, and whether the revocation of fixed link licences would be objectively justifiable and proportionate, include:

a) 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) Promoting competition, which encompasses our objective of sustaining strong competition in mobile markets;
c) Securing benefits for consumers and citizens; and
d) The impact on spectrum users in the band, aiming to meet our objectives for mmWave without imposing disproportionate costs on existing users.

# Securing optimal use of spectrum

## Achieving an efficient allocation

5.33 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 that will use the spectrum to provide the most value to society.

5.34 In the case of the 26 GHz band, it is possible that existing fixed link users would be the highest value user in some locations. This is because, while we expect new users would provide high value services, they are likely to only want to deploy extensively in high density areas.

[89] See paragraphs A5.18-A5.21.

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

5.35 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 over-clearance of the band.[90]

5.36 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. 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

5.37 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.

5.38 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

5.39 Clearing only 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.

5.40 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.[91] This option reduces the risk of over-clearance of fixed links compared to option 2.

## Supporting innovation and investment

5.41 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. Similarly, innovation will support the development of new services

[90] By over-clearance, we mean clearing fixed links in areas where they could plausibly be the highest value user due to no new user having plans to deploy in the same area.
[91] Ofcom, *Supporting the UK's wireless future: Our spectrum management strategy for the 2020s*, July 2021, page 12.

to the benefit of people and businesses, and lead to ongoing benefits from the spectrum in the future. This spectrum in particular 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.[92]

5.42 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**

5.43 As discussed above, our analysis indicates spectrum availability for low power deployments using 200 MHz channels is good, even in high density areas where fixed link deployments are more densely packed. In these areas, which are currently the most congested, we expect spectrum to be available for new low power deployments across most of the band even if fixed links remain.

5.44 However, 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 outlined above and in detail in annex 6 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,[93] 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.

5.45 As outlined above, we understand that 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, this option is less likely to support innovation and investment.

5.46 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 under consideration, in particular for holders of citywide licences, who would have to coordinate new deployments in the long run under this option. This could be particularly burdensome for prospective citywide users who are unaccustomed to coordinating deployments with other users.

[92] We set this out in more detail in section 2, in relation to our policy objectives for this award.
[93] By this we mean that each fixed links uses two channels, one in the lower part of the band and one in the upper part. For example, a link with a 3.5 MHz bandwidth in channel 1 (i.e. lower channel 1, as well as upper channel 1) transmits at 24.55075 GHz, as well as 25.55875 GHz.

### Option 2: Clear all links

5.47 Clearing the band of all links would provide the most certainty for all new users (including those in low density areas) 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 discussed in section 6). This would also support the use of large, contiguous blocks of spectrum, which we expect would support investment and innovation in new services.

5.48 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 citywide licensees, and Shared Access licensees in both high and low density areas. However, as explained in more detail in section 8, 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

5.49 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.

5.50 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. 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

5.51 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 mmWave spectrum should be made available in a timely manner for new uses. We are therefore aiming to make mmWave spectrum available by 2024, which is around when we understand mmWave deployments for new uses are likely to begin.[94]

5.52 Under all options, we would look to follow the same timeline for authorising new users under our proposals set out in section 3. There would therefore be no material difference

[94] We set this out in more detail in section 2.

in the timescales that operators would be able to acquire licences in the 26 GHz band between any of the options.

5.53 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

5.54 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.

5.55 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

5.56 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

5.57 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 citywide licensees.

## Promoting competition

5.58 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 citywide 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).

5.59 Additionally, as noted in paragraph 5.36, we consider it is possible that option 1 could risk existing fixed link licensees, some of whom are operators who may bid in an auction for citywide licences 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.

5.60 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

5.61 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.

5.62 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.

## Impact on existing spectrum users

### Cost of moving fixed links

5.63 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. More details on our modelling exercise are set out in annex 8.

5.64 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.

5.65 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.[95] Please note that the cost per link does not alter based on these three options, only the overall total cost across all licensees.

[95] In annex 8 we have also indicated alternative higher cost estimates, based on different assumptions which we believe are relevant, but less likely.

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

5.66 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

5.67 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 £1.3m on existing fixed link users in the 26 GHz band.

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

5.68 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. The total cost of this option would therefore depend on the number of high density areas we decide to adopt. As outlined in section 4, we are proposing a total of 40 high density areas, and based on this proposal, we estimate that this approach would incur a total cost of around £0.8m on fixed link users in the band. Table 5.3 below outlines our estimates for the costs of clearance of the band under the alternative options we have considered for the number of high density areas, as well as for clearing all links, as outlined in option 2 above.

**Table 5.3: Total costs for clearance of 26 GHz fixed links, based on different high density area options (baseline scenario)**

| High density areas option | Maximum % of fixed links to be revoked | Estimated cost of revocation (£m) |
|---|---|---|
| **Top 20** | 52% | 0.7 |
| **Top 40** | 61% | 0.8 |
| **Top 80** | 73% | 1.0 |
| **All UK** | 100% | 1.3 |

*Source: Ofcom*

## Risk of undue discrimination

5.69 Our initial view is that none of the options would amount to undue discrimination against any existing fixed link operators. We note that 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 because fixed link operators are not all in the same position, due to the different geographic distribution of their deployments in the band.

### Legitimate expectation

5.70 We have also considered whether any of the existing 26 GHz fixed link licensees might have a legitimate expectation that we would not revoke their licence. In this regard, we note that the existing 26 GHz licences have been issued with terms enabling Ofcom to revoke the licences, and these terms have remained part of all licences since they were issued. Furthermore, since 2017 Ofcom has consistently said that the future of the 26 GHz band would involve the introduction of new wireless services, including 5G.[96]

5.71 Therefore, our view is that no fixed link licensee has any reasonable expectation that Ofcom would not revoke their licence.

## Provisional conclusions

5.72 In light of the above, our initial view is that clearing from the 26 GHz band the fixed links in and around high density areas only (option 3) would be most likely to meet our objectives for mmWave spectrum, without imposing disproportionate costs. Our initial view is therefore that revocation of existing licences under option 3 would be objectively justifiable and proportionate.

5.73 Compared to alternative options, this approach is more likely to lead to an efficient use of spectrum, with existing fixed links continuing to operate in more remote areas and new users providing new services in high density areas. It would also promote investment and innovation, allowing new users in high density areas access to large, contiguous blocks of spectrum, while mitigating the risk of over-clearing the band. Finally, we think this option would ensure that new users will be able to access the spectrum they need without imposing disproportionate costs on existing users since (i) fixed links will remain in the 26 GHz band where coexistence allows (i.e. in most of the low density areas of the UK) and (ii) the cost to existing licensees deriving from clearing the band in high density areas would be relatively low. We also consider there would also be sufficient spectrum available in other spectrum bands to accommodate all of the fixed links that would be cleared from the 26 GHz band.

5.74 We anticipate the approach we have outlined will result in better services for people and businesses, and will impose relatively low costs on current licensees. Therefore, we propose to clear from the 26 GHz band the fixed links in and around high density areas (option 3). The remaining links in the band (i.e. those in low density areas which would not receive interference from award winners in high density areas) would be able to remain in the band. We would coordinate the deployments of new users in these areas (see section 8 for more information) to ensure appropriate protection.

[96] See paragraph 2.9 for full details.

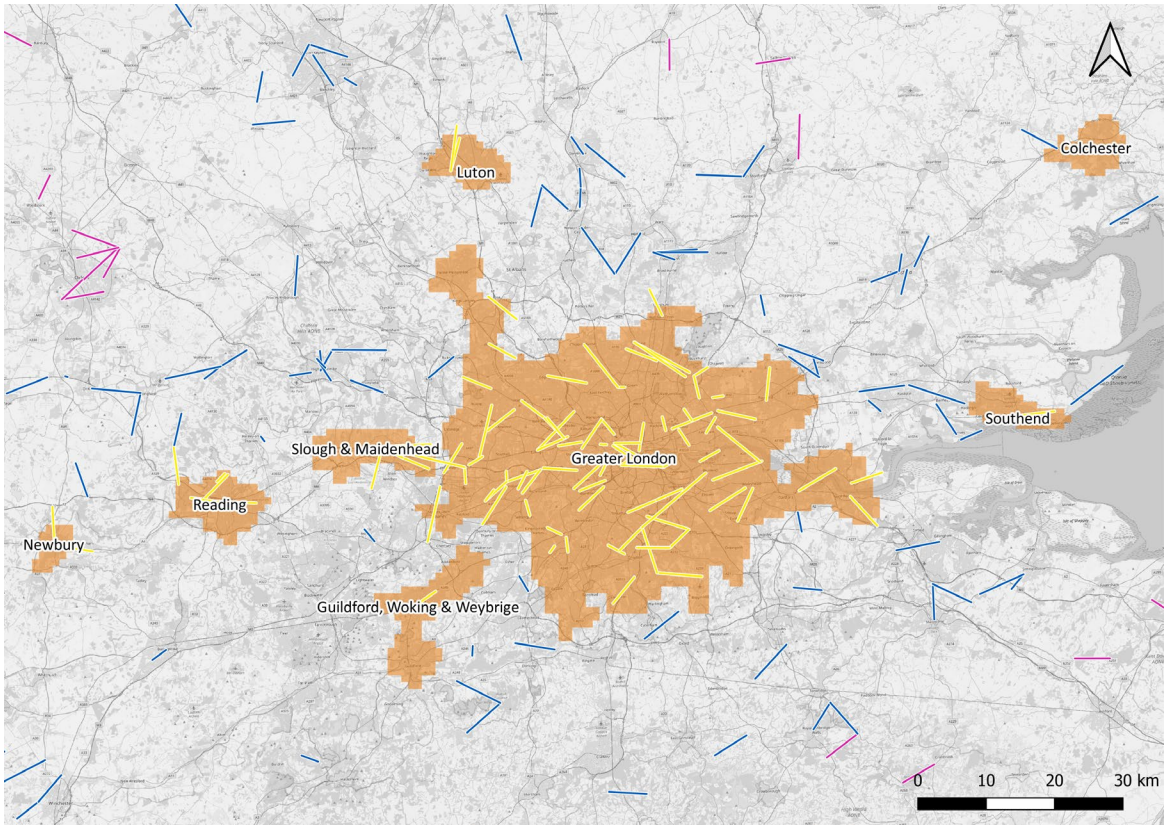
## Fixed links to be cleared under option 3

5.75 Precisely which fixed links would need to be cleared will depend on the number of high density areas we define, and would be subject to coordination calculations. The protection zones necessary to protect fixed links from co-channel interference are highly directional and the exact distances will vary based on link power, height and local clutter. We discuss this in more detail in annex 6, which outlines our analysis on coexistence and spectrum availability in the 26 GHz band.

5.76 For fixed links outside high density areas, the direction these links are pointing will be a key determinant of whether they need to be cleared. Figure 5.3 below shows links in and around the southeast of England, with prospective high density areas within the top 40 (including Greater London) highlighted in orange. Yellow links are those which **would** need to be cleared, as these overlap with high density areas; blue links **might** need to be cleared, and those pointing towards high density areas are more likely to need to be cleared; and purple links are those we currently expect should be able to stay in place.

5.77 Note that we would **not** expect all links marked as blue on the map below to be cleared. As explained above, those pointing away from high density areas are more likely to be able to remain, and this would be determined by our detailed coordination calculations further down the line.

**Figure 5.3: Map showing 26 GHz fixed links in southeast of England, including prospective high density areas within top 40 category in orange**




*Source: Ofcom; base map © OpenStreetMap contributors*

5.78 Our current estimate is that, depending on how many high density areas we decide to adopt, between around 20% and 35% of links **would** need to be cleared (as they overlap with the high density areas). However, between around 50% and 70% of links **may** need to be cleared in total, subject to coordination, once we include links that do not themselves overlap the high density areas but may receive interference from them. Figures for our different high density area options are shown in Table 5.4 below.

5.79 Based on our preferred option outlined in section 4, of 40 high density areas, we expect that around 30% of links would need to be cleared as they overlap with these areas, but up to around 60% of links may need to be cleared in total when considering those which might receive interference from within the high density areas.

**Table 5.4: Current estimates for how many links may need to be cleared based on different high density options**

| High density areas option | % of fixed links that would need to be cleared (overlapping with high density areas) | Maximum % of fixed links that may need to be cleared (overlapping, and within 25 km of, high density areas) |
|---|---|---|
| **Top 20** | 23% | 52% |
| **Top 40** | 29% | 61% |
| **Top 80** | 37% | 73% |

*Source: Ofcom*

## Next steps

5.80 If we decide to clear any fixed links from the 26 GHz band following this consultation, we would start the statutory process for revoking the relevant licences by notifying the relevant licensees of the proposed revocation of their licence.[97] We would start that process only after publishing our statement confirming our approach, which we are aiming to do in Q3 2022/23.

5.81 During the five-year notice period for revoking fixed link licences, coordination of new users in the high density areas would be necessary to ensure that existing fixed links do not suffer harmful interference from new users.

[97] WT Act 2006, Sch. 12, paragraphs 6-8.

## Consultation questions

**Question 9**: Do you agree with our proposal to clear the fixed links in and around high density areas from the 26 GHz band?

**Question 10**: Do you agree with our estimates of the cost of migrating fixed links into alternative spectrum bands?

# 6. Approach to other existing users of the 26 GHz band

## Summary

6.1 In addition to the fixed link operators discussed in section 5, other users with access to the 26 GHz band include satellite earth stations, level crossing radar used by Network Rail, ultra-wideband (UWB) radar and a range of different licence-exempt short-range devices (SRDs). There is also an allocation for programme-making and special events equipment (PMSE) from 24.25-24.5 GHz, and the Ministry of Defence (MOD) has access to the band. Since we are proposing to make the band available for new uses, we have considered whether these existing users would cause interference to, or suffer interference from, new users.

6.2 In summary, we propose that most existing uses would 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. Specifically, we are proposing the following measures to manage coexistence between existing users of the 26 GHz band and new uses:

a) **Satellite earth stations**: we propose to protect the one existing receive-only satellite earth station which is currently using the band through coordination; we would 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 short-range radar**: we do not expect that these users will cause interference to, or suffer interference from, new users of the band. Therefore we propose to allow them to remain in the band, 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 there have been no licences issued in the band since 2014. We propose to close the 26 GHz band to future PMSE licences, giving five years' notice.

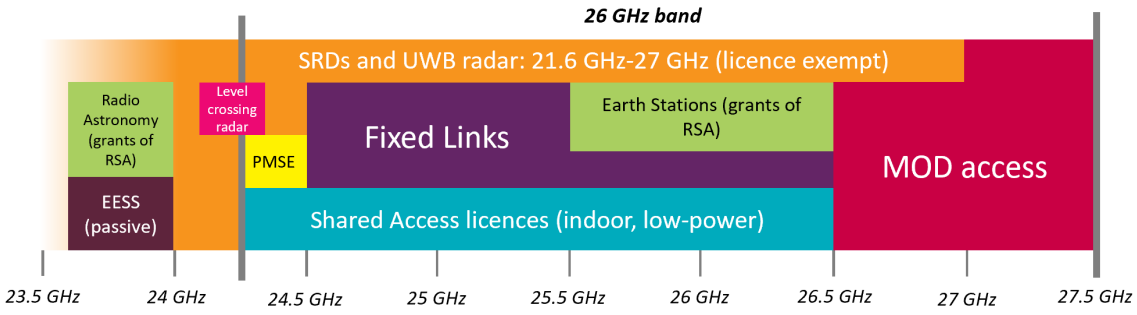
d) **Airport security scanners**: we propose to write to airports which may be using these devices to notify them of potential coexistence challenges if a 26 GHz 5G base station were to be placed nearby.

e) **MOD**: we propose to manage future access to the 26 GHz band by the MOD 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.

f) **Users in the adjacent 24 GHz band**: we have set out our proposals in our December 2021 consultation on protecting radioastronomy and passive sensors used as part of the Earth Exploration Satellite Service at 23.6-24 GHz and expect to publish a statement confirming our approach later this year.

6.3 In the rest of this section, we explain each of the different existing users in the 26 GHz band and the rationale for our proposals.

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




## Satellite earth stations

6.4 Grants of Recognised Spectrum Access for receive-only earth stations ('grants of RSA') are available in the 25.5-26.5 GHz frequency range. If a satellite earth station operator has a grant of RSA, Ofcom must take them into account in planning and managing the radio spectrum, on a comparable basis to a licensed use.[98] It is also possible for receive-only earth stations to operate on a licence-exempt basis without a grant of RSA, however this is at their own risk as without a grant of RSA they do not receive any protection from other users.

6.5 At present, there is one earth station operating in this band under a grant of RSA in the UK, on the Harwell research campus in Oxfordshire. The grant is held by Airbus and relates to an installation used by the European Space Agency to downlink traffic from Earth observation satellites as part of the European Data Relay System.

6.6 Based on our technical analysis, we do not expect the protections needed to maintain the Harwell earth station would impose a material constraint on the ability of operators to deploy new mmWave base stations. This is because the Harwell site is located in a rural area and we expect the restrictions necessary to protect it would not extend beyond around 20 km in any direction. Additionally, at the upper end of this distance it is likely that only higher power base stations on higher ground, with antennas facing towards the Harwell site, would be limited by these restrictions.

6.7 Therefore, we propose to continue to take account of this grant of RSA by restricting new deployments in the 25.5-26.5 GHz frequency range close to the Harwell earth station, in line with the protection granted by the existing grant of RSA. We intend to consult on the details of any such restrictions in our next consultation.

6.8 We are also proposing **not** to 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**

[98] WT Act 2006, section 20.

(which we outline in section 4). We do not expect that this is likely to cause a material constraint on the siting of any future earth station in this band, as satellite earth stations tend to be located outside of dense urban areas.

6.9 The band would continue to be open to new applications for satellite earth stations operating under grants of RSA **in low density areas**. Applications would be granted on a first come, first served basis and subject to coordination with existing users (as is currently the case).

### Potential for further 500 MHz extension

6.10 In our recent space strategy consultation, we said that we would consider extending the availability of grants of RSA by an additional 500 MHz (i.e. 26.5-27 GHz),[99] in line with the internationally harmonised allocation for this use, if there is clear evidence that this would be beneficial.

6.11 Should we decide to do this, then sites holding a grant of RSA in this additional bandwidth would benefit from protection (on a first come first serve basis) from other users, in the same way as they do now in 25.5-26.5 GHz. As above, we would propose that this additional bandwidth be available for grants of RSA for sites in **low density areas** only. We would not expect this to pose a material constraint to new uses in the 26 GHz band as we would not expect dense deployment of new mmWave services in the locations where satellite earth stations would be operating.

## Level crossing radar

6.12 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. In June 2020, following a consultation in December 2019, Ofcom confirmed that we would be transferring these level crossing radars from their existing licence-exemption regime to a specific licence to be held by Network Rail, in order to make sure that these systems could be deployed in as wide a range of locations as possible.

6.13 We have carried out technical work which has indicated that these radar systems are very robust against interference, and based on this we expect that new users in the band are unlikely to pose a risk of interference to these systems. We also understand that 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.

6.14 Therefore, we propose to allow level crossing radar sensor systems to remain in the band, and we do not expect any form of coordination to be necessary.

[99] The reason this allocation is only 1 GHz in the UK is due to MOD use of the spectrum from 26.5-27.5 GHz.

## Programme Making and Special Events (PMSE) equipment

6.15 The 24.25-24.5 GHz range is currently available to users of PMSE equipment, who can apply for a PMSE licence. 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 then, there has been no PMSE usage of this band.

6.16 Given this level of use and the availability of other bands for PMSE users,[100] we propose to close this band for future PMSE licences. We propose to give stakeholders a five-year notice period if we decide to implement this proposal following consultation.

## Ultra-Wideband (UWB) radar

6.17 There are various uses of UWB radar, including ground-penetrating radar and short-range devices used to monitor material quality in walls or structures (e.g. scanning the steel core inside a concrete structure to check its condition). In general, these devices operate at a short range and at low power levels, and do not cause interference to other devices using the same spectrum. UWB radar is licence-exempt, and the conditions governing its use are set out in regulations.[101]

6.18 UWB radar devices operate across a very wide range of frequencies, including several current mobile bands at lower frequencies. We are not aware of any occurrence of harmful interference between UWB radar devices and mobile services in these other bands which would cause us to be concerned about coexistence between UWB radar devices and potential new users in the 26 GHz band.

6.19 We are therefore proposing not to take any specific action to manage the risk of interference to or from UWB radar, as we judge the risk of either to be minimal.

## Short Range Devices (SRDs)

6.20 The 26 GHz band is used by a range of different SRDs on a licence-exempt basis. The conditions governing the use of SRDs are set out in regulations[102] and include the technical conditions in the "IR 2030" (interface requirements) document available on Ofcom's website.

6.21 We expect that these devices should be able to continue to operate without receiving or causing any interference because they operate at a short range and at low power levels.

### Tank Level Probing Radar (TLPR)

6.22 TLPR is used to measure the amount of fluid held in a tank, generally in industrial or manufacturing environments, or in settings such as water purification. This can be useful

[100] See the IR 2038 document on Ofcom's website.
[101] *The Wireless Telegraphy (Ultra-Wideband Equipment) (Exemption) Regulations 2015.*
[102] *The Wireless Telegraphy (Short Range Devices) (Exemption) Regulations 2021.*

when a physical probe inserted into the tank would have some adverse effect on the fluid itself.

6.23 By its nature, TLPR is not likely to cause interference to other devices, as it is designed only to operate in self-contained tanks or vats.

6.24 We are therefore proposing not to take any specific action to manage the risk of interference to or from TLPR, as we judge the risk of either to be minimal.

## Automotive Short-Range Radar (SRR)

6.25 Automotive SRR is used on vehicles to support applications including rear collision warning systems and blind spot detection. The 24.25-26.65 GHz range of frequencies is available for these systems, however this allocation is only temporary.

6.26 In 2005, the European Commission designated the 79 GHz band as the permanent band for the development and deployment of automotive SRR equipment on a licence-exempt basis.[103] However, in order to provide access to spectrum for these services in the more immediate term, the 26 GHz band was made available on a temporary basis as an immediate cost-effective solution to allow the licence-exempt use of automotive SRR devices.

6.27 This band was intended to be used until 2013, by which point automotive SRR equipment in the 79 GHz band would have been developed. However, given significant delays in the development of automotive SRR equipment in the 79 GHz band, a 2011 EC Decision allowed for these systems to continue using the 26 GHz band for longer than originally planned. Specifically, automotive SRR devices in the EU for which a type-approval had been granted before 1 January 2018 can continue to be deployed in vehicles until 1 January 2022. In the UK, Ofcom is currently consulting on proposals to close this band to new devices, however users of existing equipment may continue to use it for so long as they wish to maintain the originally installed equipment (e.g. providing spare parts, etc.).[104] As cars can stay on the road for 10-15 years or longer, it is possible that vehicles using these SRR devices could in theory be in circulation for a long while to come.

6.28 Our understanding is that automotive SRR using this band has not been deployed extensively, either in the UK specifically or Europe more generally. Additionally, as the use of these devices has been harmonised across all EU member states through EC Decisions, we believe that most vehicle manufacturers would have taken steps to switch over to the 79 GHz band or use an alternative technology.

6.29 We propose not to take any specific action to protect existing SRR devices that may be operating in the 26 GHz band as we do not expect that the introduction of new 5G users in the 26 GHz band is likely to create a significant risk of harmful interference for these devices. Similarly, we do not expect automotive SRR devices to cause any interference into

[103] EC Decision 2004/545/EC, then The Wireless Telegraphy (Automotive Short Range Radar) (Exemption) Regulations 2005.
[104] See *Proposals to amend the authorisation conditions for the use of certain Short-Range Devices, published 9 May 2022*.

new uses. However, we would be keen to hear from any stakeholders with experience in this area whether there are any issues we should be aware of which we have not considered.

### Airport security scanners

6.30 Some airport security scanners use mmWave spectrum in the 24-30 GHz range, including several models which are authorised by the Department for Transport for use in UK airports.[105]

6.31 We understand that these are generally limited to airports offering flights to the USA, as the USA's Transport Security Administration has made body scanning a requirement for passengers flying into the country.

6.32 Although generally these are self-contained booths, some types of scanners are more open and involve emissions through the open space between two 'walls'.

6.33 Due to the placement of these devices in controlled parts of airport buildings only, we are proposing not to take any specific action to manage the risk of interference to or from airport scanners using these frequencies, as we judge the risk of either to be minimal. However, if we proceed with our proposals to make the 26 GHz band available for new uses, we would write to UK airports which offer transatlantic flights to advise caution in case any 26 GHz base station were to be placed near to security scanners within these airports.

## MOD

6.34 As outlined in section 2, our intention is to continue to support the MOD's access to the 26 GHz band for future Defence requirements, when and where these arise. MOD has no current uses of this band.

6.35 We intend to coordinate new Defence uses on a first come, first served basis in the portions of the 26 GHz band that we are proposing to make available for Shared Access licences (i.e. 24.25-27.5 GHz in low density areas, and 24.25-25.1 GHz in high density areas). Additionally, we propose to safeguard MOD's access to a minimum amount of spectrum on select MOD sites for future Defence requirements. Ofcom is working with MOD to determine the sites where this safeguard would apply.

## Users in the adjacent 24 GHz band

6.36 The adjacent 24 GHz band is used by passive sensors as part of the Earth Exploration Satellite Service (EESS), as well as for Radio Astronomy Service (RAS) measurements.

6.37 In December 2021, we published a consultation on how we propose to ensure the protection of these users from interference from any future new users of the 26 GHz band.

[105] Department for Transport, *Security scanners (SSc) for aviation security: Guidance*, 19 August 2013.

In that consultation, we explained that we would include limits on the out-of-band emissions of new users in the 26 GHz band, and we consulted on proposals for additional measures to protect passive services in the 24 GHz band. We plan to publish a statement setting out our decision in the second half of 2022.

## Consultation questions

**Question 11**: Do you agree with the proposed approaches we have outlined to manage coexistence between new 5G users and the different existing users in the 26 GHz band? In particular, do you have any views on our proposals to limit future satellite earth stations in this band to low density areas only, and to end access to this band for PMSE users with five years' notice?

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

## Summary

7.1 We are proposing to enable the 40 GHz band (40.5-43.5 GHz) for new uses. This spectrum has been identified globally for mobile and as a 5G band in Europe, with work ongoing to develop harmonised technical conditions for 5G in Europe. We expect the 40 GHz and 26 GHz bands to be functionally substitutable in the long run.

7.2 We want to take a proactive approach in making mmWave spectrum available for new uses, to enable investment in faster broadband, better quality mobile services, and innovation in services. In particular, in making both the 26 GHz and 40 GHz bands available for new uses on a same or similar timeframe, we want to ensure that spectrum availability is not a barrier to innovation.

7.3 The 40 GHz band is currently licensed to H3G, MLL and MBNL, though existing licences do not allow the spectrum to be used for mobile services. We can enable the 40 GHz band for new uses (including mobile use) either by varying existing licences, revoking them and re-allocating the relevant spectrum, or a combination of both.

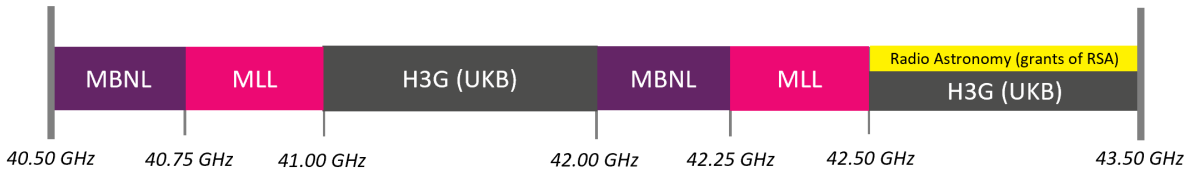
7.4 We set out the options we are considering in paragraph 7.22 below. We have carried out an assessment of each of these options against our objectives, and considered the impact of options on existing licensees. In summary, our provisional view is that the more 40 GHz spectrum that is available for re-allocation alongside the 26 GHz band, the greater the likelihood of meeting our objectives. Under certain scenarios, it is possible that we could achieve our objectives by revoking part of, but not all, existing licences. However, this would depend on how much mmWave spectrum operators are likely to require for delivering quality services.

7.5 We are seeking views from stakeholders on our assessment of options. To further inform our assessment, we particularly welcome evidence of operators' potential mmWave spectrum requirements for new uses, to deliver high quality services to people and businesses.

## Existing users in the 40 GHz band

7.6 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: 40 GHz band showing existing users of the 40 GHz band**




## Block assigned licences currently used for fixed links

7.7 There are three existing licensees in the band – H3G, MBNL, and MLL – who hold block assigned national licences.[106] The band is arranged with a duplex split, with H3G holding 2 GHz (2x1 GHz), and MBNL and MLL each holding 500 MHz (2x250 MHz). These licences were allocated by auction in 2008 on a service and technology neutral basis.[107]

7.8 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.[108] 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. [109] 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.[110] The current technical licence conditions are also not optimal for 5G, noting that harmonised technical conditions are currently in development in CEPT for new 40 GHz wireless communications services.

7.9 The 40 GHz licences are currently used for fixed links. MBNL has the largest number of fixed links in the band, totalling around 4,500 links. H3G has around 60 links.

7.10 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 are limited.[111] Since February 2018, Ofcom has been able to revoke these licences, with five years' notice, for

[106] 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. These licences are published on Ofcom's website.
[107] 10 GHz, 28 GHz, 32 GHz and 40 GHz Award page on Ofcom's website.
[108] 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.
[109] See paragraph 3(a) of Schedule 1 to the 40 GHz licences.
[110] We note that in addition to varying Schedule 1 of the 40 GHz licences, we would also need 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.
[111] 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.

spectrum management reasons.[112] After 21 February 2023, Ofcom may also impose annual licence fees on existing licences.[113]

### Radioastronomy and satellite users in 40 GHz

7.11 In addition to the existing licensees for fixed services listed above, 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. To protect radioastronomy use, an exclusion zone of 50 km applies around the Cambridge radioastronomy site for the relevant frequencies of H3G's 40 GHz licence.

7.12 We propose to continue to protect current radioastronomy use at Cambridge in these frequencies, regardless of which option we pursue for making the spectrum available for new uses. We will review whether the current exclusion zone remains an appropriate mechanism for ensuring coexistence, considering the parameters for new uses operating in this band, in our next consultation.

7.13 We note that there is also an allocation for the Earth to space and space to Earth services in the band. We investigated the coexistence of these services with mobile services as part of the studies leading to WRC-19[114] and concluded that the risk of interference to be low. We maintain this view and will provide further details in our next consultation.

7.14 Ofcom also carried out some compatibility studies between mobile services in the 40 GHz band and uncoordinated earth stations in the adjacent 39.5 – 40.5 GHz band.[115] The results indicated that no further restriction on unwanted emission limits may be required for adjacent band compatibility.

## Our coexistence analysis shows the majority of the band could be available for new uses

7.15 We have assessed coexistence between prospective new uses of the 40 GHz band, and existing fixed links. New uses and fixed links would need to be coordinated, in order to manage the risk of new services causing interference to fixed links.[116] As part of this analysis we have assessed how much spectrum could be available for new services in high density areas and we refer to this as our 'spectrum availability analysis'. The results of this

[112] See Condition 3(f) of the 40 GHz licences.
[113] See Condition 8 of the 40 GHz licences.
[114] Annex 6 to Task Group 5/1 Chairmans Report, Sharing and compatibility studies of IMT systems and the FSS (Earth to Space) in the 42.5 – 43.5 GHz frequency range, published 21 September 2018.
[115] Input to PT1, ECC PT1(21)195 Updated compatibility study between MFCN in 40.5 - 43.5 GHz and uncoordinated FSS GSO and NGSO Earth Station in the adjacent 39.5 - 40.5 GHz band, 6 September 2021.
[116] ECC Report 303, *Guidance to administrations for Coexistence between 5G and Fixed Links in the 26 GHz band*, approved June 2019, said "The results of all studies for the outdoor 5G network deployment scenarios show that coexistence between both services is possible but requires coordination". While this report concerns the 26 GHz band, we consider the same conclusion would apply to the 40 GHz band.

analysis inform the options that we are considering for enabling the 40 GHz band for new uses and the assessment of those options.

7.16 For this analysis, we have modelled the spectrum availability for new uses in six prospective high density areas, using our standard protection criteria for fixed links. We have considered both low power deployments (e.g. mobile hotspots) and medium power deployments (e.g. fixed wireless access (FWA) or mobile macro cell).

7.17 The table below summarises the high level results of this analysis, showing the availability of 200 MHz channels for these two types of deployments. We have shown the results separately for MBNL's licensed frequencies, and the rest of the band. This is because fixed links are most densely concentrated in MBNL's frequencies, while the rest of the band is largely unencumbered by fixed links. While H3G has a small number of fixed links, these are clustered around a small number of areas and so do not pose a material constraint to deployment of new uses. The percentages shown are the percent of locations in high density areas where those frequencies are available. [117]

**Table 7.1: Summary of 200 MHz channel location availability for new uses in the 40 GHz band**

| | **40 GHz** | |
|---|---|---|
| ***New wireless system power level*** | Co-channel with MBNL<br>**2 × 0.25 GHz bandwidth**<br>40.5-40.75 GHz; and<br>42.0-42.25 GHz | Not co-channel with MBNL<br>**2 × 1.25 GHz bandwidth**<br>40.75-42.0 GHz; and<br>42.25-43.5 GHz |
| **Low power** | 85-90% | > 99% |
| **Medium power** | < 50% | 85-95% |

*Source: Ofcom*

7.18 As shown above, MBNL's fixed links reduce spectrum location availability for new uses in the frequencies licensed to them. This is the case both for low power and medium power deployments, but is particularly substantial for the latter. However, we note that MBNL's frequencies comprise only a small portion of the band (500 MHz out of 3 GHz).

7.19 The spectrum location availability in the rest of the band, which is licensed to H3G and MLL, is greater than 99% for low power deployments but is reduced for medium power deployments. These frequencies comprise the majority of the 40 GHz band (2.5 GHz out of 3 GHz). Availability for medium power deployments is lower in these frequencies, compared to the analogous frequencies in the 26 GHz band (i.e. those that are not co-channel with 26 GHz fixed links). This is due to the density of MBNL's fixed links in the adjacent blocks, which means MBNL has a heightened risk of 'out of block emissions'

[117] We modelled availability in six prospective high density areas: Birmingham, Edinburgh, Glasgow, London, Manchester and Newcastle.

interference from medium power deployments in the rest of the band. This is less of a risk in the 26 GHz band, due to the smaller number of fixed links.

7.20 We have conducted sensitivity analysis which indicates that this may be a conservative view of the risk of 'out of block emissions' interference into MBNL's fixed links. We will be conducting further work and measurements to inform our understanding of the practical nature of the risk, and what interference management processes may be appropriate to manage the risk for the length of time fixed links remain in the band.

7.21 The details of our technical analysis are explained in annex 6.

## Options under consideration for enabling new uses in the 40 GHz band

7.22 The options we are considering for enabling the 40 GHz band for new uses, are:[118]

- **Option 1 – Variation of all licences** to enable existing licensees to deploy new uses in the band, including mobile. Ofcom has taken this approach in relation to other spectrum licences in the past, typically in response to a request from the licensee.[119]

- **Option 2 – Revocation[120] of all licences**, and reallocation of the entire band (3 GHz) for new uses, including mobile. 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 and MLL's licences, but not MBNL's licence. Ofcom would re-allocate the relevant spectrum (2.5 GHz) for new uses, including mobile. 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. This would also reduce costs of intervention significantly compared to option 2, by eliminating the costs of clearing MBNL's fixed links.

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[118] We are not considering the option of overlay block assigned licences, as we have done for the 26 GHz band in section 5. This is because existing licences in 40 GHz are already block assigned. While it could be possible to revoke existing licences, assign individual licences for existing fixed links and overlay block assigned licences for new users, our provisional view is there would be no clear advantage to this over the options we set out in this paragraph.

[119] 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 Statement on UK Broadband application for licence variation, published 22 November 2007, and Statement on 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.

[120] 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.

- **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), for the same reasons as above. 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. This option would further reduce the cost of intervention compared to option 2 or option 3 alone, by mitigating costs to H3G and MLL.

  Under this option, we provisionally consider 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 still allowing H3G and MLL to retain an amount of contiguous spectrum which they could credibly use for new uses.

7.23 Our provisional view is that authorising the 26 GHz and 40 GHz bands for new uses on the same or similar timeframe is most likely to deliver the best outcomes for people and businesses.[121] We would therefore aim to make both bands 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 Our assessment of options below is focused on high density areas, as this is where we expect the most mmWave spectrum deployments for new uses. If we revoke some or all 40 GHz licences, we currently expect to reflect the same approach proposed in sections 3 and 6 in relation to the use of the 26 GHz band in low density areas. In particular, we propose that existing fixed links would remain in low density areas[122] and to make spectrum available for Shared Access licences on a first come, first served basis.

## Analytical framework for assessing options

7.25 Ofcom has a statutory power to vary or revoke spectrum licences. However, we may not vary or revoke a licence unless the proposed variation or revocation 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.[123]

7.26 The factors that we have taken into account in considering whether the variation or revocation of licences (or a combination of both) would be objectively justifiable and proportionate include:

a) Securing optimal use of spectrum, which encompasses our objectives of:

[121] We set this out in more detail in section 2 at 2.46-2.54.
[122] 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 blocked assigned licences.
[123] See paragraphs A5.18-A5.21.

i) achieving an efficient allocation of spectrum,

ii) encouraging investment and innovation in services; and

iii) ensuring timely availability of spectrum;

b) Promoting competition, which encompasses our objective of sustaining strong competition in mobile markets;

c) Securing benefits for consumers and citizens;

d) The impact on existing users, aiming to meet our objectives for mmWave without imposing disproportionate costs on existing users.

7.27 A simplified summary of our assessment is shown in the table below. The table shows that the more of the spectrum we revoke and re-allocate, the higher the likelihood of meeting our objectives. This is particularly in relation to our objectives of achieving an efficient allocation of spectrum and encouraging investment and innovation. However, under some circumstances, it could be possible to still meet our objectives while imposing lower costs to existing users compared to the costs associated with revocation of all licences. We explain these conclusions in our detailed assessment of the options in the following sub-section.

**Table 7.2: Simplified high-level summary of our assessment**

| | Efficiency of allocation | Investment and innovation | Timeliness of availability | Competition | Impact on existing users |
|---|---|---|---|---|---|
| **Option 1 – variation of all licences** | Significant risk of inefficient allocation: only 3.25 GHz mmWave spectrum (the 26 GHz band) made available to all other operators; may be barriers to trading for achieving efficient allocation and contiguity of mmWave holdings | Potential barriers on the amount of investment and innovation, other than for existing licensees | Spectrum likely to be available before deployments could begin | Least likely to promote competition (although unlikely to have detrimental impact) | No costs; would increase value of licences |
| **Option 2 – revocation of all licences** | Maximises likelihood of efficient allocation: 6.25 GHz available to all prospective users of mmWave spectrum; greatest opportunities for all operators to secure large contiguous holdings | Maximises opportunities for investment and innovation | Spectrum likely to be available before deployments could begin | More likely to promote competition by enabling more operators to access mmWave spectrum | c.£2.9m-4m cost of moving MBNL's links; c.£50k-60k cost of moving H3G's links; Other minor potential costs to H3G and MLL |
| **Option 3 – partial revocation of licences (H3G and MLL, but not MBNL)** | Could enable efficient allocation depending on demand: 5.75 GHz available to all prospective users of mmWave spectrum; more opportunities than option (1) for all operators to secure large contiguous holdings | Could enable maximum investment and innovation or impose barriers, depending on demand for mmWave spectrum | Spectrum likely to be available before deployments could begin | More likely to promote competition by enabling more operators to access mmWave spectrum | c.£50k-60k cost of moving H3G's fixed links; Other minor potential costs to H3G and MLL |

| | | | | | |
|---|---|---|---|---|---|
| **Option 4 – partial variation & revocation of licences (half of H3G and MLL, no revocation of MBNL)** | Could enable efficient allocation depending on demand: 4.5 GHz available to all prospective users of mmWave spectrum; more opportunities than option (1), but less than (2) and (3), for all operators to secure large contiguous holdings | Could enable maximum investment and innovation or impose barriers, depending on demand for mmWave spectrum | Spectrum likely to be available before deployments could begin | More likely to promote competition by enabling more operators to access mmWave spectrum | c.£50k-60k cost of moving H3G's fixed links |

# Securing optimal use of spectrum

7.28 In this sub-section, we assess 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 investment and innovation in services (the second factor), while all options perform similarly in relation to timely availability (the third factor). To contextualise our assessment of options, we also 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

7.29 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 that will use the spectrum to provide the most value to society (we refer to these as 'efficient users' throughout this section). We consider it is appropriate to consider 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 so the allocation in one band may affect the efficiency of the other.

### Potential features of an efficient allocation for mmWave

7.30 The landscape for new uses of mmWave spectrum is still in a relatively early stage of development. We therefore cannot know at this stage what would be the most efficient allocation of mmWave spectrum for new uses.

7.31 However, there are some general factors which give an indication of what mmWave spectrum wider area operators (such as Mobile Network Operators (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. In particular:

a) 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 recognise that early demand indications vary widely). 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.

b) Operators may want their large block 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. We understand that there is already equipment available for new uses that spans the entire 26 GHz band, and we expect similar equipment to develop in the 40 GHz band.

c) MNOs and the wider mobile industry have indicated that contiguous blocks of spectrum are desirable, and preferred over fragmented holdings.

7.32 This suggests an efficient allocation of spectrum for citywide licences could credibly involve operators holding relatively large blocks of spectrum consolidated in one of either the 26 GHz or 40 GHz bands, rather than fragmented across both bands.

7.33 We welcome stakeholders' views and evidence on our assessment of the likely features of an efficient allocation.

### Likelihood that the current allocation is inefficient

7.34 Given the factors above, we think there is a significant risk that the current 40 GHz allocation is inefficient for new uses. Maintaining the current allocation would mean all operators other than H3G, MBNL and MLL would be constrained to the 26 GHz band for mmWave spectrum. The 26 GHz band comprises 3.25 GHz of spectrum, of which we are proposing to auction citywide licences for 2.4 GHz.[124] It is plausible that operators of new uses could require more mmWave spectrum than this in the longer term in order to deliver the best outcomes for people and businesses.

7.35 Furthermore, the current allocation resulted from an auction in 2008, before the potential uses of this 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.[125] Now that the 40 GHz band has been globally identified for mobile services, and as a 5G band in Europe, it is credible that existing licensees may not be the highest value users of their specific frequency allocations going forwards. [126]

7.36 We recognise, however, that existing 40 GHz licensees could still be efficient users of some mmWave spectrum, if not their entire existing holdings.

a) H3G is an MNO, and therefore would likely want to use at least some of its 40 GHz holdings for mobile and other new uses.[127] It also has a small number of fixed links, which it would incur costs to move (we cover costs in more detail where we discuss the impact on existing spectrum users below). However, H3G may not require its full 2 GHz for new uses, noting that this is significantly more than the upper end of early indications of demand. It is also credible that other prospective users of mmWave spectrum would place a higher value than H3G on some of its 40 GHz holdings, given that otherwise they would be limited to acquiring spectrum in only the 26 GHz band.

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[124] See section 3 – we are proposing to allocate the remaining 850 MHz on a first come, first served basis.
[125] The 40 GHz band was first identified as a band for study for wideband 5G services in the 2015 World Radio Congress, 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 2.19 of the Information Memorandum for the award.
[126] We also note that the 40 GHz band is currently configurated 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 FDD services which require separate blocks of spectrum for uplink and downlink. This duplex configuration may not be optimal for new uses.
[127] We understand from pre-consultation engagement with H3G that they are engaging with vendors on trials of new uses for 40 GHz.

This is because an operator's incremental value for additional spectrum is likely to be larger when its current holdings are smaller.

b) MLL may also want to use its 40 GHz holding to deploy new uses, although it does not currently have any active deployments in the band.[128] However, it is not clear whether other prospective users of mmWave spectrum would have a higher value for 40 GHz spectrum than MLL.

c) MBNL appears less likely to want to use its spectrum for new uses than other existing licensees,[129] but 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, it is likely to place a significant value on its spectrum due to the costs associated with moving its fixed links. However, it is also possible that prospective users could have a greater value for the spectrum for new uses.[130]

7.37 We welcome views from stakeholders on our initial assessment of the risk that the current 40 GHz allocation could prove to be inefficient. Although we are of the view that such risk could be significant, the likelihood of this risk materialising in practice is uncertain. In particular, our assessment depends on prospective users' spectrum requirements to deliver the best quality services to people and businesses.

### Assessment of options for achieving an efficient allocation

Option 1: Variation of all licences

7.38 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. However, as set out above, we think that there is a significant risk that the current allocation of the band is inefficient as a whole, given that other prospective users of mmWave spectrum may need more spectrum than would be available in the 26 GHz band to deliver quality services to people and businesses.

7.39 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.

7.40 However, there may be particular barriers to trading which could prevent the industry from reaching an efficient allocation in the case of mmWave spectrum. If all other

[128] MLL has no current active deployments at 40 GHz, though we understand from pre-consultation engagement that it has deployed in the 32 GHz and 40 GHz bands in the past, including point-to-multi-point, small cells, and FWA uses. MLL has told us it continues to research develop and deploy capabilities in technologies such as FWA and Networked point-to-point Services.

[129] MBNL is a network sharing joint venture owned by BT/EE and H3G. We therefore consider it to be less likely than H3G and MLL to be interested in deploying the types of use cases set out in section 2.

[130] Whether MBNL's fixed links are an efficient use of the band also depends on their impact on spectrum availability in the rest of the band. Our initial view is that this impact is unlikely to be significant, given the results of our spectrum availability analysis summarised at paragraphs 7.15-7.21, subject to the further work we are undertaking as outlined in paragraph 7.20.

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.[131] This would involve operators trading to achieve both the optimal amounts of spectrum and either contiguity or proximity of holdings.[132,133] Although it is theoretically possible for operators to overcome these complexities, this is likely to be difficult and/or costly. As a result, operators may then settle for less than optimal amounts of spectrum or incur the costs of split holdings, potentially resulting in poorer services to people and businesses.

7.41 We also note that the existing licensees may not have incentives 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.

7.42 We could also vary the licences with conditions to help reduce the risk of the ongoing inefficient allocation, in addition to enabling mobile use, if trading alone is not an effective mitigation. For example, we could set a fixed end date to the 40 GHz licences, which are currently indefinite. This would provide an opportunity to correct any enduring inefficiencies, by re-allocating the band at the end of the licence term. We note that we are considering the possibility of fixed term licences for any new mmWave licences we award through auction (see section 10). We could align any end date for the 26 GHz licences with the 40 GHz licences, and re-allocate both bands together at a later date. However, there is still a risk that an inefficient allocation would become entrenched over time, as operators will already have deployed using their existing holdings. In this scenario, operators may be reluctant to incur the cost of a significant change to their frequencies even if the existing allocation is inefficient. We have also considered varying the existing 40 GHz licences, to reduce the length of the notice period under which Ofcom can revoke spectrum licences for spectrum management reasons. This might enable us to re-allocate the spectrum more quickly at a later date, if it becomes clear in the future that the existing allocation is inefficient. However, this may also reduce licensees' certainty for investment.

7.43 We invite views from stakeholders on any further licence conditions we should consider for managing the risks of ongoing inefficient allocation of the 40 GHz band, if we were to start a licence variation process.

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[131] Operators could also try to secure 40 GHz spectrum before a 26 GHz auction, which would reduce these complexities.
[132] 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.
[133] In addition, the efficient amount of spectrum for each operator could be different in different high density areas, creating a further complexity.

Option 2: Revocation of all licences

7.44 Option 2 would address the risk that the current allocation is inefficient by re-allocating all of the 40 GHz spectrum in addition to the 26 GHz band (a total of 6.25 GHz of spectrum). As set out in section 3, if we were to revoke licences in the 40 GHz band, our provisional view is that we would allocate new citywide licences through an auction. We consider this would maximise the chance that the spectrum is awarded to the users with the highest valuations for the spectrum. This option 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.

7.45 In addition, we would seek to auction the 40 GHz band at the same time as the 26 GHz band, which would maximise opportunities to achieve an efficient allocation of mmWave spectrum as a whole. This would allow operators to consider their acquisition of mmWave spectrum holistically and simultaneously across both bands. In doing so, it would also provide the greatest opportunity for all operators to obtain large contiguous blocks of spectrum in either the 26 GHz or the 40 GHz band, should they wish to do so.[134] In this option, the efficient allocation of mmWave spectrum would be determined by market prices, without the spectrum trading challenges discussed above. We note that 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.[135]

7.46 However, this option would result in existing users' licences being revoked, despite those operators potentially being efficient users of the spectrum. If H3G and/or MLL are efficient users of the band, this is unlikely to result in poorer outcomes, as they could re-acquire spectrum in the auction (we discuss the potential for delayed deployment and costs associated with participating in a new award process below). This option would help to ensure that H3G and MLL acquire only the amount of spectrum that they have the highest value for, by allowing others to also bid for that spectrum.

7.47 Revoking MBNL's licence could result in a less efficient allocation in the 40 GHz band if it is the highest value user of its spectrum, due to its number of fixed links.[136] Even if MBNL had the highest value for its spectrum, it would be unlikely to be able to re-acquire its duplex holdings through any re-allocation process.[137] However, we note that MBNL could move its

[134] Auctioning the 40 GHz band after the 26 GHz band would be less likely to achieve these benefits, as this would likely still require operators to trade with each other to secure contiguity or proximity of holdings across all mmWave spectrum, once both bands had been auctioned. In addition, because of the uncertainty and complexity of potential trades, operators could instead opt to settle for a sub-optimal amount of spectrum in the 26 GHz band.

[135] Specifically, in response to our June 2018 consultation on the variation of UK Broadband's spectrum access licence for 3.6-3.8 GHz spectrum, BT/EE, O2, and Vodafone suggested we should (in the context of the licence variation) have considered the fragmentation of the wider 3.4-3.8 GHz band and identified solutions to defragment it. They suggested for example incorporating 'mandatory assignment' and 'voluntary assignment' processes in the assignment stage of the 3.6-3.8 GHz auction. See paragraph 4.12 of our December 2018 Statement.

[136] This would be subject to the considerations set out in footnote 130, on the impact of MBNL's fixed links on spectrum availability in the rest of the 40 GHz band.

[137] There could be ways of addressing this when auctioning the band. However, that would mean maintaining the duplex split in the band, which would make fragmented spectrum holdings more likely. Therefore, if we decide to revoke MBNL's licence, we would be unlikely to allow for it to re-bid for a licence with duplex frequencies.

fixed links to alternative spectrum bands, including other bands where it holds a block assigned licence (32 GHz and 10 GHz). We also expect there to be sufficient spectrum in Ofcom-managed bands (e.g. 18, 23 and 38 GHz) to accommodate all fixed links currently operating in the 40 GHz band.

7.48 Our provisional view is that therefore this option is likely to have the best chance of achieving an efficient allocation of mmWave spectrum going forward. This is because it would enable us to allocate the full band for new uses, including mobile, at the same time as the 26 GHz band.

Option 3: Partial revocation – revoke H3G and MLL's licences, but not MBNL's

7.49 This option would enable a more efficient allocation than option 1 for similar reasons to option 2. This is because it would allow us to authorise 5.75 GHz of mmWave spectrum at the same time (out of a total of 6.25 GHz), providing more opportunities for operators to obtain large blocks of spectrum in one mmWave band in comparison to option 1. However, there would be some risk that an operator would have split holdings in 40 GHz, due to MBNL's two separate 250 MHz blocks (and therefore the duplex configuration) remaining in the band.

7.50 This option would also mitigate the risk in option 2 of removing a potentially efficient user of the band, specifically MBNL. As set out above, MBNL may have a significant value for its 40 GHz holding due to its high number of fixed links. However, it is uncertain whether its value would be greater than that of a prospective user who could use this spectrum for new uses.[138]

7.51 Our provisional view is that this option could lead to an efficient allocation. However, the greater the demand from prospective operators of mmWave spectrum for new uses, the more likely that this option would lead to an inefficient allocation. In particular, if there is a reasonable chance that demand for mmWave spectrum for new uses may exceed 5.75 GHz, then option 2 could be preferable to this option.[139]

Option 4: Partial variation and partial revocation – revoke half and vary half of H3G and MLL's licences

7.52 This option would also enable a more efficient allocation than option 1 for similar reasons to options 2 and 3. Specifically, it would allow us to re-allocate 4.5 GHz, out of a total of 6.25 GHz (assuming this was combined with option 3, and so we also did not revoke MBNL's licence).

7.53 However, this option would risk a less efficient allocation than option 2 and option 3 alone. This is because H3G and MLL would continue to hold a total of 1.25 GHz, whether or not they were the highest value users of that spectrum. If there were higher value users of the

[138] This would be subject to the considerations set out in footnote 130, on the impact of MBNL's fixed links on spectrum availability in the rest of the 40 GHz band.
[139] Option 2 could also be preferable to option 3, if option 3 would be likely to lead to fragmented holdings in 40 GHz due to maintaining the duplex split, and that in turn would be likely to reduce efficiency of the allocation.

spectrum, trading would be required to reach a more efficient allocation. However, this would face the barriers discussed above.[140]

7.54 As in relation to option 3, our provisional view is that the greater the overall demand for mmWave spectrum for new uses, the more likely it is that option 4 would lead to an inefficient allocation.[141] In particular, if there is a reasonable chance that demand for mmWave spectrum from operators other than H3G and MLL may exceed 4.5 GHz, then option 2 or option 3 alone could be preferable to option 4, in order for the allocation to be more fully determined by the market.

## Supporting innovation and investment

7.55 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 is 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, for the reasons below.

7.56 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 users for new uses. 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).

7.57 Option 3 would make more spectrum available to prospective users of mmWave spectrum than options 1 and 4. However, it would still make less spectrum available compared to option 2. Therefore the same risk to prospective users' services in the licence variation options would apply, though the risk would be reduced.

7.58 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.

## Timely availability of spectrum

7.59 Under all options, we would aim to make the 40 GHz spectrum available for new uses on the same or a similar timescale to 26 GHz.

7.60 Specifically, if we were to vary the existing 40 GHz licences, our current intention is that any variation would take effect on the same or a similar timeframe as any reallocation of the 26 GHz band. If we were to revoke existing 40 GHz licences, we would prefer to

[140] This would be the case unless a more efficient allocation involved H3G trading with MLL, which would be relatively simple.
[141] If these operators required more spectrum, they would be able to obtain more in the award.

reassign the cleared 40 GHz spectrum at the same time as we auction the 26 GHz spectrum, due to the potential benefits discussed above.

7.61 We note that the existing 40 GHz licences have a five-year notice period for revocation. We propose that, if we were to revoke the 40 GHz licences, deployments by new users of 40 GHz spectrum could be coordinated with those of existing licensees during the notice period. [142] This would enable new users to deploy where the spectrum is not otherwise being used. Therefore, the spectrum would be available for new uses at the same time, whether we vary or revoke licences.

7.62 We have also considered whether revocation options could lead to delayed deployments of new uses in the 40 GHz band. This could happen if, for example, existing users could undertake initial pilots or secure equipment earlier, under the licence variation options. However, our provisional view is that material delay to deployments due to revocation of licences is unlikely in practice. This is because we are proposing to authorise the spectrum for new uses before 40 GHz equipment and devices are likely to become available, regardless of the option we pursue. We set this out in more detail below, where we discuss the impact of each option on existing users.

## Promoting competition

7.63 We consider that the options involving revocation of all or most licences (options 2 and 3) could 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.

7.64 However, while we consider some options may be more likely to promote competition, we do not expect any of the options we are considering would have a material detrimental impact on competition. This is because we think any potential longer term competition concerns associated with varying existing licences could be adequately addressed through a 'precautionary cap'. This cap would restrict the amount of spectrum H3G would be able to acquire in the 26 GHz auction. This is in line with our views on potential competition measures we may include in the award, set out in section 11.

## Securing benefits for consumers and citizens

7.65 Our view is 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 think options 2, 3 and 4 are more likely to achieve an efficient allocation and promote competition, than

[142] This coordination could be led by Ofcom or industry. If we decide to reallocate the 40 GHz spectrum, we would consult further on the detail of any coordination.

option 1. Option 2 is likely to have the best chance of achieving an efficient allocation of spectrum.

7.66 We have also considered whether the options involving revocation could lead to delayed deployments of new uses in the 40 GHz band, and therefore reduced benefits to consumers and citizens. Our provisional view is that this is unlikely in practice, which we explain in the following section.

## Impact on existing spectrum users

7.67 In this sub-section we discuss the impact of options on existing licensees. Our assessment focuses 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 make their licences more valuable to them.

7.68 In summary, option 2 would impose the highest costs on existing users, mainly due to the cost of moving fixed links for MBNL. There could also be other costs for existing users that wanted to re-acquire spectrum for new uses. Options 3 and 4, by comparison, would impose significantly lower costs to existing users than option 2.

### Cost of moving fixed links

7.69 We would look to clear relevant fixed links in high density areas if we were to revoke licences. 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 fixed links than H3G.

a) MBNL has around 4,500 fixed links in the 40 GHz band. Using the baseline scenario set out in annex 8, we estimate that it could cost MBNL around £2.9m-£4m to move its fixed links, depending on the number of high density areas we identify.[143] MBNL may also face separate licence fee costs, though this would depend on where 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 separate licence fee costs. 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 conservative estimate, assuming all fixed links would be moved to an Ofcom managed band, these licence fees could amount to around £1.8m-£2.4m per year.[144] However, as noted above, Ofcom may impose annual licence fees on existing licences in the 40 GHz band after 21 February 2023. If we vary licences, we may take into account the prices reached in the future 26 GHz auction, alongside other relevant

[143] In annex 8 we have also indicated alternative higher cost estimates, based on different assumptions which we believe are relevant, but less likely.

[144] 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.

evidence (where available). We therefore 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 has around 60 fixed links in the 40 GHz band, which we estimate could cost around £50,000-£60,000 in total to move.[145] As with MBNL, it could move its links to other Ofcom managed or block assigned bands (e.g. 28 GHz). It could also incur licence fee costs of up to around approximately £30,000-40,000 per year, if it were to move its fixed links to an Ofcom managed band.[146] 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.

c) MLL's spectrum is currently clear, which means it would not face costs of moving any existing services under any option.

7.70 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 cost of clearance (around £50,000-£60,000).

7.71 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.[147]

7.72 We note that these estimated costs of clearing fixed links in the 40 GHz band are relatively small given the size of the mobile telecoms sector. By way of illustration, the costs of clearance in the 40 GHz band represents only £0.05 per active mobile subscription.[148] This is less than 0.04% of a typical annual cost of a mobile service in 2020.[149]

## Costs related to acquiring the spectrum for new uses

7.73 Under options 2 and 3, existing licensees would face costs from participating in the process for awarding the new licences, if they wanted to acquire spectrum in the 40 GHz band for new uses.[150] These costs would be most relevant for H3G and MLL, who are most likely to want to use mmWave spectrum for new uses.

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[145] Similar to the estimates for MBNL, this estimate depends on how many of H3G's fixed links are in or close to high density areas, using the methodology described above. Under 80 high density areas, our estimate assumes H3G would likely move all of its links.

[146] 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.

[147] 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.

[148] The number of active mobile subscriptions (excluding M2M) was 84.5 million at the end of Q3 2021. See Ofcom's *Telecommunications Market Data Update Q3 2021*.

[149] The average cost of a mobile service in 2020, based on average use across all mobile users, was £10.96 per month. See Ofcom's *Pricing trends for communications services in the UK*.

[150] 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.

7.74 These costs are largely internal resource costs associated with participating in a licence award. Our initial view is these costs are likely to be manageable for operators, noting that both H3G and MLL are sophisticated operators, which have participated and won spectrum in past Ofcom auctions.[151]

7.75 Nonetheless, these costs could be mitigated by option 4, unless those operators wanted to participate in the re-allocation process to obtain more spectrum than half of their existing holdings.

## Costs related to delayed deployments

7.76 A potential source of disruption to H3G and MLL could be if revocation led to a delay in any planned deployments. For example, H3G and MLL could delay investing in equipment or piloting deployments for new uses, due to the greater uncertainty regarding their future 40 GHz spectrum holdings compared to if their licences were varied. This in turn could result in reduced benefits to people and businesses in the short-term, due to the delay in availability of services.

7.77 However, we expect equipment for 40 GHz may become available for deployments of new uses to begin around 2024.[152] This means that whether we vary or revoke existing licences, the spectrum would likely be available for new uses around the same time that deployments could begin. Therefore any potential for delay as a result of revocation would be unlikely to lead to material disruption (or resulting losses) to existing operators.[153] [154]

7.78 While we think that the risk of materially delayed deployments associated with revocation is low, this could nonetheless be mitigated to a large extent by re-allocating only half of the frequencies licensed to H3G and MLL (option 4). This would enable H3G and MLL to retain a portion of their spectrum, supporting the potential for early deployments by existing licensees.

## Loss of opportunity to profit from trades

7.79 Options involving revocation would also mean existing licensees would lose the opportunity to trade some or all of their 40 GHz spectrum, and potentially profit from the sale. Our initial view is that the licensees' ability to profit from any potential trade is not relevant to an analysis of whether an allocation of spectrum is likely to be efficient. However, it is a relevant consideration in deciding whether revocation of licences would be appropriate and proportionate, given the possibility that a more efficient allocation could

[151] Existing licensees would also need to pay for the spectrum in an auction. We assume that this would not be an additional cost associated with revocation, as these operators would need to pay annual licence fees if we were to vary their licences, and when setting these fees Ofcom would seek to reflect the full market value of the spectrum.
[152] We set explain this in more detail in section 2.
[153] We also note that existing licensees could begin pilots and discussions with equipment manufacturers before the re-authorisation process, on the assumption that they would be likely to acquire licences in the 40 GHz band. This seems credible, given we would be authorising a large amount of spectrum.
[154] There would be a chance of H3G and MLL acquiring new licences for MBNL's frequencies, which are encumbered with fixed links. However, given that this is in two 250 MHz blocks, we do not think this would delay deployments in the band.

be achieved through trading. As discussed above, we consider that there may be particular barriers to trading which could prevent the industry from reaching an efficient allocation in the case of mmWave spectrum.

## Other impacts

### Risk of undue discrimination

7.80 Our initial view is that none of the options would amount to undue discrimination against any existing or potential new licensee. The options that we are considering may have a differential effect on operators. However, we do not consider this differential effect would amount to undue discrimination against any operator. This is because operators are not all in the same position due to a number of factors, such as their different spectrum holdings in the 40 GHz band and their different level of use (or expected use) of the frequencies licensed to them.

### Legitimate expectation

7.81 We have also considered whether any of the existing 40 GHz licensees, or any potential new licensee, might have a legitimate expectation that we would proceed with any particular option. In this regard, we note that the existing 40 GHz licences were awarded with terms enabling Ofcom to revoke or vary the licences, and these terms have remained part of the licences since they were awarded. This is 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 reasonable expectation about the exercise of Ofcom's powers to vary or revoke these licences at the end of their initial term.

# Provisional conclusions

7.82 We want to pursue the option that is most likely to achieve our objectives, which derive from our statutory duties. In assessing the options, we have also considered the impact of these options on existing licensees so as to avoid imposing disproportionate costs in achieving our objectives.

7.83 Our initial view is that option 1 (variation of all licences) 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. An ongoing inefficient allocation of spectrum in turn could pose barriers to investment and innovation, and result in poorer quality services to people and businesses. While this risk could be potentially be mitigated by trading, this may require a complex series of trades across the 26 GHz and 40 GHz bands which are likely to be difficult and/or costly. Our provisional conclusion is therefore that this option is unlikely to meet our objectives.

7.84 Option 2 (revocation of all licences) would by contrast maximise opportunities to achieve an efficient allocation and for investment and innovation by a wide range of operators. This option would however impose the highest costs on existing licensees, particularly MBNL

which would face the highest cost associated with moving its fixed links. These costs are still relatively small, given the size of the wider mobile sector.

7.85 Options 3 and 4 (partial revocation of licences) could also achieve our objectives, if these options were to make sufficient mmWave spectrum available, when combined with the 26 GHz band, for all operators to deliver quality services. While these options are less straightforward than option 2, they have the benefit of mitigating the cost of intervention to existing licensees.

a) Option 3 (revocation of H3G and MLL's, but not MBNL's, licences) could potentially secure an efficient allocation, if demand for mmWave spectrum is unlikely to exceed 5.75 MHz.[155] It would also significantly reduce the costs related to moving fixed links compared to option 2 (revocation of all licences), given MBNL has the largest number of fixed links.

b) Option 4 (revoking half and varying half of H3G and MLL's licences) could potentially secure an efficient allocation if demand for mmWave spectrum from operators other than H3G and MLL is unlikely to exceed 4.5 GHz, while also imposing lower costs on H3G and MLL. Assuming this option was combined with option 3, it would significantly mitigate the bulk of costs to all existing licensees compared to option 2.

7.86 We are seeking views and evidence from stakeholders on our initial assessment, to inform our view on which option is most likely to meet our objectives. We are particularly seeking views on operators' demand for mmWave spectrum and the costs of revocation. We also welcome comments on any other factors that we should take into consideration, including any other credible options for making the 40 GHz band available for new uses that Ofcom should consider.

## Next steps

7.87 Following responses to this consultation, we intend to reach a provisional conclusion on which option to pursue to enable the 40 GHz band for new uses.

7.88 If we were to vary licences, we would consult further on the detail of any licence variation and which competition measures (if any) we might include in the award to address any potential competition concerns. We would aim to complete the licence variation process on a similar timeframe to making the 26 GHz band available.

7.89 If we were to start the revocation process, we would aim to issue notices of revocation to existing licensees on the same timescale as issuing notices of revocation to 26 GHz licensees, should we decide to go ahead with the proposals set out in section 5. Licensees would have the opportunity to make representations as part of the statutory revocation process. We would also consult on the detail of how we propose to award licences for the 40 GHz band, alongside the 26 GHz band, in a subsequent consultation.

[155] This would also be subject to the considerations set out in footnote 130, on the impact of MBNL's fixed links on spectrum availability in the rest of the 40 GHz band.

7.90 We note that Ofcom may charge annual licence fees for the existing 40 GHz licences from February 2023. We will consult on setting annual licence fees for the band once we decide on the future of these licences.

## Consultation questions

**Question 12**: Do you agree with our initial assessment on which option for enabling the 40 GHz band for new uses would best achieve our objectives?

**Question 13**: Do you agree with our analysis of the impact on existing 40 GHz licensees, including our estimates of the cost of moving fixed links under the options involving revocation (options 2, 3 and 4)?

# 8. Extending the Shared Access licence in the 26 GHz band

## Summary of our approach

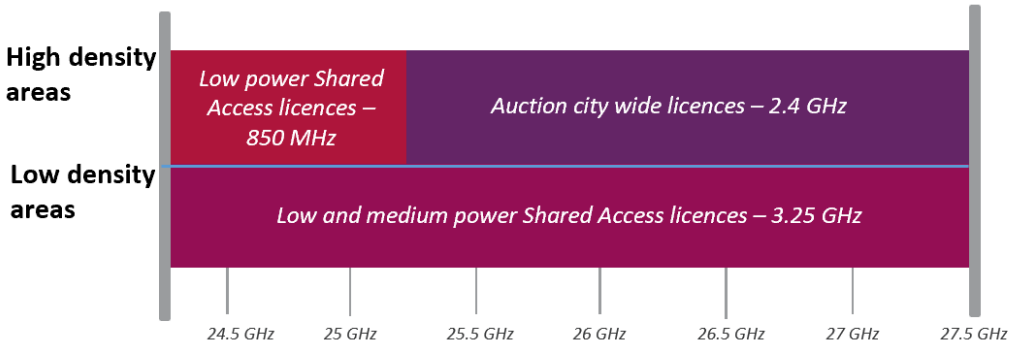
8.1 In section 3, we set out our proposals to make part of the 26 GHz band available via local licences, to be authorised on a first come, first served basis.

8.2 Access to the 24.25-26.5 GHz range is currently available under Ofcom's low power Shared Access licence for indoor use only. We are proposing to extend the Shared Access licensing framework in the 26 GHz band to the following **indoor**[156] **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;

b) In low density areas, in the full 24.25-27.5 GHz band, for low power and medium power use.

**Figure 8.1: Proposed 26 GHz band plan**




8.3 We consider that coordination would be feasible with both existing fixed link users and new users, noting that we already do this for the 3.8-4.2 GHz Shared Access band. Therefore, we propose to extend the Shared Access licensing framework to the 26 GHz band regardless of our final decisions on the authorisation of the 26 GHz band for other new users, and on the future of existing fixed links in the band.

8.4 In this section we set out how we propose to extend the Shared Access framework in the 26 GHz band only. In section 2, we outlined that, if we were to re-allocate spectrum in the 40 GHz band, we are minded to adopt a similar approach to authorising new uses in the 40 GHz band as in our proposals for the 26 GHz band. We consider that the approach we

[156] As set out in the Shared Access licence, 'indoor' or 'indoors' means inside premises which have a ceiling or a roof and, except for any doors, windows or passageways, are wholly enclosed. 'Outdoor' or 'outdoors' refers to all other deployments.

outline here could be extended to the 40 GHz band in the future, depending on the outcome of this consultation.

## The Shared Access framework meets our objectives for this band

8.5 We expect that many prospective users of the 26 GHz band will require localised access to this spectrum, and that providing such access would help achieve our policy objectives. We propose to provide such access through a local licence. We believe that this approach would achieve a reasonable balance by enabling local users to deploy where they wish to, without taking up spectrum in areas where they do not intend to deploy. We consider this approach would meet our objective to achieve efficient allocation of spectrum and encourage investment and innovation in new uses by a wide range of users.

8.6 We consider that extending an existing Ofcom licensing framework to this band would allow us to implement the changes more quickly than creating a new licence product, thus fulfilling our aim to ensure timely availability of spectrum. We also consider that using an existing product would keep costs lower, which in turn would help to limit licence fees for future users, thus supporting investment and innovation in new uses.

8.7 As explained in sections 5 and 6, we anticipate that licences would need to be coordinated with existing fixed links and satellite earth stations in the 26 GHz band. Measures may also be required to ensure coexistence between new 26 GHz users and Earth Exploration Satellite Service (EESS) and Radio Astronomy Service (RAS) users in the adjacent 23.6-24 GHz band, depending on the outcome of our separate consultation on protecting these users. Given that deployments of outdoor equipment could also cause interference to one another without coordination, we also propose to ensure that new licences do not overlap in location and frequency, as this would lead to poor quality or loss of service. We therefore propose to use a coordinated licence product for local use in the 26 GHz band.

8.8 We have considered other options for this licence, including self-defined areas, setting a uniform power level for all areas (rather than defining low power and medium power separately), and creating a new licence product. Our initial view is that Ofcom's existing Shared Access licensing framework achieves our objectives above – being a local licence which would enable us to coordinate with new and incumbent users, promote innovation and implement more quickly than a new framework, especially as Shared Access licences are already partially available in this band for indoor use. It would also minimise disruption to existing 26 GHz indoor Shared Access licensees.

8.9 We are therefore proposing that our approach to local licensing in the 26 GHz band should be to extend the existing Shared Access licensing framework.

## How the Shared Access licence works

8.10 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').[157]

8.11 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 pay a licence fee that reflects the costs of issuing the licence.

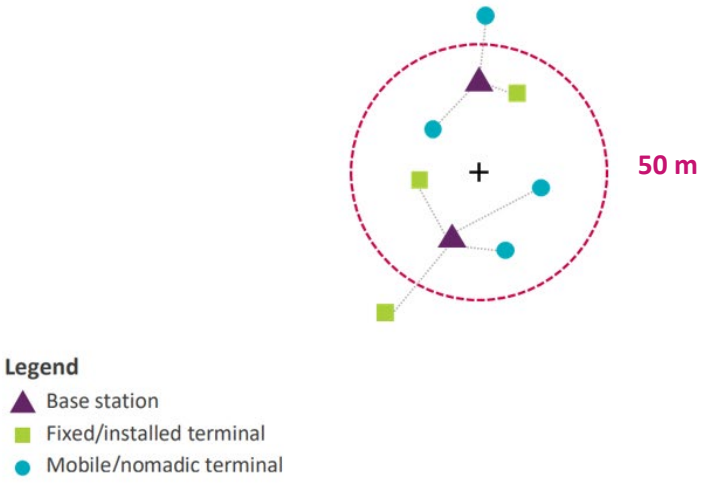
8.12 There are two types of Shared Access licence, distinguished primarily by permitted power levels, to cater for different types of potential uses: **low power** and **medium power** licences.

8.13 In our December 2018 consultation on introducing the Shared Access licence, we said we intended to add other bands to our spectrum sharing framework as appropriate. Considering the above factors, we propose to add the 26 GHz band to the Shared Access licence for low power use nationwide, both indoors and outdoors, as well as medium power use in low density areas.

## Low power licences

8.14 Low power Shared Access licences authorise multiple base stations, in an area with a 50 m radius around a given point provided to Ofcom by the user. In current Shared Access bands, users may add or move base stations within the area without needing to inform 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.

**Figure 8.2: Low power Shared Access licence**




[157] 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). We are also separately consulting on adding the 6425-7070 MHz band to the Shared Access framework for low power, indoor-only use, in *Enabling spectrum sharing in the upper 6 GHz band*.

8.15 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. Applications are assessed on a case-by-case basis.

8.16 We propose to align the height restriction for low power licences in 26 GHz with that in other Shared Access bands (10 metres).

### Density limits to monitor impact on passive services

8.17 We are separately considering proposals to protect passive services at 23.6-24 GHz from future 26 GHz deployments, in our consultation published in December 2021. In that consultation, we proposed to limit the number (within any 300 $km^2$ area) of outdoor base stations deployed in the lowest 800 MHz of the 26 GHz band (24.25-25.05 GHz) to protect EESS from out-of-band interference. Density limits would not apply to indoor base stations. These proposals have not been finalised and are subject to change before a final decision is reached. However, if we were to proceed with the proposed density limits, we would need a method to know how many base stations were deployed under each licence, in order to ensure we do not exceed these limits.

8.18 We propose to do this, if the proposals in the consultation on passive services are implemented, by limiting the number of outdoor base stations that could be deployed under each low power Shared Access licence in the bottom 800 MHz of the 26 GHz band. 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. This would enable us to monitor deployment density while offering flexibility to licensees – they would not have to inform us if they wish to deploy an additional base station, for example, as long as they stay within the limit of their licence. At this stage, we provisionally propose to set this limit at two outdoor base stations[158] per low power licence, and welcome comments from stakeholders. We expect to consult further on the details of this in a future consultation, if we decide to proceed with the proposals in our December 2021 consultation.

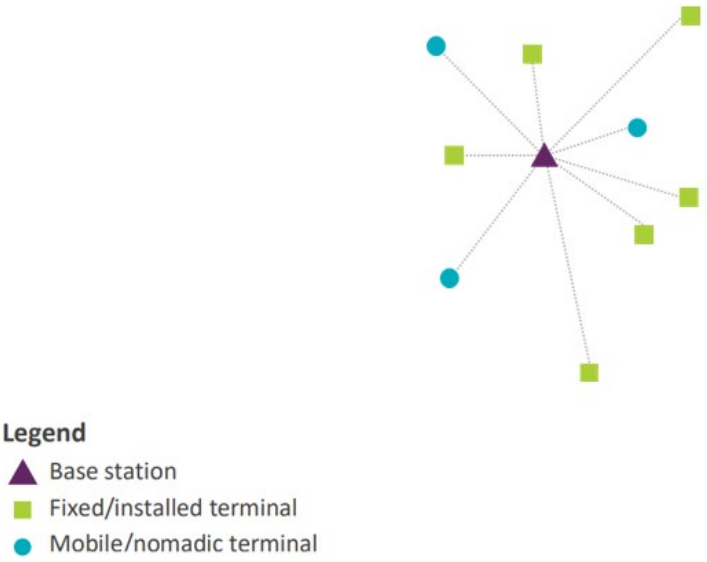
8.19 We propose that low power licences would be available in the bottom 850 MHz of the 26 GHz band in high density areas, and in the full band in low density areas. If we proceed with the proposals outlined in our December 2021 consultation, density limits would apply to outdoor low power licences in all areas in the bottom 800 MHz of the band only. This means that licensees in the top 50 MHz of Shared Access spectrum in high density areas could operate without this restriction, providing an additional option for users who want to plan more dense deployments in a 50 MHz bandwidth.

[158] For the purposes of this provision, a base station would comprise of a single sector with a horizontal coverage angle of about 120°. Therefore, a base station with multiple sectors would count as multiple base stations, for the purposes of the proposed EESS density limits.

## Medium power licences

8.20 Medium power licences are issued on a per base station basis[159] as they have a larger potential interference area than low power licences. This is because medium power licences have higher power limits and are not subject to antenna height restrictions.

**Figure 8.3: Medium power Shared Access licence**




8.21 We are proposing to not allow medium power Shared Access deployments in high density areas since they sterilise a large area and would deny the opportunity for a number of other users to deploy spectrum in those areas. 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.

# Licence conditions

## Non-technical licence conditions

8.22 The standard non-technical licence conditions for the Shared Access framework would apply to the 26 GHz band. These are set out in more detail in our guidance document[160] and, at a high level, include the following:

a) Licences are indefinite, subject to the payment of an annual licence fee (see paragraph 8.29).

b) Ofcom can revoke licences for spectrum management purposes, subject to a minimum revocation notice period of one month. Should we consider repurposing the band for

[159] As noted above, under the provisions we are separately consulting on to protect EESS in the adjacent band, a base station would comprise of a single sector with a horizontal coverage angle of about 120°. If we implement those proposals, we would need to consider how this might affect our authorisation of medium power deployments.
[160] Ofcom, *Shared Access Licence Guidance document*, paragraph 5.12.

alternative use, we would give a reasonable notice period. This is likely to be longer than one month and would not occur without us first conducting a formal consultation, of which Shared Access users would be notified.

c) Licensees are required to start transmission within six months of the issue of their licence and remain operational thereafter ('use it or lose it' clause).

d) Licences include clauses which reserve to Ofcom the right to access and inspect the licensee's radio equipment to assess compliance, and to require the licensee to modify, restrict or close down the use of its radio equipment if we have reasonable grounds to believe the licensee has breached the terms of its licence.

e) Licensees are required to maintain a record of the address and transmitter type of all deployments and to provide us – on request – with general information regarding their equipment and use of frequencies, or the rollout of their network.

## Technical licence conditions (overall approach)

8.23 At a high level, we intend our approach to the technical licence conditions for this band to be aligned with the other Shared Access bands. Below we detail the ways in which we anticipate how the existing technical licence conditions (for sub-6 GHz bands) might need to be modified for mmWave bands.

### Power and antenna height limits

8.24 Power levels are likely to be stated in Total Radiated Power (TRP) instead of Effective Isotropic Radiated Power (EIRP), which is currently used for Shared Access licences. This is because 5G mmWave systems are likely to use active antenna systems (AAS) and highly directional antennas for which units of TRP are likely to be more appropriate.

8.25 In order to maintain broad equivalence with the existing Shared Access licence power limits, we provisionally expect the power limit for mmWave licences to be around 25dBm/200 MHz TRP for both indoor[161] and outdoor low power licences and 30dBm/200 MHz TRP for medium power licences. In line with other Shared Access bands, we also intend to propose an outdoor antenna height limit of 10 m above ground for low power equipment only.

8.26 For terminal stations, we provisionally expect the power limit to remain equal to 23dBm TRP in line with the current 26 GHz indoor Shared Access licence.

### Maximum bandwidth

8.27 As with the current 26 GHz indoor Shared Access licence, we propose to have bandwidth options of 50 MHz, 100 MHz and 200 MHz. However, we are open to considering additional options if we understand there is interest from stakeholders. We therefore

[161] Currently, 26 GHz Shared Access indoor licences allow 23dBm/200 MHz TRP for base stations.

welcome comments on whether any further bandwidth options would be useful for applicants, to cover anticipated uses.

8.28 We expect to consult on proposed technical conditions in more detail in our further consultation on the 26 GHz and 40 GHz bands. In this consultation, we welcome comments on what we should be considering as we develop the technical licence conditions for low and medium power licences in this band.

### Fees

8.29 We propose to take the same approach to setting licence fees as we have done for the other Shared Access bands. In our July 2019 statement on introducing the Shared Access licence, we said that we considered it appropriate to have a simple, cost-based pricing structure to keep licences affordable, incentivise innovation and provide the opportunity for efficient use of spectrum. As such, we propose to maintain the cost-based fee when extending the Shared Access licence in the 26 GHz band.

8.30 In the 1800 MHz, 2300 MHz and 3.8-4.2 GHz bands, fees are charged by bandwidth. In the 26 GHz band, there is currently a standard annual fee of £320 per licence, regardless of bandwidth requested up to the 200 MHz limit. Given the changes we are proposing to the licensing framework in the 26 GHz band, we anticipate that fees for indoor and outdoor licences will be charged by bandwidth under the new approach.

8.31 We are likely to use a base price for a reference bandwidth, which would increase or decrease in proportion to bandwidth requested. As there is substantially more spectrum available in this band than in the other Shared Access bands, using the same baseline (e.g. £80 per 10 MHz) would lead to over-recovery of costs. Therefore, while we are proposing to take the same overall approach to setting the annual fee for this band, the exact structure is likely to look different and will be set out in our next consultation. We welcome initial views from stakeholders on our proposed high level approach to setting fees for Shared Access licences in the 26 GHz band.

## Coordination and coexistence between existing users and new Shared Access licensees

8.32 We will be consulting on the full details of coordination procedures in our next consultation, alongside detailed proposals for technical licence conditions. Currently, we are seeking stakeholders' views on our proposed high level approach to coordination.

8.33 At a high level, we propose that the coordination procedure for allocating new Shared Access licences will involve different steps for low power indoor licences, low power outdoor licences, and medium power licences.[162]

[162] It is possible to have indoor-only medium power licences as well as outdoor ones, but we do not expect the steps followed for coordination to differ in this case.

8.34 We anticipate that coordination for new Shared Access licences in 26 GHz will involve a number of different forms of coordination, taking into account the different characteristics of existing uses, as well as those we expect to see from new uses. In particular, we expect the following coordination procedures may all play a role:

a) **Technical coordination**: this refers to the detailed coordination calculations Ofcom will carry out between a new user and existing users, using technical parameters of each deployment to determine whether the deployments will interfere with each other if the new user's deployment is approved. For example, we currently use this approach for coordinating most Shared Access users.[163]

b) **Reuse distances**: these are the minimum distances between base stations belonging to different licensees needed to prevent interference. Reuse distances can be appropriate for scenarios where the distances between different licensees is small and where full technical coordination might be disproportionate to manage the interference risk. For example, we use a reuse distance between 26 GHz indoor Shared Access users.[164]

c) **Exclusion zones**: an exclusion zone is a defined geographic area in which no deployments are permitted at the given frequencies. These are often used around sites with equipment that is particularly sensitive to interference, such as radioastronomy or Defence sites.[165]

d) **Field strength limits**: this means that if a user proposes a new base station which would exceed an agreed field strength trigger level at a boundary then the base station parameters could be altered to meet that trigger level or it may be possible for more detailed coordination to be carried out. For example, we use this form of coordination trigger between 28 GHz regional licensees.[166]

e) **Deployment density limits**: means that if a new user proposes a base station which would exceed a trigger limit in a geographic area then that base station application would be rejected. Deployment density limits are used when the risk of interference occurs only when there are too many base stations in an area rather than a risk being from an individual base station. In our consultation on protecting passive services at 23.6-24 GHz from future new uses in 26 GHz, we proposed to limit the number of outdoor 26 GHz base stations deployed in the lowest 800 MHz of the 26 GHz band within any 300 $km^2$ area.

8.35 Below, we outline the overall coordination procedure we expect for low power indoor, low power outdoor and medium power Shared Access licence applications.

8.36 In practice, we would generally put the most restrictive steps at the beginning of the process, such as exclusion zones which might entirely prevent a licence application being

[163] These users include those in the 1800 MHz, 2300 MHz and 3.8-4.2 GHz bands, as outlined in the document *OfW 590 Technical Frequency Assignment Criteria for Shared Access Radio Services*.
[164] *OfW 590*, page 12.
[165] For example, in the 3.8-4.2 GHz Shared Access licences there are 5 km exclusion zones around GCHQ Bude in Cornwall and RAF Menwith Hill in North Yorkshire, as outlined in *OfW 590*, page 15.
[166] Ofcom, *SPECTRUM CO-EXISTENCE DOCUMENT: Spectrum Access 28 GHz*, February 2018.

approved, then move onto those which would narrow down the range of available channels at a location.

8.37 The following coordination procedures would apply to applicants for Shared Access licences in the 26 GHz band. 'Low power indoor' refers to users who specify on their application that their deployment will be indoors only. 'Low power outdoor' refers to users who specify on their application that their deployment includes any outdoor elements, including licensees with both indoor and outdoor equipment.

**Table 8.1: Proposed procedures for coordinating Shared Access licences with existing users**[167]

| Existing user | Low power indoor | Low power outdoor | Medium power |
|---|---|---|---|
| **Block assigned licence holders in high density areas**[168] | Reuse distance from high density area boundary | Reuse distance from high density area boundary | Field strength limit at boundary of high density area |
| **Fixed links** | N/A – not needed | Technical assignment | Technical assignment |
| **Satellite earth stations** | Exclusion zone[169] | Technical assignment | Technical assignment |
| **Shared Access licences (medium power)** | Reuse distance | Technical assignment | Technical assignment |
| **Shared Access licences (low power outdoor)** | Reuse distance | Reuse distance | Reuse distance |
| **Shared Access licences (low power indoor)** | Reuse distance | Reuse distance | Reuse distance |
| **Radio Astronomy**[170] | N/A – not needed | Exclusion zone | Exclusion zone |
| **EESS**[170] | N/A – not needed | Base station density calculation | Base station density calculation[171] |

[167] For the purposes of our high level coordination and coexistence proposals in this section, 'existing users' refers to any existing users in the 26 GHz band at the time of the licence application (or in the adjacent 23.6-24 GHz band for Radio Astronomy and EESS). This includes existing 26 GHz users, including fixed links, as well as any citywide licences in high density areas and any Shared Access licences Ofcom would have already granted in the band.

[168] Coordination with block assigned licence holders in high density areas would not be necessary for the bottom 850 MHz of the band.

[169] At present, *OfW 590* outlines that 26 GHz Shared Access licences are subject to a 1 km exclusion zone around Harwell earth station and two radio astronomy sites. Our consultation on protecting passive services in the 24 GHz band has proposed removing this requirement. Our inclusion of this restriction in this table is a reflection of the current situation.

[170] Note that our proposals here for coordination with RAS and EESS in the adjacent 24 GHz band are based on the proposals we have outlined in our separate December 2021 consultation on protecting users in the 24 GHz band from new users in 26 GHz. These proposals are subject to a decision in a statement we will publish later in the year.

[171] This would not be required for an indoor-only medium power Shared Access deployment. While we do not expect such deployments to be likely, it would be possible to apply for one.

## Next steps

8.38 If we decide to proceed with our proposals to extend the Shared Access licence in this band, we would set out more detailed proposals on the licence conditions in our further consultation on the 26 GHz and 40 GHz bands. Following the second consultation, we would look to implement our final decisions as soon as feasible.

### Impact on existing Shared Access users in 26 GHz

8.39 We propose to migrate current Shared Access licensees in the 26 GHz band, holding indoor-only licences, to the revised licence product. In practice, the impact of this would be low as equipment could still be used under the same parameters. Additionally, there are few Shared Access licences allocated in this band at present.

8.40 There is a small risk that users in high density areas would have to move frequency if they were operating above 25.1 GHz at the time of migration, but this should be mitigated by the fact that most 26 GHz equipment can tune across the full band. There are currently no licensees in any of the proposed high density areas.

## Consultation questions

**Question 14**: Do you have any comments on our high-level Shared Access proposals (including technical and non-technical licence conditions and proposed approach to setting fees)?

**Question 15**: Do you agree with the overall approach we have set out to coordination and coexistence between new Shared Access users in the 26 GHz band and existing users?

# 9. Initial views on auction design

## Summary

9.1 As discussed in section 3, we are proposing to auction 2.4 GHz of spectrum in the 26 GHz band in high density areas. This section sets out our initial views on aspects of auction design for the band, in order to obtain initial views from stakeholders to inform more detailed proposals in our next consultation. As explained in section 7, depending on our approach to existing users in the 40 GHz band, we may also auction some or all 40 GHz frequencies at the same time as lots in the 26 GHz band. The considerations discussed in this section would apply whether or not this is the case.

9.2 Our view is that an auction involving generic spectrum lots, rather than lots that relate to specific frequencies, would be appropriate. As a result, we propose an auction in two stages:

a) a principal stage, to determine the amounts of spectrum to be acquired by winning bidders within particular lot categories; and

b) an assignment stage, in which bidders make bids to win specific frequencies for those winning blocks.[172]

9.3 The aspects of auction design we have considered and our initial views are as follows:

a) **Geographic lot categories:** Our initial view is to auction the spectrum in each high density area as a separate lot category in order to allow operators with demand for mmWave spectrum in individual or specific cities and towns to take part in the auction. Our approach could be implemented in different ways, which we describe below at paragraph 9.13.

b) **Lot categories within the 26 GHz band:** Due to the presence of fixed links in the bottom part of the 26 GHz band, we have considered whether we should auction the top and bottom part of the band as separate lot categories. We are currently minded towards either having one lot category for the whole of the 26 GHz band, or having two lot categories with re-arrangement for long-term contiguity (where a first assignment stage would determine specific frequencies in a particular lot category while the spectrum remains encumbered, and a second assignment stage would determine contiguous frequencies across the auctioned spectrum after fixed links have vacated the band). We are minded towards these options as they would ensure operators have contiguous spectrum in the longer term.

c) **Principal stage auction format:** Our initial view is that an auction involving bidding for individual lot categories separately (rather than package bidding) is likely to be appropriate and our preference at this stage is to use a Clock auction format.

[172] A final price for each bidder would be calculated after the assignment stage, which combines the base price, resulting from the principal stage of the auction, and any additional prices arising from the assignment stage.

d) **Assignment stage auction format:** Our initial view is that a sealed-bid second price auction is likely to be appropriate. If we have geographic lot categories in the principal stage, our preference is to have multiple assignment rounds, with rounds for each geographic area run sequentially.

9.4 We explain our initial views on each of the design aspects above in the remainder of this section.

9.5 We will set out more detailed proposals on the auction design in a further consultation once we have received initial responses on our initial views above and have decided whether 40 GHz frequencies will be included in the auction.

## Geographic lot categories

9.6 We have considered whether to have geographic lot categories for bidders to reflect differences in demand for mmWave spectrum in different high density areas. In particular, there may be operators that would consider deploying in individual or specific cities, but would not consider doing so across all high density areas. National operators could also potentially have different levels of demand for mmWave spectrum in different areas depending on relative prices.

9.7 The options we have considered are:

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. (We explain how this aggregation could work below).

b) **'Sub-national' 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.

9.8 We discuss the advantages and disadvantages of each approach, before explaining how our preferred approach (geographic lot categories) could be implemented.

### Geographic lot categories

9.9 The main advantage of geographic lot categories is that they would enable entry from operators with use cases in specific cities and towns, who may be unlikely to take part in the auction if we had 'sub-national' lot categories. This would likely facilitate a more efficient allocation of the 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. In addition, it could also help to achieve a more efficient allocation of spectrum if national operators have different levels of demand in different areas.

9.10 The main disadvantages of individual lot categories relate to additional costs and complexity national operators might face. In particular:

a) National operators could win different amounts of spectrum and different frequencies in different high density areas. This may mean operators face additional equipment or logistical costs, in managing deployments across different high density areas. Our initial view is that this would be unlikely to be a large additional cost in comparison to the alternative. For example, our understanding is that if operators won different frequencies within the 26 GHz band, they would be able to use the same equipment, as the tuning range of 26 GHz equipment is likely to span the whole band. We also expect that the logistical cost of managing these differences would be relatively small.

b) Geographic lots could increase complexity of bidding in the auction for national bidders, compared to if they were to bid in sub-national lot categories covering all high density areas.[173] However, our current view is that this should be relatively straightforward to manage for national bidders who are likely to be experienced in bidding for spectrum in auctions.

### Sub-national lot categories

9.11 The advantages and disadvantages of sub-national lots would be the inverse of the above. This approach would be unlikely to enable entry from operators considering deploying in individual or specific cities, as they would need to bid for spectrum throughout all high density areas of the UK. However, it would be likely to minimise costs and complexity for national operators, if those operators want the same amount of spectrum in all high density areas.

### Implementation of geographic lot categories

9.12 Overall, we currently favour geographic lots, as our initial view is that the potential benefits in terms of enabling entry and a more efficient allocation are likely to outweigh the costs to national operators.

9.13 As explained above, geographic lots may result in bidders having to place separate bids in multiple lot categories (in both the principal and assignment stages of the auction), potentially resulting in bidders winning different frequencies in different areas. We have therefore considered how to reduce the complexities associated with geographic lots.

a) One way we could simplify the principal stage of the auction would be to aggregate high density areas which bidders do not express a preference to be auctioned as separate lots in an initial application stage (before the principal stage). For example, as part of their application, bidders could tell us whether they had any preferences for particular geographic areas to be auctioned separately.[174] We could then offer separate categories: (i) for each city which bidders have specified they wish to bid on separately, and (ii) a single aggregated lot category for all other high density areas.[175] This approach could reduce the number of geographic lot categories national operators

[173] This would not apply to bidders who only want spectrum in some cities or towns, who would be unlikely to bid if we did not have geographic lots.
[174] We would be likely to ask for a deposit on areas bidders told us they wanted to bid for (whether aggregated or separate) in order to encourage more truthful responses.
[175] For example, this could mean that (e.g.) Manchester and Edinburgh were available as separate lots, but then (e.g.) Norwich, Cambridge and Exeter were aggregated as a single lot.

would need to bid for in the principal stage, as well as increase the likelihood of winning similar frequencies across high density areas. However, this approach would involve having an additional stage in the auction which could increase auction complexity.[176]

b) There may also be ways to simplify the assignment stage if we were to offer separate geographic lots in the principal stage. For example, if the same bidders have each won the same amounts of spectrum across multiple areas, these could be combined into a single assignment stage round.[177] 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.

9.14 We propose to auction each high density area as a separate lot category. However, we welcome views on the alternative approach of aggregating geographic areas before the principal stage, as well as suggestions for any other options that could mitigate the costs of geographic lots to national operators.

## Lot categories within the 26 GHz band

9.15 When specific frequencies have similar values to bidders, these can be placed into the same lot category and be auctioned as generic lots in the principal stage. Alternatively, if there are 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.

9.16 As set out in section 5, we are required to give five years' notice before revoking fixed links licences for spectrum management reasons. Therefore, if we proceed with our proposals to revoke fixed links in and around high density areas, there would still be a period after the auction during which new users would need to coexist with current licensees. Our spectrum availability analysis shows that during the five year notice period for revocation, the presence of existing fixed links would reduce the spectrum availability for new uses in the bottom portion of the band where we propose to auction citywide licences (25.1-26.5 GHz). In contrast, in the top of the band, where there is no fixed link use, spectrum availability is less of a constraint for new uses (26.5-27.5 GHz).[178] This may mean bidders have different values for spectrum at the top of the band to spectrum at the bottom of the

[176] This approach could also reduce the ability for operators to switch between areas. For example, if one city became too expensive, an operator would only be able to switch demand from that city to an alternative, if that alternative city had already been disaggregated from the larger group of cities and towns.

[177] For example, if Bidders A, B and C each win 800 MHz of spectrum, in each of London, Manchester and Birmingham, 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 areas. However, if Bidders A, B and D won spectrum in Liverpool this would be a separate assignment stage round.

[178] In section 5 we set out the availability of spectrum for new users based on 200 MHz channels. In the bottom part of the band that we propose to auction (25.1-26.5 GHz), the analysis shows that more than 97% of locations are available for low power use in high density areas, whereas for medium power the availability is 65-90%. For the top of the band (26.5-27.5 GHz), availability is greater than 99% for both low and medium power in high density areas.

band. Therefore, we have considered whether we should separate the 26 GHz band into two lot categories, and have identified 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)

   There would 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 a particular lot category while the spectrum remains encumbered during the five year notice period for revocation. The second would determine the contiguous frequency assignment bidders would hold once the revocation notice period for fixed links ends.[179]

### Assessment of options

9.17 The main trade-off between having one lot category and two lot categories is between awarding contiguous spectrum and enabling bidders to express their preferences over encumbered and unencumbered spectrum during the principal stage.

9.18 The option of two lot categories with re-arrangement for long-term contiguity could alleviate the trade-off described above, but at the cost of extra complexity for two reasons. First, it would require two assignment rounds for every geographic lot category. This would increase the complexity of participating in the auction. Second, operators would be required to retune their infrastructure equipment after five years, if assigned a different frequency range in the second assignment stage.

[179] Here we provide an illustrative example to show how this option would work. In the principal stage, a bidder has won 200 MHz of encumbered spectrum (in the frequencies 25.1-26.5 GHz) and 400 MHz of unencumbered spectrum (in the 26.5-27.5 GHz range). The bidder would participate in the first assignment stage, which would allow it to express preferences for where its specific frequencies are placed in their respective categories. The bidder ends up with the following frequencies 25.1-25.3 and 26.7-27.1 GHz; which are fragmented. In the second assignment stage, the bidder wins the frequencies 25.1-25.6 GHz. As such, the bidder would have fragmented holdings for the first five years, after which it would need to re-tune its base station equipment to 25.1-25.6 GHz.

9.19 We seek views on all three options, and whether any option would pose significant challenges. We are currently minded towards either options (a) or (c), because they would guarantee contiguous spectrum for all bidders (in the longer term in the case of option (c)).

## Principal stage auction format

9.20 We have used a range of auction formats in the past, depending on which design we considered to be appropriate under the circumstances. The formats we have considered for this auction include: the Clock, the Simultaneous Multiple Round Ascending (SMRA) auction and the Combinatorial Clock Auction (CCA), which can all involve bidding for categories of generic spectrum lots.[180] We describe these formats below before setting out our preferred approach in this auction.

### Clock format

9.21 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.

9.22 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'). Intra-round bids can be used when a bidder's demand changes[181] between the price in one round and the next. In this case, a bidder can submit an intra-round bid indicating the precise price point at which its demand changes, allowing it to bid its specific valuation for the spectrum.[182]

### SMRA format

9.23 Similar to a Clock format, a SMRA is an ascending auction for different lots of spectrum simultaneously that takes place over a number of rounds. The main difference in comparison to a Clock is that in a SMRA, Ofcom would allocate Standing High Bids to the highest bid(s) placed on each lot category after each round.[183] When the auction ends,

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[180] We have previously described the SMRA and CCA formats, as well as the benefits and drawbacks of each, from paragraph 7.33 onwards in Award of the 700 MHz and 3.6-3.8 GHz, December 2018.

[181] Demand could increase as well as fall, following switching from another lot category.

[182] For example, if the Round 1 price was £100 per lot, Bidder X may want to bid for two lots at £100. However, if this price were to rise to £110 per lot in Round 2, Bidder X's demand may fall such that it does not want any lots for £110 each. However, an intra-round bid would enable Bidder X to signal the price at which its demand fell from two lots to zero lots, by submitting an intra round bid of (for example) £105. This would give Bidder X the opportunity to win two lots at £105, provided that no other bidders have demand for all the available lots at the Round 2 price of £110 per lot.

[183] Standing High Bids will either be bids placed at the round price (which will be 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 will also be selected among bidders who bid at a lower price in previous rounds.

Standing High Bids become winning bids and the bidders pay the amounts they bid. Unlike the Clock format, the SMRA does not allow intra-round bids.

### CCA format

9.24 The 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 (this is known as 'package bidding'). Bidders are either awarded a package of lots for which they bid in its entirety or nothing at all. This differs from the Clock and SMRA, in which a bidder submits bids in a number of individual lot categories separately, with the possibility of it winning fewer lots than it bid for.

9.25 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).[184] This is different to the Clock and SMRA, where bidders pay the amount that they bid for the lots that they win (a 'pay as bid' price rule).

### Preferred principal stage auction format

9.26 Our choice of auction design is often driven by the level of aggregation and substitution risk that bidders could face. [185] For this auction, we consider that there may be some aggregation and substitution risks, but that these are unlikely to be large enough to require package bidding to mitigate these issues. We therefore consider that a format that involves bidding on individual lot categories, such as the Clock and SMRA formats, would be more appropriate. These auction formats are simpler and conceptually more straightforward.

9.27 Between the Clock and SMRA formats, our preference is currently for a Clock auction. While the high level benefits of both are similar, the Clock format allows for a faster and simpler auction design because it removes the standing high bid mechanism, which is used in the SMRA.

## Assignment stage auction format

9.28 Upon completion of the principal stage of the auction, which determines the amount of spectrum that each bidder wins in each lot category, we propose to hold an assignment stage to determine the exact location of the spectrum won by each bidder.

9.29 Our preference is to use a single-round, sealed bid auction with a second price rule[186] for the assignment stage, as we have done in previous auctions.[187] Under this format bidders

[184] The second price rule requires bidders to pay an amount that is just sufficient to ensure that no other bidder or coalition of bidders was prepared to pay more for that package.
[185] Aggregation risk occurs when a bidder values a combination of lots more than the sum of the values of the individual lots in that combination. Substitution risk is the risk that bidders are unable to move all of their demand from one lot category to another (substitutable) lot category in response to a relative change in prices, and end in a situation with lots across both lot categories.
[186] The second price rule means that the price paid is the second-highest bid (or opportunity cost).
[187] 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.

are invited to bid for the exact location of their frequencies, amongst the permissible assignment plans. Bidders are invited to submit bids for all permissible options. We then identify the highest value combination of bids that can be accommodated. Alternatively, in the unlikely event that there is only one permissible assignment plan, there is no bidding in the assignment stage and bidders are assigned the frequencies corresponding to the spectrum they won in the respective band in accordance with this assignment.

9.30 If we have geographic lot categories as proposed above, we propose to run multiple assignment stage rounds to determine exact frequency locations within each different 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 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. We would also consider aggregating geographic lot categories with identical principal stage results before starting the assignment stage, as described at paragraph 9.13(b).

## Next steps

9.31 We will set out more detailed proposals on the auction design in a further consultation once we have received initial responses on the aspects above and reached a decision in relation to the proposed clearance of fixed links from the 26 GHz band in high density areas (in so far as it affects lot categories) and whether 40 GHz frequencies will also be included in the auction.

## Consultation questions

**Question 16**: Do you have any comments on our initial views in relation to auction design?

# 10. Duration of auction licences

## Duration of new citywide mmWave licences

10.1 When determining the appropriate duration of spectrum licences, we aim to strike a balance between ensuring licensees have sufficient long-term certainty for investment and maintaining ongoing optimal use of spectrum.

10.2 The spectrum licences for mobile bands that we have awarded in the most recent auctions[188] have:

a) an indefinite term (i.e. they continue in force until revoked by Ofcom 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.

10.3 Following an auction, operators may trade their awarded spectrum licences, which could help to ensure ongoing efficient allocation of spectrum. After the initial term of 20 years, Ofcom may also set annual licence fees based on administered incentive pricing (i.e. fees that reflect the opportunity cost of spectrum denied to other uses), as a further incentive for operators to trade their licences if they are no longer the highest value user of that spectrum. However, we also recognise that there may be transaction costs or barriers that licensees face in spectrum trading, for example in determining complex technical and commercial arrangements for a trade.[189]

10.4 In light of the emerging potential of new uses for mmWave spectrum, 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 our most recent approach of auctioning indefinite licences with an initial term of 20 years could result in an allocation of mmWave spectrum which could become inefficient over time, noting operators may face barriers in trading. We consider it may be appropriate to adopt alternative approaches to the duration of new licences we would award via auction in the 26 GHz or 40 GHz bands. These alternatives would involve awarding licences with either a fixed term (instead of an indefinite term) or an indefinite duration with an initial licence term of less than 20 years. In particular, we are considering 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.

[188] 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).

[189] *Consultation: Supporting the UK's wireless future: our spectrum management strategy for the 2020s*, published 4 December 2020, paragraph 7.18.

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 WT Act 2006 after the initial term).

10.5 In general, a fixed term licence (high level options (a) and (b) above), when compared to an indefinite licence, would mitigate the risk that trading alone may not be sufficient to maintain ongoing efficient allocation of spectrum. This is because Ofcom would have the opportunity to re-allocate the spectrum at the end of the term more readily and flexibly than under an indefinite licence approach.

10.6 A shorter initial or fixed term licence of 5, 10 or 15 years (high level options (b) and (c) above), when compared to a 20-year term, would also facilitate the ongoing optimal use of spectrum as it would allow Ofcom to intervene earlier to correct any inefficient allocation of mmWave spectrum. In particular, Ofcom could intervene by introducing annual licence fees or revoking licences at the end of the initial period of an indefinite licence, or by reallocating the spectrum at the end of a fixed term licence. However, a shorter-term length, particularly for a fixed term licence, would provide less investment certainty for the licensee than an indefinite licence.

10.7 We have considered what length of the fixed licence term or the initial term is likely to provide an appropriate level of investment certainty for citywide licensees. Our initial view is that five years is likely to be too short a period to provide meaningful investment certainty. [190] Twenty years would provide the most investment certainty, but presents a greater risk of allowing enduring inefficiency in the allocation. We consider that between 10 to 15 years may be reasonable to allow operators to recoup the costs of establishing their networks.

10.8 We are currently minded to adopt fixed term licences with a term between 10 to 15 years. However, we are seeking early views from stakeholders on all possible alternative options for licence duration for the 26 GHz and 40 GHz bands discussed in this section. We are planning to use these responses to refine the options we will consult on in more detail in our second consultation for new mmWave licences that we auction.

## Consultation questions

**Question 17**: Do you have any comments on the licence duration options we have considered in this section for new licences for the 26 GHz and 40 GHz bands that we would auction?

[190] A report by Nokia Bell estimated Return on Investment (RoI) of 20-30% for mmWave with payback periods less than four years when used in the right deployment scenarios for the right use cases, What is the business case for 5G mmWave? - Nokia Bell Labs (bell-labs.com). However we note that deployments may be somewhat constrained during the first five years while the incumbent licences remain in the 26 GHz and 40 GHz bands, since we must give five years' notice of revocation. We also note that business cases for new uses of mmWave spectrum are still developing, though we expect the potential benefits of these new uses to be high. This may mean operators' investment timelines for mmWave deployments may be longer than five years.

# 11. Potential competition measures in an award

## Summary

11.1 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.[191] Such benefits can include lower prices, greater choice for consumers and greater innovation in the market.

11.2 In sections 5 and 7 of this consultation, we have set out our assessment of the impact on competition of the options we have considered for existing licensees in the 26 GHz and 40 GHz bands respectively. In this section, we discuss potential competition concerns that might arise in the context of the proposed auction of new 26 GHz licences in high density areas, which might also include new 40 GHz licences if both bands were re-allocated on the same timeframe.[192]

11.3 For the purposes of this analysis, we have provisionally assumed that we would revoke existing spectrum licences in high density areas in the 26 GHz band and auction new licences, as we propose in section 3 of this consultation. In section 7 of this consultation, we set out four potential options in relation to the 40 GHz band.[193] We have therefore considered the potential competition concerns that might arise under each of the options for 40 GHz alongside the proposed auction of new 26 GHz licences. We have focused our analysis on mobile markets and high density areas as this is where we consider any competition concerns are most likely to arise.

11.4 In summary, our analysis is as follows (as explained above, each of the options for the 40 GHz band is assessed alongside the proposed auction of new 26 GHz licences):

- **Option 1 – Variation of all current 40 GHz licences** for new uses including mobile, without reallocating spectrum. Our provisional view is that varying the 40 GHz licences to allow for mobile use without reallocating the 40 GHz band could potentially lead to a competition concern arising in the longer term due to the magnitude of H3G's current 40 GHz holdings. This is because these holdings could allow it to provide services that other MNOs are unable to offer and be detrimental to competition. In that case, it may be appropriate to impose a competition measure such as a 'precautionary cap' which would prevent H3G from acquiring large amounts of 26 GHz spectrum.

[191] 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 as set out in paragraph 11.15.

[192] In sections 5 and 7, we have assessed the extent to which the options we are considering for our approach to existing licensees in the 26 GHz and 40 GHz bands may promote competition. In this section we assess whether we should impose any competition measures in the proposed auction of mmWave spectrum.

[193] We also assess the impact of these four potential policy options on competition in section 2 as part of our assessment against our broader analytical framework (see paragraphs 7.63-7.64).

- **Option 2 – Revocation of all 40 GHz licences** and reallocation of the entire band (3.25 GHz) for new uses, including mobile. Our provisional view is 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. Therefore, our provisional view is that it is unlikely that competition measures would be required under this option.

- **Option 3 – Partial revocation of 40 GHz licences** - revocation of H3G and MLL's licences, but not MBNL's licence.[194] Again, our provisional view is that a competition concern would be unlikely to arise under this option due to the large quantity of spectrum available to all MNOs and the fact that no MNO would start out with significant holdings of mmWave spectrum which could potentially be suitable for mobile use. As with option 2, it is unlikely that competition measures would be required under this option.

- **Option 4 – Partial variation and partial revocation of 40 GHz licences**, by varying H3G and MLL's licences to enable new uses, but only in relation to some of their existing frequencies.[195] Ofcom would revoke and re-allocate the rights to use H3G's and MLL's other 40 GHz frequencies.[196] Our provisional view is that a competition concern is 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. When compared with option 1 (variation of all 40 GHz licences), it is less likely, though still possible, that we would need to impose a competition measure such as a precautionary cap under this option.

11.5 Our reasoning for these provisional views is set out in this section and we welcome views from stakeholders on our analysis.

11.6 Following responses to this consultation we plan to publish a statement in Q3 2022/2023 which will include our provisional conclusion in relation to existing licences in the 40 GHz band. We intend to also publish a further consultation which will include (among other things) our detailed proposals on any measures we might include in the award to address potential competition concerns. For the avoidance of doubt, if we were minded to vary either all (option 1) or some (option 4) of the current 40 GHz licences, our further consultation would include the detail of any licence variation along with any competition measures which we might include in the award.

[194] Under this option, we would not vary MBNL's licence.
[195] We have provisionally proposed that we would vary half of H3G and MLL's 40 GHz licences and revoke and reallocate the other half.
[196] Under this option, we would be unlikely to revoke MBNL's licence or vary it.

## The context for our analysis

11.7 The 26 GHz and 40 GHz spectrum bands have been identified for International Mobile Telecommunications.[197] We think that these mmWave bands will be functionally substitutable[198] and therefore we consider the relevant spectrum bands for our provisional competition considerations to be the 26 and 40 GHz bands. We have not considered holdings of sub-6 GHz spectrum in our analysis as we consider mmWave spectrum is likely to be used in a very different way to sub-6 GHz spectrum by MNOs. The large bandwidths available in these 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.[199]

11.8 The potential uses of these mmWave spectrum bands are still emerging. This means that there is a range of estimates as to how much of this spectrum MNOs and others are likely to want to acquire[200] and that therefore it is not fully clear in what circumstances any potential competition concerns could arise. In general terms, we would tend to be concerned if there was a significant imbalance in spectrum holdings which could result in a weakening of competition.

11.9 There are four national MNOs in the UK: EE, Vodafone, O2 and H3G (Three). O2 has the largest market share (c. 35%), followed by EE (c. 34%), Vodafone (c. 18%) and H3G (c. 13%).[201] Data is an increasingly important part of their offering, with total aggregate monthly mobile data traffic increasing by a multiple of 20 between 2011 and 2021.[202] We consider that the current provision of mobile services is functioning well, with competition between the MNOs delivering good outcomes for consumers.

11.10 All four MNOs currently have holdings of sub-6 GHz spectrum which they use for mobile.[203] However, in terms of the mmWave spectrum bands which we plan to make available for mobile use in the future (26 GHz and 40 GHz), H3G is currently the only MNO with holdings in these bands (although its current licence does not allow it to use these holdings for mobile). The figure below shows current holdings in the 40 GHz band as well as the amount of 26 GHz spectrum proposed to be made available in this auction.

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[197] For further detail see paragraphs 2.10 and 2.14.

[198] As set out in paragraphs 2.47 and 2.51.

[199] See paragraph 2.4.

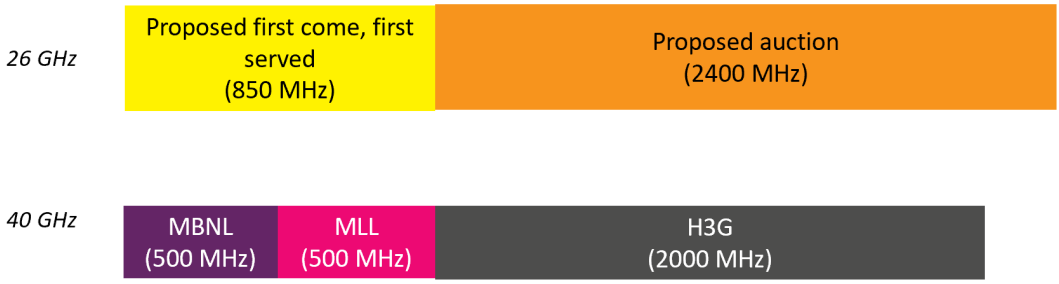
[200] See paragraph 2.41.

[201] On a consumer subscriber basis in Q1 2021 – Source: Ofcom, Main Technology Tracker 2021 data tables pages 157-159, QD10: "Which mobile network do you use most often?". Figures for Virgin Media O2 include giffgaff, Sky Mobile, TalkTalk and Tesco Mobile; figures for EE include BT, Plusnet, Utility Warehouse and Virgin Media; figures for Three include iD Mobile and Smarty; and figures for Vodafone include Asda Mobile, Lebara, Lyca Mobile, Talk Mobile and Voxi.

[202] As referenced in Discussion paper: Ofcom's future approach to mobile markets, page 14.

[203] For full breakdown of spectrum holdings by MNO see: Frequency allocations: Mobile and wireless broadband below 5 GHz.

**Figure 11.1 Current holdings of 40 GHz spectrum[204] and amount of 26 GHz spectrum potentially available (if we were to revoke existing licences in the 26 GHz band)[205]**




11.11 If we were to vary the 40 GHz licences then H3G would be the only MNO with significant existing holdings of mmWave spectrum which could be used for mobile use in the future. Of the 6,250 MHz of spectrum available in the mmWave bands which could be suitable for mobile use in the future[206], H3G currently holds 2000 MHz of nationwide block-assigned licences (equivalent to 32% of total spectrum in the two bands).[207] [208]

## Framework to assess potential concerns

11.12 In principle, the framework that we use to assess any potential competition concerns that might arise in the context of the proposed auction of new 26 GHz licences (which might also include new 40 GHz licences if both bands were re-allocated on the same timeframe) consists of the following steps:

- Identifying any spectrum allocations arising from the auction which might give rise to **competition concerns** i.e. distributions of spectrum holdings that could weaken future competition in mobile markets[209]. We would also consider the potential **severity** of the effect on competition if these outcomes were to occur.
- Considering how **likely** it is that these outcomes would arise as a result of participants' behaviour in the auction in the absence of any competition measures.

[204] Note that the current licences for this band do not allow for mobile use – this would require a licence variation.
[205] Note that this would not be all existing licences in the 26 GHz band but only those in and around high density areas as set out in section 3.
[206] Subject to the variation of 40 GHz licences.
[207] We note that this percentage would increase to 37% of spectrum in high density areas if we include only the 2400 MHz of 26 GHz spectrum that will be made available for city-wide licences and exclude the 850 MHz that will be made available on a first come, first served basis.
[208] MBNL, which holds 500 MHz of 40 GHz spectrum, is jointly owned by H3G and EE. We will take into account their access to this spectrum in our competition assessment.
[209] Or any other relevant services such as FWA or other users.

- Where there is a strong likelihood of a such a competition concern arising, we would then set out our assessment of possible **competition measures** which we could impose to address our concerns (e.g. spectrum caps).

11.13 We have taken account of this framework in this assessment, and will apply it in more detail when we consult further on any measures we might include in the award to address potential competition concerns.

## Where could competition concerns arise?

11.14 We have focused our analysis of competition concerns on the mobile market. Although the range of possible uses for the 26 GHz (and 40 GHz) spectrum is wider than this and includes for example Fixed Wireless Access, we have not identified any potential concerns relating to other use cases. In the case of Fixed Wireless Access, this is because connectivity could be provided using other mmWave spectrum bands[210] and fixed broadband – the main substitute – is widely available in the UK. We therefore consider that the proposed auction is unlikely to have a notable impact on competition for Fixed Wireless Access in high density areas. We have also focused our assessment on spectrum awarded in high density areas on the basis that we have proposed to award spectrum by auction only in these areas.

11.15 In general, we would tend to be concerned if there was a significant imbalance in spectrum holdings that resulted in a weakening of competition. Our provisional view is that imbalances of mmWave spectrum are unlikely to cause a competition concern in the shorter term. We expect that the amount of spectrum available will be sufficient to meet the requirements of all the MNOs for delivery of new uses of mmWave spectrum in the short term. That is, even if there are imbalances in spectrum holdings, the availability of spectrum would mean that competition would not be weakened.

11.16 However, it is unclear whether this will remain the case in the long term as new use cases emerge. If new use cases emerged which require significantly larger holdings of mmWave spectrum to deliver services to users, imbalances could potentially lead to a competition concern. Therefore, our analysis considers whether competition concerns are likely to arise in the long term.

11.17 In considering where potential competition concerns could arise, we assess the likelihood of strategic bidding occurring. Strategic bidding occurs (for example) where a bidder bids above its intrinsic valuation of the spectrum in order to try to prevent other bidders from obtaining it and thereby weaken competition. Our provisional view is that the benefits of preventing other bidders from obtaining large amounts of spectrum are uncertain, as use cases and likely spectrum requirements for these bands are still emerging, particularly over the long term. Also, given the amount of spectrum that would be available, the costs of such a strategy could be high. Even if the price of the spectrum were relatively low, an

[210] Such as the 28 GHz, 32 GHz and 57-71 GHz bands.

operator would need to acquire a large quantity of spectrum in the auction in order to prevent its rivals acquiring what they needed.

## If we were to revoke and re-allocate licences in all or the majority of the 40 GHz band in addition to the 26 GHz band, we have not identified any competition concerns

11.18 Two of the potential options for consultation with regards to licensees in the 40 GHz band involve revocation of the majority of existing licences in the band and reallocation of this spectrum for mobile use, alongside the 26 GHz band. Under option 2, all existing 40 GHz licences would be revoked and re-allocated, and under option 3 H3G and MLL's licences would be revoked and re-allocated, but not MBNL's. These options are discussed in more detail in section 7. In both of these scenarios, there would be a large amount of mmWave spectrum (around 6 GHz) available for mobile use with none of the MNOs holding any licensed mmWave spectrum for mobile use in high demand areas at the start of the auction process.

11.19 Given the amount of spectrum available in such a scenario, we expect that MNOs would be able to acquire as much mmWave spectrum in the auction as they need.

11.20 Whilst we might in theory be concerned about a hypothetical outcome in which one MNO obtained a very high proportion of the total available 26 GHz and 40 GHz spectrum bands, we consider that such an outcome would be unlikely because of the large amount of spectrum available in these options and the fact that no MNO would have any prior holdings. Likewise, the risk of strategic bidding in such an auction appears to be low, as discussed in paragraph 11.18 above.

11.21 On this basis, our provisional view is that there are unlikely to be any competition concerns arising either in the short term or the longer term, or competition measures required if we were to adopt either option 2 or option 3, revoking the 40 GHz licences and reallocating them for mobile use, alongside the 26 GHz band.

## Varying existing 40 GHz licences could risk a competition concern emerging in the longer term

11.22 The remaining options we are considering with respect to 40 GHz involve varying some or all of the licences of existing spectrum holders in the 40 GHz band to allow mobile use, alongside allocating the 26 GHz band to new users.

11.23 Option 1 involves variation of all current 40 GHz licences, without reallocating the spectrum, and is explained in more detail in section 7. Our provisional view is that adopting this option could potentially lead to a competition concern arising in the longer term, in the absence of any competition measures, because of the magnitude of H3G's existing holdings in the 40 GHz band.

11.24 As set out above, H3G currently holds 2000 MHz of 40 GHz spectrum which is a significant proportion (32-37% depending on the assumptions used) of the total mmWave spectrum which could be suitable for mobile use in the future (i.e. across the 26 GHz and 40 GHz bands), whilst the other three MNOs do not currently have any direct holdings in these bands. In this scenario if H3G were to acquire a significant amount of 26 GHz spectrum in the auction, it would hold a majority of the mmWave spectrum suitable for future mobile use.

11.25 As explained previously, our provisional view is that such large imbalances of mmWave spectrum are unlikely to cause a competition concern in the shorter term. This is because we expect that the amount of spectrum available in the auction will be sufficient to meet the requirements of all the MNOs in the short term.

11.26 However, we consider that one MNO holding such a large proportion of mmWave spectrum could potentially become a competition issue in the longer term if MNOs require increasing amounts of mmWave spectrum for new use cases in the future. As noted previously, the mmWave landscape is still developing, and we expect new use cases to emerge over time.[211]

11.27 It is difficult to define the exact nature and severity of such a potential competition concern because future use cases remain speculative and the amount of mmWave spectrum that is likely to be required by MNOs in the longer term is unknown. However, we would in general be concerned if H3G were to acquire such a large amount of mmWave spectrum that, in the longer term, it was able to offer superior services that other MNOs were not able to replicate. This could lead to weaker competition and therefore higher prices or lower quality services in the longer term.

11.28 The likelihood of such a competition concern occurring is not clear. This is because use cases for mmWave spectrum are still emerging and estimates on how much spectrum MNOs would require to provide these vary widely.

11.29 Although the nature of this potential competition concern is not yet clear in terms of either its severity or likelihood, we may need to consider implementing some form of competition measure to address this and to ensure that strong competition is maintained in the mobile market in the face of uncertainty around the future use cases of mmWave spectrum and the likely amounts required.

11.30 In deciding whether or not to impose a competition measure, we would consider a range of factors, including:

a) What evidence is there of use cases which are likely to require large amounts of mmWave spectrum in the future?

[211] For further detail, see paragraphs 2.40-2.41.

b) When will 40 GHz spectrum be available for mobile use?[212] (noting our provisional view to enable the 40 GHz band for new uses on the same or similar timeframe to the 26 GHz band)

c) What is the proposed licence duration for 26 GHz licences? (i.e. is it fixed term or indefinite? If it is indefinite, what is the length of the initial term?).

11.31 One potential competition measure which we are considering is a 'precautionary cap' which would prevent H3G from acquiring large amounts of 26 GHz spectrum in addition to their current holdings in the 40 GHz band. Such a cap would likely be less restrictive than measures that we have imposed historically, reflecting the uncertainty which surrounds potential future competition concerns. For example, it could still enable H3G to acquire spectrum in the 26 GHz band, but would prevent a very large spectrum asymmetry between MNOs from occurring, which could potentially be damaging to competition in the future.

11.32 We have also considered an option of partial variation and partial revocation of the licences in the 40 GHz band as provisionally considered in section 7, where half of H3G and MLL's existing frequencies are re-allocated for new uses (option 4). This option would likely be in addition to option 3 (not revoking MBNL's licence). This option is set out in more detail in section 7. Our provisional view is that this option, which would allow for an additional 1.25 GHz of mmWave spectrum for new uses, would be less likely to lead to a competition concern than option 1. This is because although H3G would begin the auction process with existing holdings of mmWave spectrum, these would be much lower than under option 1 (16-19% depending on the assumptions used). Therefore, H3G would need to acquire much more of the available spectrum in the 26 and 40 GHz awards for there to be an imbalance in spectrum holdings that could potentially lead to a competition concern in the longer term. It is therefore less likely, though still possible, that we would need to impose a competition measure such as a precautionary cap under this option than under Option 1. If the proportion of H3G and MLL's frequencies to be revoked and re-allocated was not set at half of the frequencies currently authorised under their 40 GHz licences, as provisionally proposed in section 7, this would affect our assessment of competition concerns.

11.33 However, as explained above, if our provisional conclusion following responses to this consultation was that we were minded to propose option 1 or option 4, we would further consult on the detail of any licence variation and which competition measures (if any) we might include in the award to address any potential competition concerns.

[212] This would consider both the timing of the potential licence variation and also the availability of equipment for 40 GHz.

## Consultation question

**Question 18**: Do you agree with our assessment of potential competition concerns and that it may be appropriate to impose a competition measure such as a 'precautionary cap'?

# 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 18 July 2022.

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, 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
Spectrum Group
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 if your response is submitted via the online web form, but not otherwise.

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 Helen Yu on 020 79813000, or by email to the consultation email address 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 all responses on the Ofcom website as soon as we receive them.

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 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

A1.15 Following this consultation period, Ofcom plans to publish a statement in Q3 2022/2023.

A1.16 If you wish, you can register to receive mail updates alerting you to new Ofcom publications.

## Ofcom's consultation processes

A1.17 Ofcom aims to make responding to a consultation as easy as possible. For more information, please see our consultation principles in annex 2.

A1.18 If you have any comments or suggestions on how we manage our consultations, please email us at consult@ofcom.org.uk. We particularly welcome ideas on how Ofcom could more effectively seek the views of groups or individuals, such as small businesses and residential consumers, who are less likely to give their opinions through a formal consultation.

A1.19 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

# 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 a summary of no more than two pages. We will try to make it as easy as possible for people to give us a written response. If the consultation is complicated, we may provide a short Plain English / Cymraeg Clir guide, to help smaller organisations or individuals who would not otherwise be able to spare the time to share their views.

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 all the responses on our website as soon as we receive them. After the consultation we will make our decisions and publish a statement explaining what we are going to do, and why, showing how respondents' views helped to shape these decisions.

# 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? _____

_____

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

## DECLARATION

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

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

Name Signed (if hard copy)

# A4. Consultation questions

A4.1 We invite responses to the questions listed on pages 125 and 126. We also welcome any other comments on our proposals set out in this consultation.

**Question 1**: (Section 2) Do you have any comments on our assessment of potential use cases, demand and deployment strategies for new uses of mmWave spectrum?

**Question 2**: (Section 2) Do you have any comments on our proposed overall approach to mmWave spectrum (including our aim to make the 26 GHz and 40 GHz bands available for new uses on the same or similar timeframe)?

**Question 3**: (Section 3) Do you agree with our approach of specifying high and low density areas in the UK, and authorising new uses differently in those areas?

**Question 4**: (Section 3) Do you agree with our overall authorisation approach in high density areas for the 26 GHz band (i.e. to grant Shared Access licences on a first come, first served basis for the bottom 850 MHz of the 26 GHz band, (24.25-25.1 GHz), and to auction citywide licences for the rest of the 26 GHz band (25.1-27.5 GHz))?

**Question 5**: (Section 3) Do you agree with our overall authorisation approach in low density areas for the 26 GHz band (i.e. to grant Shared Access licences on a first come, first served basis)?

**Question 6**: (Section 3) Do you agree with adopting a similar approach to authorising the 40 GHz band as our proposals for the 26 GHz band, if we were to decide to re-allocate the 40 GHz band?

**Question 7**: (Section 4) Do you agree with our proposed methodology for identifying and defining high density areas?

**Question 8**: (Section 4) Do you agree with our proposed cut-off point of 40 high density areas?

**Question 9**: (Section 5) Do you agree with our proposal to clear the fixed links in and around high density areas from the 26 GHz band?

**Question 10**: (Section 5, Annex 8) Do you agree with our estimates of the cost of migrating fixed links into alternative spectrum bands?

**Question 11**: (Section 6) Do you agree with the proposed approaches we have outlined to manage coexistence between new 5G users and the different existing users in the 26 GHz band? In particular, do you have any views on our proposals to limit future satellite earth stations in this band to low density areas only, and to end access to this band for PMSE users with five years' notice?

**Question 12**:(Section 7) Do you agree with our initial assessment on which option for enabling the 40 GHz band for new uses would best achieve our objectives?

**Question 13**: (Section 7, Annex 8) Do you agree with our analysis of the impact on existing 40 GHz licensees, including our estimates of the cost of moving fixed links under the options involving revocation (options 2, 3 and 4)?

**Question 14**: (Section 8) Do you have any comments on our high-level Shared Access proposals (including technical and non-technical licence conditions and proposed approach to setting fees)?

**Question 15**: (Section 8) Do you agree with the overall approach we have set out to coordination and coexistence between new Shared Access users in the 26 GHz band and existing users?

**Question 16:** (Section 9) Do you have any comments on our initial thinking in relation to auction design?

**Question 17**: (Section 10) Do you have any comments on the licence duration options we have considered in this section for new licences for the 26 GHz and 40 GHz bands that we would auction?

**Question 18**: (Section 11) Do you agree with our assessment of potential competition concerns and that it may be appropriate to impose a competition measure such as a 'precautionary cap?