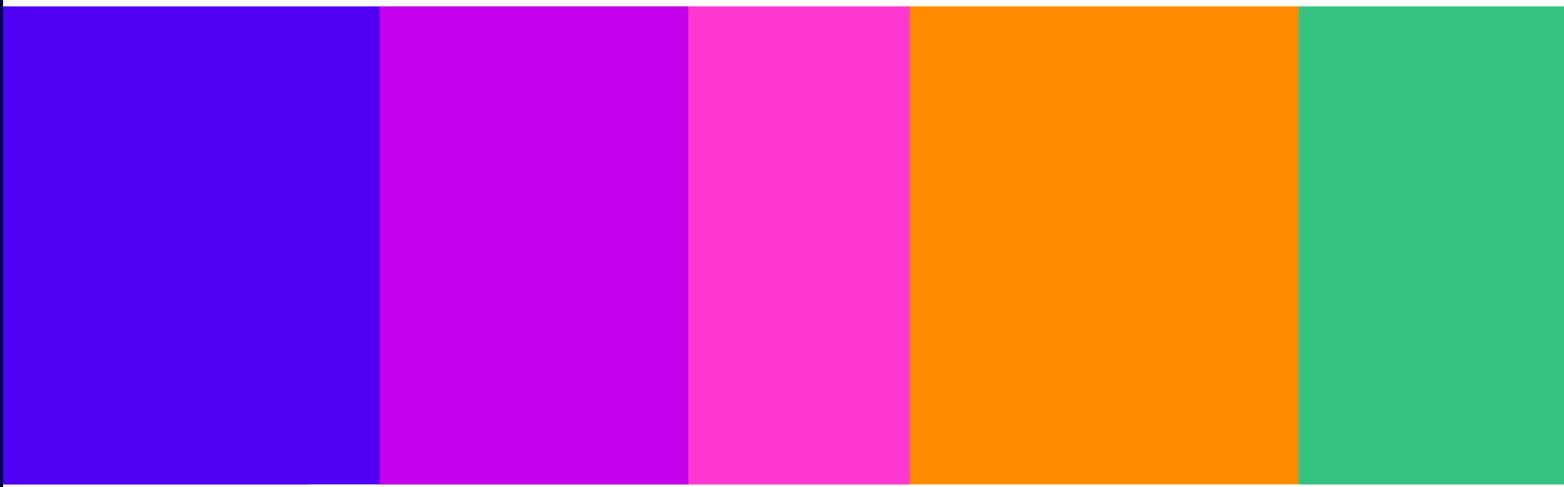


Enabling mmWave spectrum for new uses

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

Statement

Published 27 September 2023



Contents

Section

1. Overview.....	3
2. Authorisation of the 40 GHz band.....	7
3. Identifying fixed links in the 26 GHz and 40 GHz bands which are likely to receive harmful interference from mobile services.....	13
4. Coordination.....	25
5. Non-technical conditions for the award licences.....	49
6. Award licence duration	59
7. Technical licence conditions for award licence and Shared Access licences.....	71
8. Shared Access licences	83
9. Other comments	95

Annex

A1 Legal framework.....	98
A2 Fixed links in the 26 GHz band for revocation	103

Annexes 3-10 are available as separate documents on [Ofcom's website](#)

A3 Draft coordination notice	
A4 Sample award licence	
A5 Sample Shared Access licence	
A6 Draft Interface Requirements for 26 GHz award licences	
A7 Draft Interface Requirements for 40 GHz award licences	
A8 Draft Interface Requirements for medium power Shared Access licences	
A9 Draft Interface Requirements for low power Shared Access licences	
A10 High density areas booklet	

1. Overview

- 1.1 We are enabling the industry to use a large amount of spectrum in the 26 GHz and 40 GHz bands (together, “**mmWave spectrum**”) for new services, including 5G. The 26 GHz and 40 GHz spectrum bands, which together comprise 6.25 GHz of spectrum, have both been identified for mobile services globally, and for 5G in Europe. Making mmWave spectrum available for new uses has the potential to deliver significant benefits to people and businesses in the UK. This policy offers operators the opportunity to access very large contiguous blocks of spectrum, which can enable services requiring very high capacity and speeds. We expect that mmWave spectrum will play an important role in enabling operators to meet future growth in demand for data and to develop innovative services.
- 1.2 In March 2023, we set out how we will allocate mmWave spectrum to best support new uses:
 - a) In the 68 major towns and cities, in which we expect the highest volume of mmWave deployment (“**high density areas**”), we will both: assign local licences on a first come, first served basis, using our Shared Access licensing framework and award citywide licences by auction.
 - b) Elsewhere in the UK (“**low density areas**”), we expect deployments to be sparser, and so we will assign local licences on a first come, first served basis, using our Shared Access licensing framework.
- 1.3 We now set out our decisions on the licence conditions which we will use in authorising this spectrum. We will publish a separate document setting out our decisions and further proposals for the design of the auction of citywide licences authorising use of this spectrum later this year.

What we have decided – in brief

We are enabling opportunities to access mmWave spectrum across the country for a variety of new uses, including 5G. In this document, we set out our decisions to:

- Auction Spectrum Access licences to use both 26 GHz and 40 GHz spectrum in the major towns and cities, where we expect the highest volume of mmWave deployment (“**high density areas**”). We refer to these licences as the “**award licences**” in the remainder of this document.
- Hold this auction after the CMA’s decision on the proposed merger between H3G and Vodafone.
- Set a 15 year term for these award licences and consult on our approach to ensuring an efficient allocation of the spectrum at the end of this term.
- Include the majority of our standard Spectrum Access licence terms and conditions in the award licences, and our standard Shared Access licence terms and conditions in the Shared Access licences.
- Include technical conditions specific to mmWave spectrum, in particular we will set a maximum transmit power of 36 dBm in the award licences and the medium power Shared Access licences.

- Use the method that we proposed in March 2023 for identifying which fixed links using mmWave spectrum and located outside high density areas are likely to receive harmful interference from new users operating in high density areas.

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

Our decisions

Auction timing

- 1.4 In the March 2023 Statement and Consultation, we set out our intention to hold the auction for citywide licences for mmWave spectrum in Q1 of FY 2024/25 and for Shared Access licences in the 26 GHz band to be available at the same time. Several consultation respondents encouraged us to make mmWave spectrum available as quickly as possible.
- 1.5 However, in June 2023, H3G and Vodafone announced their intention to merge their UK operations, subject to regulatory approvals. The CMA's decision on the proposed merger is expected in September 2024.
- 1.6 After careful consideration, given these specific circumstances, to avoid the risk of an inefficient allocation of spectrum, we have decided to delay commencing the auction process. Therefore, we will not commence the auction process until the CMA has taken its decision on the proposed merger. We therefore do not expect the award process to begin before Q3 FY 2024/25.
- 1.7 Nevertheless, we plan to make Shared Access licences available in the 26 GHz band early next year.

Award (Spectrum Access) licence conditions

- 1.8 We will award **15 year, fixed term** licences in the auction. These licences will authorise medium power use of this spectrum in all of the designated high density areas. The licences will contain all of the non-technical conditions normally included in Ofcom's existing Spectrum Access licences typically held by mobile operators (other than in relation to their geographic scope and their term).
- 1.9 Further detail about the licence conditions on which we will award mmWave spectrum is available in Section 5-7.

Shared Access licence conditions

- 1.10 We will issue Shared Access licences in the 26 GHz and 40 GHz bands based on the existing Shared Access framework and non-technical licence conditions. Shared Access licences authorising use of mmWave spectrum will be available in:
 - a) all of the designated high density areas, where 650 MHz of the 26 GHz band (24.45-25.1 GHz) will be available for low power use; and
 - b) in low density areas, where the 26 GHz (24.45-27.5 GHz) and 40 GHz (40.5-43.5) bands will be available for low power and medium power use on a coordinated basis with existing users.

- 1.11 The technical conditions in these licences will be specific to mmWave spectrum. In particular, we will set a maximum transmission power limit of:
- a) 36 dBm / 200 MHz TRP for medium power base stations; and
 - b) 25 dBm / 200 MHz TRP for low power indoor and outdoor base stations, with an antenna height limit of 10m for outdoor low power base stations.
- 1.12 Low power Shared Access licences in the 24.45-25.05 GHz band will allow licensees to deploy up to three outdoor transmitters under each licence in order to protect Earth Exploration Satellite Services (EESS). Licensees wishing to deploy more than three outdoor transmitters in a 50 metre radius will need to obtain an additional licence.
- 1.13 We will offer channel sizes of 50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz, with a licence fee of £80 per 100 MHz of spectrum, subject to a minimum licence fee of £80 for bandwidths of 100 MHz or less.
- 1.14 In the 26 GHz band, Shared Access licences will be available from early 2024, and in the 40 GHz band they will be available from 2028.
- 1.15 Further detail about the conditions on which we will make Shared Access licences available are set out in Section 8.

Coordination

- 1.16 We have decided to set conditions for mitigating the risk of harmful interference between all licensed users of the 26 GHz and 40 GHz bands once new uses are authorised.
- 1.17 In the 26 GHz band, we will coordinate deployment of Shared Access licensees' medium power base stations (which will only be allowed outside high density areas), and require minimum separation distances between their low power base stations. We will also require all new licensees to comply with a field strength limit at the boundary of any high density areas.
- 1.18 We will not make Shared Access licences available in the 40 GHz band until 2028, removing the need for coordination until that point.
- 1.19 We will also set conditions for mitigating the risk of harmful interference between all existing fixed links in the 26 GHz and 40 GHz bands and the winners of award licences in high density areas for the period during which they will both be authorised to use mmWave spectrum:
- a) In the 26 GHz band, we will do this by designating coordination areas around fixed links in high density areas during this period. Within these areas, we will require new high density area licensees to have new deployments coordinated and authorised by Ofcom. Outside these coordination areas, we will allow new high density area licensees to deploy without first applying to Ofcom.
 - b) In the 40 GHz band, we will coordinate award winners' deployments with incumbent fixed links during this period.

Identification of fixed links for clearance

- 1.20 In the March 2023 Statement and Consultation, we consulted on a proposed method for identifying which fixed links around high density areas operating in the 26 GHz band and the 40 GHz band are unlikely to be able to coexist with mobile base station deployments in these areas, due to the likelihood that the links would receive harmful interference from new users operating in these areas.

- 1.21 Having considered stakeholders' comments, we have now decided to proceed with the method that we proposed, with two changes that: account for the increase in the maximum transmission power limit of a mobile base station from 30 to 36 dBm / 200 MHz TRP, and correct implementation errors.
- 1.22 We will use this method to determine:
- a) the existing 26 GHz licences authorising fixed links around any designated high density area in relation to which we will shortly start the statutory revocation process; and
 - b) the existing links operated by H3G and MBNL in the 40 GHz band around any designated high density area in relation to which we will offer to grant individual fixed link licences before the end of the revocation period (i.e., before June 2028). As set out in more detail in our [Update Note](#), we have recently completed the statutory process for revoking existing licences in the 40 GHz band and revoked them with effect from 1 June 2028.

Impact assessment

- 1.23 In reaching the decisions set out in this statement, we have considered the impact of our decisions on relevant stakeholders, including citizens and consumers. We discuss stakeholders' comments on the impact of our proposals and explain how we have taken them into account in reaching our final decisions, where relevant. As set out in the March 2023 Statement and Consultation (paragraph 2.78), we do not consider that our decisions have equality implications under the 2010 Act or the 1998 Act.

Next steps

- 1.24 We intend to publish later this year a statement and further consultation setting out our decisions and further proposals on the design of the auction, and a draft of the Auction Regulations (the statutory instrument which will give effect to our decisions on the auction design).
- 1.25 To implement our policy decisions on how we intend to authorise use of mmWave spectrum, we also need to make various other statutory instruments. In particular, we need to make regulations to (i) exempt the use of relevant terminal equipment from the need to hold a licence; (ii) make the new licences tradable; and (iii) include information about these new licences in our wireless telegraphy register. We also need to make an order to specify that we will grant a limited number of award licences for the use of the mmWave bands in high density areas and that their precise number will be determined by the application of the procedure set out in the Auction Regulations. We will consult on our proposed statutory instruments next year.
- 1.26 We will shortly issue notices of proposed revocation in relation to any fixed links operating in the 26 GHz band which are either (i) in the high density areas or (ii) around high density areas and likely to receive harmful interference from new mobile services. As part of this process, licensees will have the opportunity to make representations, which we will consider before making a final decision.

2. Authorisation of the 40 GHz band

Summary

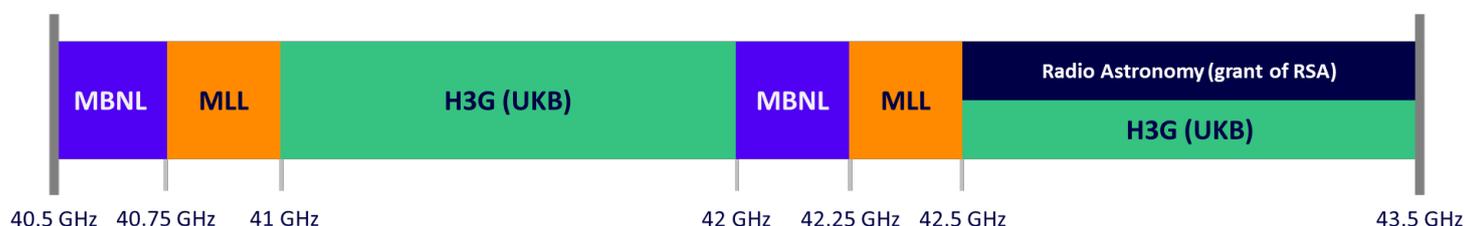
2.1 In line with our consultation proposals, we have decided to make the whole of the 40.5-43.5 GHz band (the “**40 GHz band**”) available for auctioned citywide Spectrum Access licences covering 68 designated High Density areas¹ and, in the rest of the country, to make the whole band available for local first come, first served licences from June 2028, using our Shared Access licensing framework.

Background

2.2 As shown below, there are three existing licensees in the 40 GHz band – UK Broadband,² MBNL,³ and MLL - which hold block assigned national licences that were allocated by auction in 2008.⁴ 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. UK Broadband and MBNL use the 40 GHz band to provide point-to-point fixed links, while MLL has no deployments in the band.

2.3 There is also one grant of Recognised Spectrum Access (“**RSA**”) for radio astronomy at 42.5-43.5 GHz.⁵ A 50km exclusion zone applies around the radioastronomy site at Cambridge for these specific frequencies.

Figure 2.1: Existing users of the 40 GHz band



2.4 In the [March 2023 Statement and Consultation](#),⁶ we decided to start the statutory process for revoking the three existing licences in the 40 GHz band to make the relevant spectrum available for new uses, and to award both 40 GHz and 26 GHz spectrum in high density areas in a single auction. In addition (i) we decided to offer to grant individual fixed link licences for links already in place in the 40 GHz band where these are outside the designated high density areas and unlikely to receive interference from mobile deployments in such areas,

¹ We will also enable access to the auctioned spectrum through our Local Access licensing framework, as explained in further detail in Section 5.

² UK Broadband is owned by H3G.

³ MBNL is a joint venture between H3G and BT/EE.

⁴ The 40 GHz licences are published on the “[Mobile and wireless broadband above 5 GHz](#)” page of Ofcom’s website.

⁵ Ofcom’s 19 August 2022 frequency allocation table, “[Space science and meteorology spectrum allocations in the UK](#)”, p. 8.

⁶ [March 2023 Statement and Consultation](#), Section 7.

and (ii) we consulted on a method for identifying which links around high density areas are likely to receive interference from mobile deployments in those areas.⁷ As set out in Section 3, we have now decided to apply the method set out in the March 2023 Statement and Consultation⁸ for identifying which links around the designated high density areas are unlikely to receive interference from new mobile services in those areas and are therefore eligible for being migrated into new individual fixed link licences.

- 2.5 On 20 March 2023, we sent a notice of proposed revocation to UK Broadband, MLL and MBNL. On 25 May 2023, after considering licensees' representations in response to our notice of proposed revocation, we completed the statutory process for revoking existing licences in the 40 GHz band and revoked them with effect from 1 June 2028.⁹ In light of MBNL's representations, we decided to offer to grant MBNL individual temporary licences (starting on 1 June 2028 and expiring on 1 January 2030) for up to 500 of its existing fixed links that are outside the top 10 high-density areas, Dover, Folkestone & Hythe and Stansted Airport.

Authorisation of the 40 GHz band in high density and low density areas

Our proposals

- 2.6 We proposed to make the whole of the 40 GHz band available:
- a) for auctioned citywide licences in high density areas, with potential access to the auctioned spectrum also through the [Local Access licensing framework](#),¹⁰ and
 - b) for local first come, first served licences in the rest of the country from June 2028, using our Shared Access licensing framework. In line with our 26 GHz authorisation model, we proposed that both low and medium power (shared access) licences would be available in these areas¹¹ and that we would allow any of the existing licensees' fixed links which operate outside high density areas and which are unlikely to receive interference from new mobile services to continue to operate in the band.¹²

Summary of responses

- 2.7 Four stakeholders commented on our approach to authorisation of the 40 GHz band – the majority supported our proposals. In particular:
- a) BT/EE¹³ agreed with our proposals to make low and medium power shared access licences available in low density areas only after the end of the 5-year revocation period (i.e. from June 2028).
 - b) Qualcomm¹⁴ said that it “supports Ofcom proposal [of] allowing MNOs to be awarded licenses in high density areas”.

⁷ March 2023 Statement and Consultation, paras. 1.13, 7.8, 7.170-7.176 and Annex A16.

⁸ March 2023 Statement and Consultation, Annex A16.

⁹ Ofcom's 30 May 2023 [Update on revoking licences in the 40 GHz band](#).

¹⁰ March 2023 Statement and Consultation, paras. 1.4, 3.67-3.70 and 11.22-11.24.

¹¹ March 2023 Statement and Consultation, paras. 1.4 and 3.74-3.76.

¹² March 2023 Statement and Consultation, paras. 1.13 and 7.170-7.176.

¹³ [BT/EE response to the March 2023 Statement and Consultation](#), p. 3.

¹⁴ Qualcomm response to the March 2023 Statement and Consultation, p2

- c) VMO2¹⁵ said that our proposed approach “will provide operators using both licensed and shared use spectrum, with full access to spectrum in all likely deployment areas from 2028” and that by that time “the mmWave ecosystem and business case will, hopefully, be well developed”. However, VMO2¹⁶ expressed concerns about our proposal to extend the Local Access licensing framework to the auctioned mmWave spectrum because (i) mmWave spectrum will only be available in high density areas, (ii) “the shared access spectrum acts [as] an effective substitute” and (iii) making Local Access licences available might act as a “further disincentive to acquire mmWave spectrum at auction, due to the impact on rights to deploy, the introduction of delay and the associated complexity”.
- d) An individual respondent [CONFIDENTIAL ✕] commented on our approach to authorising the spectrum in light of his views about the limited realistic use cases for mmWave spectrum. He set out his view that mmWave spectrum should be deployed by neutral hosts, and/or a substantial degree of shared network infrastructure and spectrum, and that accordingly we should make more spectrum available for shared access, and less by auction.

Ofcom’s decision

- 2.8 We note that we set out our decisions on how we should authorise the 26 GHz band in the March 2023 Statement and Consultation, and the views expressed by [CONFIDENTIAL ✕] in support of making more spectrum available for shared access, and less by auction, do not change our decision on this. In light of this respondent’s comments, we have considered whether we should allocate more of the 40 GHz band through our Shared Access licensing framework. We do not consider this would be appropriate. We carefully considered the appropriate balance between Shared Access and auctioned citywide licences in the March 2023 Statement and Consultation.¹⁷ We remain of the view that making 650 MHz of spectrum (24.45-25.10 GHz) available for Shared Access use in high density areas, and 6.05 GHz of spectrum (24.45-27.5 and 40.5-43.5) available for Shared Access use in low density areas, strikes an appropriate balance between these different users.
- 2.9 As explained in the March 2023 Statement and Consultation,¹⁸ we consider that making 650 MHz of spectrum available for Shared Access licences in high density areas in the 26 GHz band (24.45-25.10 GHz) is likely to be sufficient to meet the requirements of local users, in particular because 650 MHz is within range of early indications of demand (200 MHz-1 GHz, as set out in the May 2022 Consultation) and the GSMA¹⁹ said that 150- 400 MHz would be required for an enterprise network (i.e. mobile private network). We therefore consider that 650 MHz would allow for multiple users to deploy in a particular location and/or a single local user to access larger bandwidths for use cases that require more than 400 MHz. We also note that, should local users require more than 650 MHz in the longer term, there may be alternative routes for these users to be able to access more spectrum in high density areas. For example, Ofcom’s Local Access licensing framework provides a mechanism to enable local users to access auctioned spectrum where it is unused for a three-year fixed term (unless the user can agree otherwise with the existing licence holder).

¹⁵ [VMO2 response to the March 2023 Statement and Consultation](#), p. 31.

¹⁶ VMO2, pp. 34-36.

¹⁷ March 2023 Statement and Consultation, paras 3.34-3.45.

¹⁸ March 2023 Statement and Consultation, paras 3.34-3.45.

¹⁹ GSMA’s June 2022 research report, “[Vision 2030: mmWave Spectrum Needs](#)”.

- 2.10 In light of stakeholders’ responses, we have decided to make the whole of the 40 GHz band available for auctioned citywide licences in high density areas (with access to the auctioned spectrum also available through our Local Access licensing framework), and to make the whole band available for local first come, first served licences from June 2028, using our Shared Access licensing framework, in the rest of the country.
- 2.11 In Section 5, we respond to VMO2’s comments on Local Access licensing, and explain why we consider it is appropriate to make Local Access Licences available in high density areas.

Fees for fixed links which we will allow to remain in the 40 GHz band

Our proposals

- 2.12 In the March 2023 Statement and Consultation,²⁰ we set out our decision to start the process for revoking the existing 40 GHz block assigned licences, but to offer to grant individual fixed link licences for links already in place in the 40 GHz band where these are not in or around high density areas, consistent with our approach in the 26 GHz band. We said that as part of that process we would need to set a fee for the new fixed link licences in the 40 GHz band, and noted that the formula for calculating fees for point-to-point fixed links is set out in Schedule 3 of the [Wireless Telegraphy \(Licence Charges\) Regulations 2020](#).
- 2.13 We asked stakeholders whether they agreed that the fees for 40 GHz links should be the same as for the 26 GHz band.

Summary of responses

- 2.14 VMO2 and Vodafone both agreed with our proposal, while BT/EE thought we should wait to decide on fees until nearer the end of the revocation period. In particular:
- a) BT/EE²¹ said we should consult and decide on the appropriate fees for these links nearer the end of the 5-year revocation period, when the extent of demand for mobile use will be more apparent. It also noted that cost-based fees would be more appropriate than administrative incentive pricing; and
 - b) Vodafone²² said that our proposed approach “appears reasonable”, and that “[r]eplicating the 26GHz fees means that the licensees will be subject to similar fees to those experienced by other fixed link users, so taking this as a proxy is justified on the basis of equitability.”

Ofcom’s decision

- 2.15 We agree with BT/EE that it makes sense to wait until nearer the end of the revocation period to decide on the appropriate fees for any fixed links which remain in the 40 GHz band, given that demand for mmWave spectrum will be more apparent by that point. We will consult on the appropriate fees nearer the time.

²⁰ March 2023 Statement and Consultation, paras 7.170-7.176.

²¹ BT/EE, p. 4.

²² Vodafone, p. 2.

Protection of the radio astronomy site in Cambridge

Our proposals

- 2.16 To protect radioastronomy use, an exclusion zone of 50km currently applies around the Cambridge radioastronomy site at 42.5-43.5 GHz. In the March 2023 Statement and Consultation,²³ we proposed to authorise the 40 GHz spectrum in Cambridge the same way as elsewhere. However, in order to protect the Cambridge radio astronomy site, we proposed that we would replace the current exclusion zone with a coordination zone of the same size (50km) and require the holders of the auction licences for 40 GHz spectrum to comply with a spectrum quality benchmark (“**SQB**”) limit to protect the RAS within such coordination zone.
- 2.17 We said that, as a result of the proposed power limits, we expected that all 40 GHz licensees would only be able to operate at low power in most locations in Cambridge but that there should be little constraint on low or medium power deployments in high density areas further from the Cambridge radio astronomy site, including Peterborough, Luton and Stansted Airport.²⁴

Summary of responses

- 2.18 VMO2²⁵ agreed with our proposals to protect the radio astronomy site at Cambridge from mobile users using the 40 GHz band. Vodafone²⁶ agreed in principle, but sought clarifications as to whether the emission limitation would be uniform across the band or “more extreme in the upper part”. Vodafone said that in the former case the limitation might affect the valuation of the 40 GHz band relative to the 26 GHz band, while in the latter case the differential might justify different lot types for the 40 GHz band.

Ofcom’s decision

- 2.19 Subject to the outcome of the process for varying the Cambridge grant of RSA,²⁷ we are minded to protect the Cambridge radioastronomy site as we proposed, by requiring all award winners of 40 GHz spectrum to comply with a SQB limit to protect the RAS within 50km of the RAS. In addition, we will only grant new 40 GHz Shared Access licences within 50km of the RAS where they comply with this SQB limit. We explain this limit in further detail and respond to Vodafone’s comment in Section 4.

Conclusion and next steps

- 2.20 In conclusion, as shown in the diagram below, we will authorise use of the 40.5 GHz-43.5 GHz band as follows:

²³ March 2023 Statement and Consultation, paras. 3.72, 7.22, 10.11 and 10.101-10.104.

²⁴ March 2023 Statement and Consultation, para. 3.72(a).

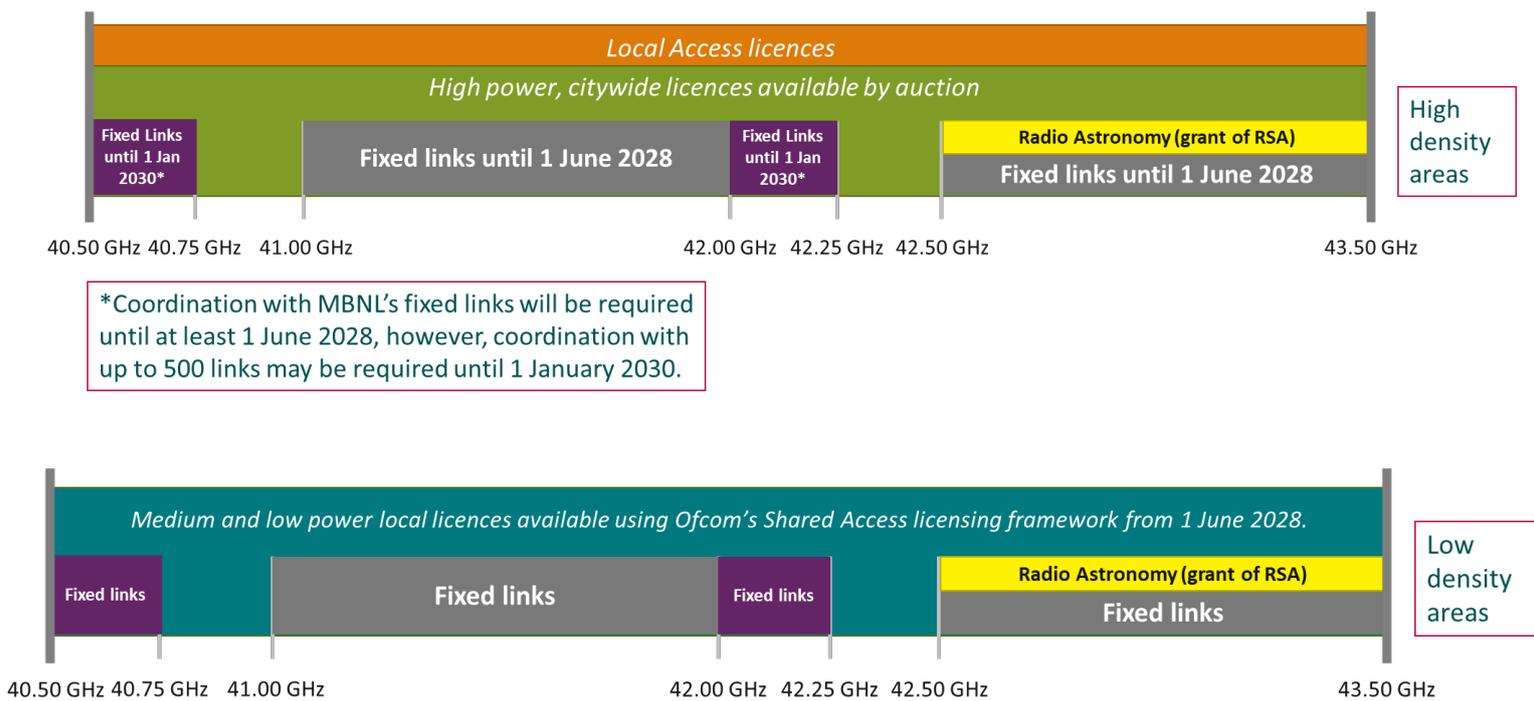
²⁵ VMO2, p. 35.

²⁶ Vodafone, p. 8.

²⁷ To include a 50km coordination zone with a SQB level of -207 dBW/500 kHz, and remove the existing 50km exclusion zone applying in the 42.5-43.5 GHz band from June 2028. See Section 4 (paragraph 4.82) for further details.

- a) we will auction citywide Spectrum Access licences, each of which will authorise spectrum use in all of the 68 high density areas we have designated, and we will extend the Local Access licensing framework to cover this spectrum;
- b) in the rest of the country (low density areas), we will make local licences available via our Shared Access licensing framework from June 2028. We will also offer to grant (i) individual fixed link licences to UK Broadband and MBNL for the links already in place at the time of publishing the March 2023 Statement and Consultation, where these are not likely to receive harmful interference from new uses in high density areas,²⁸ and (ii) up to 500 temporary individual fixed link licences to MBNL, expiring on 1 January 2030.²⁹

Figure 2.2: How we will authorise use of the 40 GHz band



²⁸ March 2023 Statement and Consultation, paras. 7.170-7.176.

²⁹ Ofcom's 30 May 2023 [Update on revoking licences in the 40 GHz band](#).

3. Identifying fixed links in the 26 GHz and 40 GHz bands which are likely to receive harmful interference from mobile services

Summary

- 3.1 In the [March 2023 Statement and Consultation](#)³⁰ we consulted on a proposed method for identifying which fixed links around high density areas operating in the 26 GHz band (specifically, the frequency range 24.5–26.5 GHz) and the 40 GHz band (40.5–43.5 GHz) are unlikely to be able to coexist with mobile base station deployments in these areas, because we consider the links would be likely to receive harmful interference from new users operating in these areas.
- 3.2 Having considered stakeholders’ comments, we have now decided to proceed with the method that we proposed, with two changes: to account for the increase in the maximum power of a medium power base station from 30 dBm to 36 dBm / 200 MHz TRP, as outlined in section 7; and to correct implementation errors.
- 3.3 We will use this method to determine:
- a) the existing 26 GHz licences authorising fixed links around high density areas in relation to which we will shortly start the statutory revocation process; and
 - b) the existing links operated by H3G and MBNL in the 40 GHz band around any high density area in relation to which we will offer to grant individual fixed link licences closer to the end of their revocation period (i.e., closer to June 2028).

Background

- 3.4 As set out in the March 2023 Statement and Consultation, we are currently preparing to make the 26 GHz and 40 GHz bands available for new uses, including 5G, in the following way:
- a) in the 68 “**high density areas**” which we have designated (i.e., the UK’s biggest towns and cities),³¹ by a combination of auctioned citywide licences and local licences available through our Shared Access and Local Access licensing frameworks; and
 - b) in the rest of the country, using our Shared Access licensing framework.
- 3.5 In order to ensure the spectrum we make available in the high density areas is clear for new uses, in Section 5 of the March 2023 Statement and Consultation we said we would revoke any existing licences authorising the use of fixed links in the 26 GHz band which our analysis shows are likely to receive harmful interference from new mobile use of the spectrum.³² This

³⁰ [March 2023 Statement and Consultation](#), paras. A16.34–A16.49.

³¹ March 2023 Statement and Consultation, para. A6.56 and Table A6.8.

³² March 2023 Statement and Consultation, paras. 5.39–5.42.

includes two categories of licences which currently authorise use of fixed links in the 26 GHz band:

- a) links **in** high density areas (i.e., any link where either station, or any part of the link pathway, overlaps with any high density area); and
- b) links **around** high density areas, where we consider them likely to receive harmful interference from new users in the high density areas.

3.6 In Annex 16 of the March 2023 Statement and Consultation,³³ we proposed a method for identifying the fixed links around high density areas which would be likely to receive harmful interference, using a sterilisation area prediction to identify which fixed links would be impacted by mobile base station deployments in the high density areas.

3.7 We also proposed to use the same method for identifying which of H3G's and MBNL's links operating in the 40 GHz band around high density areas could continue to be licensed after the revocation of the 40 GHz licences, on the basis that they would be unlikely to receive harmful interference from the new uses.³⁴

Fixed links in the 26 GHz band

3.8 The 26 GHz band is 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.

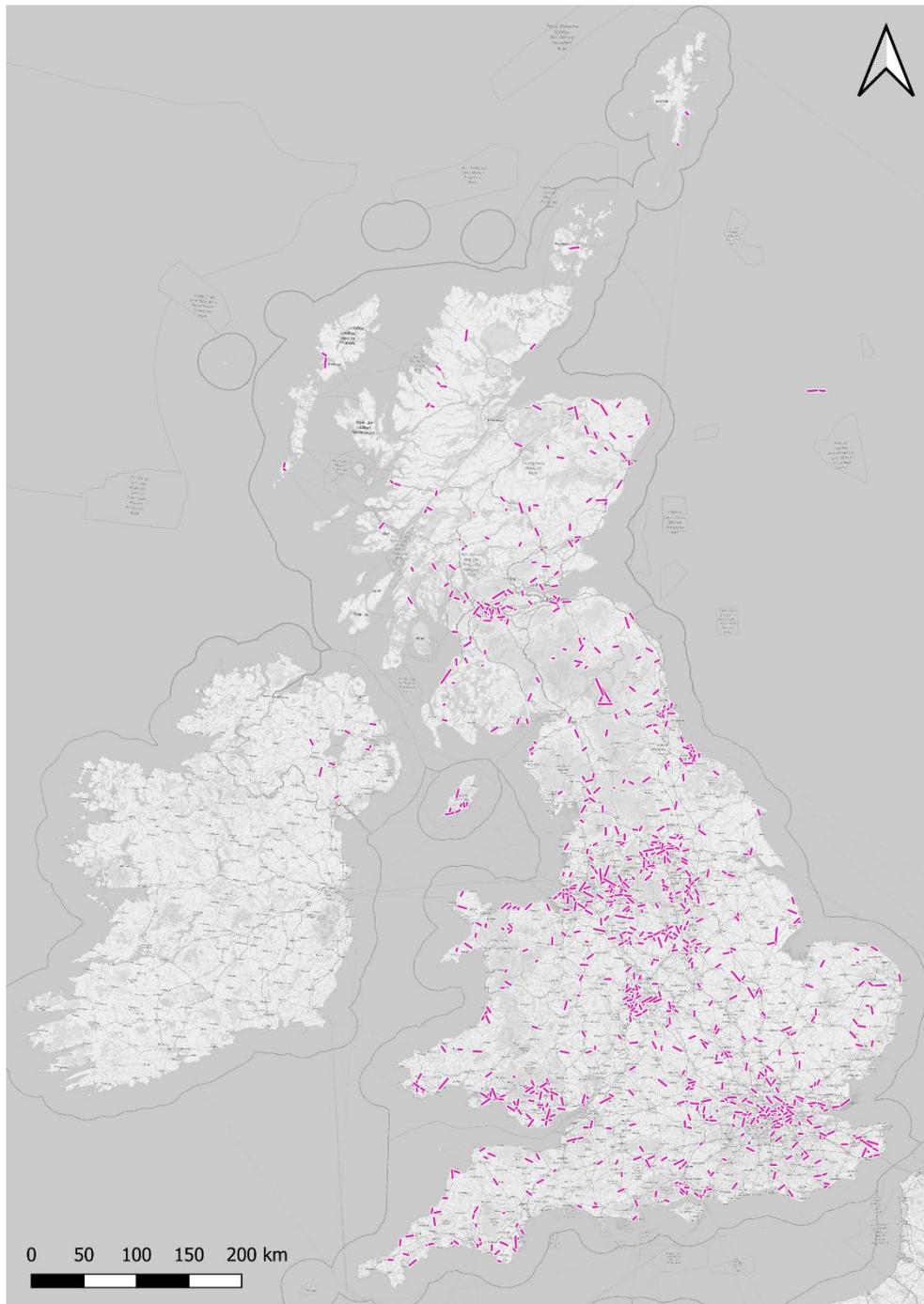
3.9 The 26 GHz band is an “Ofcom-managed” band, meaning that Ofcom individually licenses and coordinates each fixed link that operates in the band. As of 10 July 2023, there are 999 fixed links in the 26 GHz band, across the frequency range 24.5–26.5 GHz. There are no fixed links in the 24.25–24.5 GHz and 26.5–27.5 GHz frequency ranges.

3.10 The links in this band are located throughout the UK, but are more densely concentrated around the largest cities, as shown in Figure 3.1. 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.

³³ March 2023 Statement and Consultation, paras. A16.34–A16.49.

³⁴ March 2023 Statement and Consultation, paras. 7.171 and A18.4.

Figure 3.1: Map showing fixed links in the 26 GHz band as of 10 July 2023



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

3.11 The 26 GHz fixed links are operated by 37 different licensees, but a small number of licensees operate the majority of the links in the band. Airwave, which provides the current emergency services communications network, holds more than half of the licences issued in the band and the top 9 users account for 90% of all links in the band, as outlined in Table 3.1 below.

Table 3.1: Top fixed link licensees in the 26 GHz band, by number of links

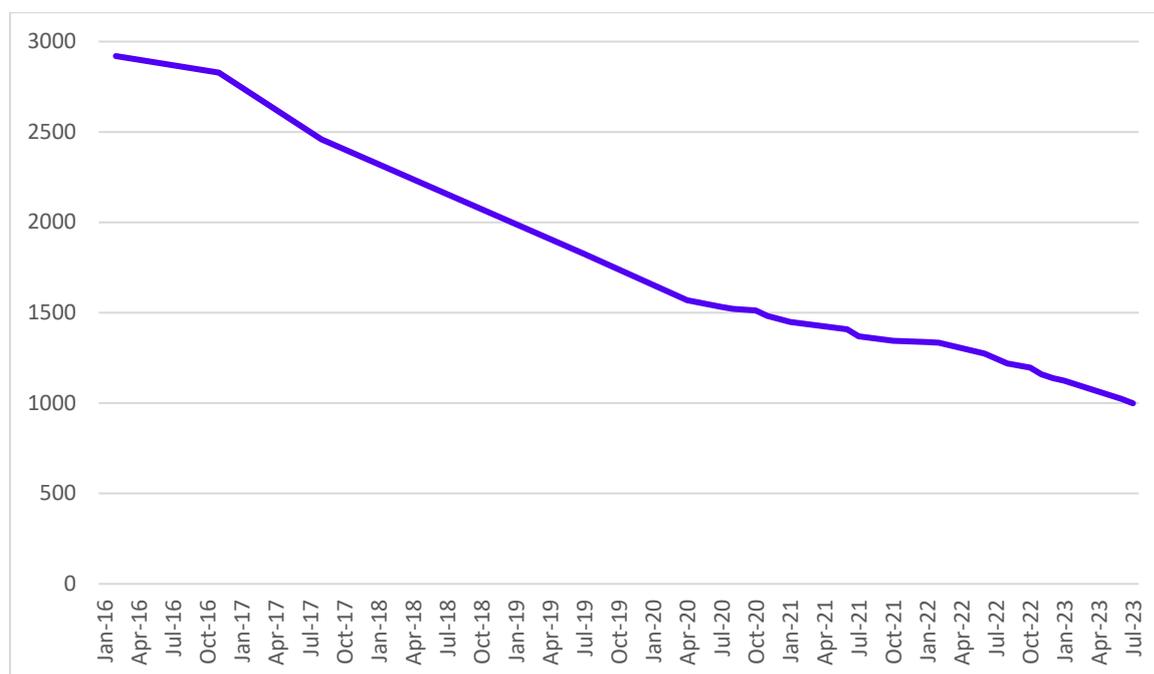
Licensee	Number of links
Airwave	568
Vodafone	78
MBNL	67
National Grid Telecoms*	61
BT	42
M247 UK	42
New Line Networks	14
Aquila Air Traffic Management Services	13
Mckay Brothers International SA	10

Source: Ofcom; *formerly known as WPD Telecoms

3.12 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 3.2 below. Since 2017 Ofcom has indicated its intention to make the 26 GHz band available for mobile technologies, including 5G.³⁵

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

Figure 3.2: Number of fixed links in the 26 GHz band over time, 2016–2023



Source: Ofcom

3.14 In Section 5 of our [May 2022 Consultation](#), we proposed that we would start the statutory process for revoking the 26 GHz licences which authorise fixed links in high density areas. We also proposed that we would start the process for revoking the 26 GHz licences which authorise fixed links around high density areas, where these would be likely to receive harmful interference from new users within those areas. In Section 5 of our March 2023

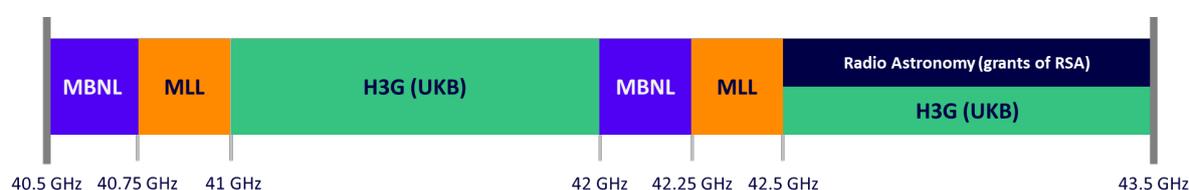
³⁵ Ofcom’s 8 February 2017 [Update on 5G spectrum in the UK](#).

Statement and Consultation, we confirmed that we would take this approach, and consulted on the method by which we would identify the affected fixed links around high density areas.

Fixed links in the 40 GHz band

3.15 As shown below, there are three existing licensees in the 40 GHz band (UK Broadband,³⁶ MBNL,³⁷ and MLL) which hold block assigned national licences that were allocated by auction in 2008.³⁸ 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. UK Broadband and MBNL use the 40 GHz band to provide point-to-point fixed links, while MLL has no deployments in the band.³⁹

Figure 3.3: 40 GHz band existing users



Source: Ofcom

3.16 In Section 7 of the March 2023 Statement and Consultation, we said that we had decided to start the statutory process for revoking these licences to make spectrum in the 40 GHz band available for new uses in a single auction, alongside the 26 GHz band. We also (i) decided to offer to grant individual fixed link licences for links already in place in the 40 GHz band where these are outside high density areas and unlikely to receive interference from mobile deployments in such areas, and (ii) consulted on our proposed method for identifying such links.⁴⁰

3.17 On 25 May 2023, after considering licensees’ representations, we completed the statutory process for revoking existing licences in the 40 GHz band and decided to revoke them with effect from 1 June 2028.⁴¹ In light of MBNL’s representations, we also decided to offer to grant MBNL individual temporary licences – starting on 1 June 2028 and expiring on 1 January 2030 – for up to 500 of its existing fixed links that are outside the top 10 high density areas, Dover, Folkestone & Hythe and Stansted Airport. We decided to offer MBNL this mitigation in light of MBNL’s preference to replace its fixed links with fibre, which we think is likely to benefit consumers, and its representations that doing so could give rise to a residual risk that replacement of a small proportion of MBNL’s existing fixed links is not complete within five years (given that MBNL will need to replace approximately 3,200 links within five years).

³⁶ UK Broadband is owned by H3G.

³⁷ MBNL is a joint venture between H3G and BT/EE.

³⁸ The 40 GHz licences are published on the “[Mobile and wireless broadband above 5 GHz](#)” page of Ofcom’s website.

³⁹ There is also one grant of Recognised Spectrum Access for radio astronomy at 42.5–43.5 GHz.

⁴⁰ March 2023 Statement and Consultation, paras. 1.13, 7.8, 7.170–7.176 and annex A16.

⁴¹ Ofcom’s 30 May 2023 [Update on revoking licences in the 40 GHz band](#).

Identification of fixed links which are likely to receive harmful interference from new uses in high density areas

Our proposals

- 3.18 We proposed to identify the affected links around each high density area by modelling the sterilisation area⁴² for each fixed link receiver and then checking whether this sterilisation area intersected with the high density area.⁴³ We only considered fixed link receivers in this sterilisation analysis and not mobile base station receivers because our coexistence analysis showed that the dominant direction of interference was likely to be from mobile base stations to fixed links rather than the other way around.⁴⁴ We proposed to use a radiofrequency coverage prediction tool (HTZ Communications) to calculate the sterilisation area in a similar way to the way we had calculated spectrum availability in Annex 6 of our May 2022 Consultation. Within HTZ Communications, we proposed to use clutter and terrain files for the UK with a resolution of 100m by 100m and we proposed to calculate the sterilisation area for each fixed link receiver within 50km of the centre of each high density area.⁴⁵ We then proposed to import the calculated sterilisation areas into a numeric computing and engineering software tool (MATLAB) so that we could identify which fixed links had sterilisation areas which intersected with high density areas and would therefore be at risk of receiving harmful interference from deployments in those areas.
- 3.19 We provided a detailed description of this method in paragraphs A16.43–A16.49 of our [March 2023 Statement and Consultation](#).

Summary of responses

- 3.20 In summary, we received the following comments from stakeholders:
- BT/EE⁴⁶ agreed with our analysis for identifying affected fixed links around the designated high density areas, specifying that it agrees “that the dominant interference scenario would be from mobile into the fixed links”.
 - Vodafone⁴⁷ said that our proposed methodology “appears reasonable”.
 - Both Virgin Media O2 (VMO2) and BT/EE raised some specific points regarding the details of the proposed approach, which we consider below.

⁴² The sterilisation area is the area in which a piece of radio equipment risks causing harmful interference to (or receiving harmful interference from) another user.

⁴³ We calculate the sterilisation area by using HTZ Communications to perform a “reverse coverage” calculation to show the area in which harmful interference to a fixed link receiver would occur were a mobile base station to be deployed in that area. This approach models the fixed link receivers as transmitters in order to use HTZ Communication’s coverage prediction functionality to create a map of the sterilisation area, however, the coverage threshold is set using the interference threshold of the fixed link receivers rather than the receiver wanted signal threshold.

⁴⁴ March 2023 Statement and Consultation, paras. 10.99 and A16.37–A16.42.

⁴⁵ Except for Greater London, where we calculated the sterilisation area for fixed links within 100km of the centre of the Greater London high density area because this area is particularly large.

⁴⁶ [BT/EE response to the March 2023 Statement and Consultation](#), p. 3.

⁴⁷ [Vodafone response to the March 2023 Statement and Consultation](#), p. 2.

Distance of some identified links from high density areas

3.21 VMO2⁴⁸ said it was “surprised that Ofcom’s methodology for identifying which fixed links around high density areas are deemed likely to suffer interference from new users within high density areas, results in a number of links being identified which are a considerable distance (up to 28 km) away from the border of the nearest high density area polygon”. VMO2 provided nine examples of such links, which it had measured to be between 21.6km and 35.2km from the nearest high density area. On that basis, VMO2 requested “that Ofcom provides clarification to further explain and justify its methodology, along with the results derived from it”.

Ofcom’s response

3.22 We have reviewed the examples provided by VMO2 and we found that four of the fixed links we had identified as at risk of interference from mobile base stations in high density areas were identified correctly, but that five were identified incorrectly in Annex 18 to the March 2023 Statement and Consultation.

3.23 For all four fixed links that we identified correctly, we note that for each pair of fixed link receivers, one of the pair was pointed directly towards a high density area (whilst the other fixed link receiver was pointed away from the high density area). Most fixed links are bidirectional, so we consider that a risk of interference to one of the two stations is a risk of interference to the pair as a system. There were also other factors which contributed to the large sterilisation areas for these four fixed links:

- a) Two of the fixed links were in coastal areas where propagation over water resulted in elongated sterilisation areas;⁴⁹
- b) One of the fixed links was mounted high on a mast in a flat area;⁵⁰ and
- c) One of the fixed links was on high terrain overlooking a high density area.⁵¹

3.24 We observed that errors in the implementation of our proposed method, rather than the method itself, resulted in us incorrectly identifying five of the fixed links flagged by VMO2.

3.25 The errors resulted from:

- a) incorrectly including in our analysis fixed link receivers which operate between 24.5–25.1 GHz, in which frequencies we will not permit medium power mobile use in high density areas, and as a result we do not consider that these fixed links would be likely to receive harmful interference from mobile use of the band;⁵² and
- b) a transposition error meant that some smaller regions did not correctly align the calculated sterilisation areas with the boundaries of the high density areas when this data was imported into MATLAB to test whether the sterilisation area for each fixed link intersected with a high density area.

⁴⁸ [VMO2 response to the March 2023 Statement and Consultation](#), p. 31.

⁴⁹ Fixed link receivers for licence numbers 1004125/1 and 1113603/1 had sterilisation areas which intersected with the Blackpool high density area.

⁵⁰ One of the fixed link receivers for licence number 1120024/1 was mounted on a 43m-high mast pointing towards Norwich with line of sight of parts of the high density area.

⁵¹ One of the fixed link receivers for licence number 1159603/1 was on a mast near Whaup Knowe (304m) in the Cheviot Hills, with clear line of sight to the Tyne & Wear high density area.

⁵² The coexistence analysis set out in Annex 6 of the May 2022 consultation showed that the risk of interference from low power base stations to fixed links was low and therefore we considered that only medium power base stations would be likely to cause harmful interference to fixed links.

- 3.26 We have now corrected the implementation of the method to correct these errors.
- 3.27 We have included a revised list of fixed links in the 26 GHz band which we consider will be at risk of receiving harmful interference from mobile deployments in high density areas in Annex 2 of this document. With reference to the provisional results of our analysis set out in paragraph A16.48 of the March 2023 Statement and Consultation, this previous implementation error resulted in us incorrectly identifying 79 links in the 26 GHz band and 189 links in the 40 GHz band (i.e., a total of 268 links) as being at risk of receiving harmful interference from mobile deployments in high density areas.

Overall changes to the estimated number of fixed links to clear from the 26 GHz and 40 GHz bands

- 3.28 We note that in the March 2023 Statement and Consultation, we proposed to clear from the 26 GHz and 40 GHz bands the fixed links in both bands which our analysis showed were either (i) in high density areas, or (ii) outside high density areas, but likely to receive harmful interference from new mobile use of this spectrum within high density areas. In the March 2023 Statement and Consultation, we estimated that this would require clearance of:
- a) 691 fixed links in the 26 GHz band;⁵³
 - b) 3,262 of MBNL's fixed links operating in the 40 GHz band;⁵⁴ and
 - c) 62 of H3G's fixed links operating in the 40 GHz band.⁵⁵
- 3.29 We have now made the following adjustments to our method for identifying which fixed links outside high density areas are likely to receive interference from new mobile services operating in high density areas:
- a) As explained in greater detail in Section 7, paragraphs 7.8-7.14, of this document, we have decided to increase the maximum permitted power level for mmWave base stations from 30 dBm to 36 dBm / 200 MHz TRP;
 - b) We have corrected the implementation errors described at paragraph 3.24 and 3.25 above; and
 - c) We have redone the analysis using an updated data set of the fixed links which were operating in the 26 GHz band in July 2023, H3G's fixed links operating in the 40 GHz band in February 2023, and MBNL's fixed links operating in the 40 GHz band in May 2023.
- 3.30 Although the increase in permitted power levels for mmWave base stations has the effect of increasing the number of fixed links to be cleared from the 26 GHz and 40 GHz bands,⁵⁶ the impact of correcting the implementation error identified by VMO2, as well as the reduction in the number of fixed links operating in both bands, means that we are still expecting to clear fewer links than we originally estimated in the March 2023 Statement and Consultation. Specifically, we are now expecting to clear:
- a) **562** links from the 26 GHz band (of which 445 are in high density areas, and 117 are around high density areas);

⁵³ March 2023 Statement and Consultation, para. 5.4.

⁵⁴ March 2023 Statement and Consultation, para. 7.171.

⁵⁵ March 2023 Statement and Consultation, fn. 444.

⁵⁶ In particular, increasing the maximum permitted power level results in identification of approximately 200 additional links which are likely to receive harmful interference from new mobile services. Specifically, the number of links in the 26 GHz band which will be subject to clearance because they are outside high density areas but likely to receive interference from new mobile use increases by 18 due to this increase in permitted power level, and the number of links in the 40 GHz band increases from 900 to 1064.

- b) **3,231** of MBNL’s links from the 40 GHz band (of which 2,169 are in high density areas, and 1062 are around high density areas); and
- c) **62** of H3G’s links from the 40 GHz band (of which 60 are in high density areas, and 2 are around high density areas).

Antenna gain and free space path loss used in our analysis

3.31 VMO2⁵⁷ said that it considers our assumption of “a 28 dBi BTS antenna gain on the mobile bore site and the fixed link facing back straight back with a 36 dBi antenna gain” as a scenario which is “highly unlikely in practice”. In its view, this is because “in the real-world, obstacles in the environment will also block interfering signals over long distances”.

Ofcom’s response

3.32 In the May 2022 Consultation and the March 2023 Statement and Consultation, we considered whether the probability of antenna alignment between fixed links and mobile base stations should be taken into account in the value of the worst-case reduction factor (“ F_{wcr} ”).

3.33 In Annex 16 of the March 2023 Consultation and Statement we presented measurement evidence which showed that periods of interference, even when brief (e.g., when antennas were aligned), could result in harmful interference to a fixed link receiver.⁵⁸ We therefore considered that the peak envelope radiated power of the mobile base station was relevant for assessing coexistence with fixed links because using the average radiated power would not be sufficient for modelling the risk of interference arising from brief antenna alignment events. Nevertheless, we acknowledged that there remained a risk that our analysis of the risk of interference between fixed links and new mobile base stations could be overly conservative for reasons unrelated to the probability of antenna alignment events. We proposed to include additional realism in our analysis by introducing a 12 dB worst-case reduction factor (“ F_{wcr} ”) to reduce the conservatism arising from these other factors.⁵⁹

3.34 We agree with VMO2 that terrain and clutter can block signals, especially over long distances, and have taken this into account by using propagation model ITU-R P.452-17 along with terrain and clutter maps for the UK in our work modelling the risk of interference between medium power mobile base stations and fixed links.⁶⁰ We therefore remain of the view that our modelling approach is appropriate for identifying the fixed links that are likely to be at risk of interference from new mobile base station deployments in high density areas.

Identifying the dominant direction of interference

3.35 BT/EE agreed with us that “the dominant interference scenario would be from mobile into the fixed links” rather than the other way around. BT/EE suggested that the bandwidth adjustment factor for the fixed link to mobile interference assessment set out in table A16.3 of the March 2023 Statement and Consultation⁶¹ should be 0 dB rather than 5.5 dB, “if considering interference from a single fixed link of 56 MHz with a mobile receiver of 200 MHz”.⁶²

⁵⁷ VMO2, p. 31.

⁵⁸ [March 2023 Statement and Consultation](#), para. A16.26.

⁵⁹ March 2023 Statement and Consultation, paras. A16.18–A16.29.

⁶⁰ March 2023 Statement and Consultation, Figure A16.1.

⁶¹ March 2023 Statement and Consultation, p. 13.

⁶² BT/EE, p. 3.

Ofcom's response:

- 3.36 We agree with BT/EE's correction because the mobile base station receiver bandwidth (200 MHz) is larger than the fixed link transmission bandwidth (56 MHz), so no bandwidth correction is necessary for calculating the interference power falling into the victim receiver bandwidth. We note that this correction further reinforces our view that the dominant direction of interference risk will be from mobile base stations to fixed links rather than the other way around. We therefore continue to consider that our approach, which considers the risk of interference to fixed link receivers around high density areas but not the risk of interference to mobile base station receivers in high density areas, remains appropriate.

Other comments

- 3.37 Respondents also commented on some issues which fell outside the scope of our consultation. These issues are set out below.

Funding for clearance of fixed links

- 3.38 National Grid Electricity Distribution (“**NGED**”) said that Ofcom should consider a compensation scheme for operators of fixed links being cleared from the band, particularly given Ofcom's revised estimates of the cost associated with clearing fixed links outlined in Annex 7 of the March 2023 Statement and Consultation. It also argued that the costs of migrating fixed links integral to the electricity networks would be borne by consumers, and would be an indirect tax on UK households for the benefit of the MNOs.⁶³
- 3.39 As stated in our March 2023 Statement and Consultation,⁶⁴ we do not consider that the circumstances of the 26 GHz band make compensation appropriate in this case, as we will give licensees reasonable periods of notice in accordance with the terms and conditions of their licences, and we have been indicating our intention to make the 26 GHz band available for mobile technology, including 5G, since February 2017.

Cost benefit analysis

- 3.40 NGED⁶⁵ also said that while Ofcom had acknowledged the costs of clearing users from the band, we had not quantified the benefits of introducing new uses into the 26 GHz band. It argued that a partial rather than full release of the spectrum would be proportionate to avoid regulatory failure.
- 3.41 As set out in the March 2023 Statement and Consultation,⁶⁶ although we remain uncertain about the precise levels of demand, to enable industry to realise the potential which mmWave spectrum offers for investment and innovation, we consider it appropriate both to make mmWave spectrum available to a range of different users and to provide the opportunity for operators to access 1 GHz or more each. Regarding NGED's suggestion of a partial rather than full release of the band, we note that by enabling fixed links which are unlikely to receive harmful interference to remain in the band, while introducing new users in other areas, this is exactly what we are aiming to facilitate.

⁶³ [National Grid Electricity Distribution \(NGED\) response to the March 2023 Statement and Consultation](#), p. 3.

⁶⁴ March 2023 Statement and Consultation, paras. 5.33–5.35.

⁶⁵ NGED, p.3.

⁶⁶ March 2023 Statement and Consultation, para 2.61.

Future availability of spectrum for fixed links, and for the utilities sector

- 3.42 NGED⁶⁷ commented that the changes to the 26 GHz band have created a level of uncertainty that would lead to energy network operators removing links from the band across the country, and suggested that Ofcom should consider the extent to which fixed links could be re-introduced into the band in future.
- 3.43 NGED⁶⁸ also commented that the energy sector would need additional access to radio spectrum to achieve its goals in the transition to a future “smart grid”, not reduced access as it said was occurring in the 26 GHz band.
- 3.44 On NGED’s concern about uncertainty for fixed link operators, we are clear that while some links in and around high density areas will need to be cleared, links in the band which are unlikely to receive harmful interference from new uses operating in high density areas will be able to remain in place, should licensees wish to continue using them. We note that we set out in Section 10 of the March 2023 Statement and Consultation how we proposed to coordinate new uses of the spectrum in order to ensure protection of any fixed links which remain in the band, and we set out our final decisions in Section 4 of this statement. We are not currently considering the re-introduction of fixed links back into the 26 GHz band in future. As we set out in the March 2023 Statement and Consultation,⁶⁹ the sharing of spectrum between Frequency Division Duplex (FDD) use cases such as fixed links, and Time Division Duplex (TDD) use cases such as 5G, is likely to lead to large separation distances between deployments and inefficient use of spectrum.
- 3.45 In terms of the future spectrum needs of the utilities sector, Ofcom recently published a [call for inputs on potential spectrum bands to support utilities sector transformation](#),⁷⁰ which closed on 7 September 2023. For fixed links, licensees can apply for fixed links in alternative Ofcom-managed fixed link bands (such as the 18 GHz, 23 GHz or 38 GHz ranges), in line with our normal assignment policy.

Availability of alternative spectrum for migrating fixed links

- 3.46 NGED⁷¹ said that Ofcom had assumed that there would be sufficient alternative fixed link spectrum in other bands to accommodate the displacement of links from the 26 GHz band, but “it is not obvious that Ofcom have undertaken the necessary technical assessment to confirm this hypothesis.” NGED noted that “fixed links that are integral to the operational integrity of an Electricity Network are designed and deployed to ensure high availability which may not be possible or practical at alternative frequencies for individual scenarios.”
- 3.47 We remain of the view that there is sufficient spectrum availability in alternative spectrum bands to accommodate the fixed links which we are requiring users to clear from the 26 GHz band. To the extent that existing licensees may want to replace any fixed links with equivalent fixed links, there are other bands available which they can access. In Ofcom-managed fixed link bands, such as the 18 GHz, 23 GHz and 38 GHz bands, Ofcom assigns licences for each fixed link on a first come, first served basis. Ofcom’s publicly available [spectrum information portal](#) contains information about the current use of all these fixed link bands.

⁶⁷ NGED, p.3.

⁶⁸ NGED, p.2.

⁶⁹ March 2023 Statement and Consultation, para 5.21.

⁷⁰ Ofcom’s 29 June 2023 call for inputs, “potential spectrum bands to support utilities sector transformation”.

⁷¹ NGED, p.3.

Conclusion and next steps

- 3.48 We have decided to use the method that we proposed in the March 2023 Statement and Consultation⁷² for identifying which fixed links are likely to receive harmful interference from new users operating in these areas, with the following changes:
- a) as set out in more detail in Section 7, we have decided to increase the maximum permitted power of a mobile medium power base station from 30 dBm to 36 dBm / 200 MHz TRP. We will use this revised power level as an input into our analysis.
 - b) to correct implementation errors, as explained at paragraph 3.24 and 3.25 above.
- 3.49 A revised list of the 26 GHz fixed links around high density areas which we consider likely to receive harmful interference from new users operating in these areas is set out in Annex 2.⁷³ Please note that, in addition to the correction and change explained above, we have also omitted the links which have been cleared from the 26 GHz band since 5 January 2023 (the date of the fixed link data we used in our March 2023 Statement and Consultation).
- 3.50 We will shortly issue notices of proposed revocation in relation to any fixed links operating in the 26 GHz band which are either (i) **in** our designated high density areas or (ii) **around** our designated high density areas and likely to received harmful interference from new mobile services deploying in the high density areas. Affected licensees will have a period of at least 30 days to make representations to Ofcom on our proposals for their licences. We will take into account any representations before reaching a final decision in relation to each licence. We will write to affected licensees within one month of the deadline for their representations to confirm our final decision for their licence.⁷⁴ Licensees will have at least five years from the date of the final notice before the revocation of their licence takes effect.
- 3.51 Shortly after publication of this statement, we will also contact UK Broadband and MBNL (the existing 40 GHz licensees with deployments in the band), to inform them of which fixed links around high density areas we will offer to re-authorise at the end of the revocation period, on the basis of the method that we have decided to use for this purpose. In addition, we will contact UK Broadband and MBNL closer to the end of the revocation period (i.e., closer to June 2028) to confirm which of their eligible links they would like Ofcom to migrate to a new fixed link licence. We will issue these new licences ahead of the expiry of the existing 40 GHz licences to ensure that links can continue to operate uninterrupted.⁷⁵

⁷² March 2023 Statement and Consultation, paras. A16.34–A16.49.

⁷³ Our initial list was set out in [Annex A18](#) to the March 2023 Statement and Consultation.

⁷⁴ Wireless Telegraphy Act 2006, Schedule 1, paragraph 7.

⁷⁵ March 2023 Statement and Consultation, para. 7.175.

4. Coordination

Summary

4.1 In this Section we set out how we have decided to coordinate use of spectrum by all licensed users of the 26 GHz and 40 GHz bands once new uses are authorised. In general, our decisions reflect the proposals on which we consulted in our March 2023 Statement and Consultation. We have refined our approach in two areas:

- a) we have decided to adopt a hybrid approach of Options 2b and Option 3 on which we consulted⁷⁶ for coordination between award winners and fixed links in the 26 GHz band during the revocation period, which reflects stakeholders’ responses. In the 40 GHz band, we will coordinate award winners and fixed links during the revocation period;
- b) we have considered the appropriate field strength limit to impose on transmissions from all medium power base stations at the boundary of any high density areas in light of [ECC Recommendation 23\(02\)](#)⁷⁷ and decided to impose a limit which is in line with the value agreed at Project Team 1 (“PT1”) within the Electronic Communications Committee (“ECC”) (ECC PT1) for international coordination at 26 GHz.

4.2 A high level summary of how we have decided to coordinate use of mmWave spectrum is shown in the tables below:

Table 4.1: coordination in high density areas

		Existing users				
		Award winners	Shared Access	Fixed links	Satellite Earth Stations	Radio Astronomy
New Users	Award winners <i>25.1-27.5 GHz & 40 GHz</i>	N/A: no coordination required	Field strength limit at the boundary of the high density areas see paragraphs 4.85 - 4.103	Coordination zone maps and/or Technical Assignment see paragraphs 4.54 - 4.70	N/A: no SES in high density areas	Coordination zone and SQB limit for Cambridge site at 40 GHz see paragraphs 4.71 - 4.84
	Shared Access <i>24.45 - 25.1 GHz</i>	N/A: no coordination required	Minimum separation distance	Technical Assignment	N/A: no SES in high density areas	N/A: No 24 GHz RAS in high density areas

⁷⁶ [March 2023 Statement and Consultation](#), para. 10.81.

⁷⁷ [ECC Recommendation 23\(02\)](#), 07 July 2023

		Existing users				
		Award winners	Shared Access	Fixed links	Satellite Earth Stations	Radio Astronomy
			see paragraphs 4.12 - 4.26	see paragraphs 4.27 - 4.34		

Table 4.2: coordination in low density areas

		Existing users				
		Award winners	Shared Access	Fixed links	Satellite Earth Stations	Radio Astronomy
New user	Shared Access <i>26 GHz only</i>	Field strength limit at the boundary of the high density areas	Minimum separation distance or Technical Assignment	Technical Assignment	Technical Assignment	Exclusion zones around 24 GHz RAS
		See paragraphs 4.91-4.103	See paragraphs 4.12-4.26	See paragraphs 4.27-4.34	See paragraphs 4.35-4.39	See paragraphs 4.71-4.84

Coordination concepts and definitions

4.3 This section explains:

- a) our method for determining the effective isotropic radiated power (“EIRP”) for active antenna systems (“AAS”) from Total Radiated Power (“TRP”) for the purposes of coordination; and
- b) our general approach to determining suitable coordination mechanisms for different scenarios.

Conversion from TRP to EIRP

4.4 We note that most mmWave base stations are likely to use AAS and that the emissions from this type of base station are usually specified using the TRP, which is the power that the radio equipment radiates in all directions. We also note that the limits on in-block and unwanted emissions specified in our mmWave technical licence conditions are also in units of TRP. However, real antennas have directivity which describes the extent to which the antenna is focusing that radiated power into one or more specific directions. This is particularly relevant for mmWave AAS, because they use large arrays of antenna elements to focus data beams towards users. We define the power radiated in a specific direction in units of EIRP. For the purposes of assessing coexistence and for coordination, we need to know what the EIRP of radio equipment is because radio equipment may transmit much

more power in some directions (e.g. the boresight) than others (e.g. the sidelobes and backlobes).

4.5 We calculate the EIRP of AAS stations in our coordination tool using Equation 4.1.

Equation 4.1

$$EIRP = TRP + Antenna Gain$$

Where:

EIRP is the Effective Isotropic Radiated Power in units of dBm

TRP is the Total Radiated Power in units of dBm;⁷⁸ and

Antenna Gain is the antenna gain of the AAS in dBi. This value will depend on the system with which coexistence is being assessed. If the system with which coexistence is being assessed is:

- i) another mobile system (e.g. new citywide licensee, Shared Access) then this value is the **average** antenna gain of the AAS.⁷⁹
- ii) a non-mobile system (e.g. fixed links, satellite earth station) then this value is the **peak envelope** antenna gain of the AAS.⁸⁰

Minimum separation distances

4.6 Minimum separation distances between stations, also known as “reuse distances”, may be appropriate for coordination where different licensees' deployments are close to each other and where full technical assignment might be disproportionate to manage the interference risk.

Field strength limits at a boundary

4.7 Field strength limits at a boundary may be appropriate when we are coordinating without precise knowledge of where the deployments are either side of a boundary.⁸¹ In these cases, any new base station deployments should not exceed a certain field strength limit at a specified height at a geographic boundary.

Technical Assignment

4.8 Technical Assignment may be appropriate when we are seeking to coordinate certain spectrum users with systems that would generally be high power and/or require a high availability of service. To undertake this form of coordination, Ofcom carries out detailed coordination calculations between a new user and existing users, using the technical

⁷⁸ The value of TRP will be the same as the conducted power into the antenna assuming that the antenna is 100% efficient with perfect impedance matching.

⁷⁹ We describe how we have calculated average antenna gain for AAS in paras A6.47 to A6.52 of [the March 2022 Consultation](#).

⁸⁰ The peak antenna gain of a base station is often also referred to as the boresight antenna gain.

⁸¹ Power flux density limits can fulfil a similar role, however, we note that ECC Recommendation (23)02 on 26 GHz cross-border coordination uses field strength and not power flux density as its figure of merit at the border line.

parameters of each deployment to determine whether the deployments would interfere with each other if the new user's deployment were authorised.

Shared Access licences in the 40 GHz band

Our proposals

4.9 In the 40 GHz band, we proposed to make Shared Access licences available only after the end of the revocation period of current licences in that band, and then only in low density areas.⁸² We said we would consult on detailed technical parameters for coordination before Shared Access use of the 40 GHz band becomes available in low density areas.⁸³

Summary of responses

4.10 BT/EE⁸⁴ was the only respondent to comment on this proposal, which it supported.

Ofcom's decision

4.11 As set out in section 2, we have decided not to make Shared Access licences available in the 40 GHz band in low density areas until after the end of the revocation period for current licences in that band (i.e. until June 2028), as we proposed. We will consult on detailed technical parameters for coordination before that date.

Coordination between 26 GHz Shared Access licensees' deployments

Our overall approach

Our proposals

4.12 In the 26 GHz band, we proposed to use technical assignment to coordinate deployment of Shared Access licensees' medium power base stations (which will only be allowed outside high density areas), and to require minimum separation distances between Shared Access licensees' low power base stations (both in low density areas in all of the 26 GHz band, and in high density areas in the 24.45-25.1 GHz block).⁸⁵ Table 4.3 below summarises how we proposed to manage coexistence between Shared Access licensees.

⁸² March 2023 Statement and Consultation, para. 10.68

⁸³ March 2023 Statement and Consultation, para. 10.3

⁸⁴ [BT/EE response to the March 2023 Statement and Consultation](#), p. 3.

⁸⁵ March 2023 Statement and Consultation, para. 10.2

Table 4.3: Shared Access to Shared Access coordination method in the 24.45-27.5 GHz band

		Existing users		
		Low power (indoor)	Low power (outdoor)	Medium power
New users	Low power (indoor)	Separation distance 100m	Separation distance 200m	Technical assignment
	Low power (outdoor)	Separation distance 200m	Separation distance 200m	Technical assignment
	Medium power	Technical assignment	Technical assignment	Technical assignment

Summary of responses

- 4.13 Vodafone⁸⁶ and BT/EE⁸⁷ said our proposals were “reasonable”. BT/EE noted that our approach “could be refined over time as experience is gained in use of the mmWave bands.”
- 4.14 Stakeholders provided also more specific comments in relation to our proposed separation distance and technical assignment, which we consider below.

Minimum separation distances

Summary of responses

- 4.15 We received comments from Nokia, VMO2 and H3G on our proposed minimum separation distances. Nokia⁸⁸ agreed with our proposed fixed separation distances for low power deployments in the 26 GHz band.
- 4.16 VMO2⁸⁹ suggested that our use of the P.1411-11 and free space path loss (“FSPL”) propagation models for determining the separation distance between mmWave new uses is “unnecessarily conservative” because “in the real world, often hills will block signals, as will buildings, and also trees”. According to VMO2, “[in] practice, the predictions will not be accurate and the interference predicted by new mobile use, will not be evident”.
- 4.17 H3G⁹⁰ provided a confidential response about our proposed separation distances between Shared Access stations for indoor and outdoor deployments. It said: “Ofcom proposes a minimum separation distance of 200 metres. We consider that this should be [CONFIDENTIAL ✂]. Our understanding is that the maximum coverage of 26GHz is approximately [CONFIDENTIAL ✂], and so two users would need to be [CONFIDENTIAL ✂] apart to avoid any interference”.

Our Decision

- 4.18 In response to VMO2, we agree that considering the P.1411-11 line-of-sight and FSPL models in isolation could result in overly conservative minimum separation distances for low power base stations. We observed in the March 2023 Consultation and Statement that there was

⁸⁶ [Vodafone response to the March 2023 Statement and Consultation](#) p. 7.

⁸⁷ BT/EE, p. 10.

⁸⁸ [Nokia response to the March 2023 Statement and Consultation](#) p. 3, response to Q. 7.

⁸⁹ [VMO2 response to the March 2023 Statement and Consultation](#), p. 31.

⁹⁰ H3G confidential response to the March 2023 Statement and Consultation, p. 9.

large variation in propagation distances between the P.1411-11 line-of-sight and non-line-of-sight models and we observed that we could not set a minimum separation distance based on these modelling approaches alone. We therefore also took into account the typical coverage radius of low power outdoor base stations (100m) and set the minimum separation distance between base stations such that there would be no overlapping coverage (200m).⁹¹

- 4.19 In response to H3G, we continue to consider that the typical coverage radius of a low power base station will be around 100m. In the March 2023 Consultation and Statement we supported our view with a reference to a publication from the GSMA.^{92,93} Additionally, we note that in our May 2022 Consultation we used a user equipment (“UE”) distribution model for UEs attaching to a low power base station which was based on the ITU TG 5/1 studies⁹⁴ and we observed that this resulted in the vast majority of UEs being within 100m of their serving base station.⁹⁵ We consider that the coverage distance suggested by H3G, [CONFIDENTIAL ✂], is more similar to the sort of distances proposed for [CONFIDENTIAL ✂] base stations and therefore is not representative of the coverage of low power base stations. For example, the GSMA gives a figure of [CONFIDENTIAL ✂] for the coverage radius of a mmWave [CONFIDENTIAL ✂] base station⁹⁶ and the [CONFIDENTIAL ✂].⁹⁷
- 4.20 We therefore remain of the view that our proposed approach to coordinating new low power Shared Access users with one another is appropriate and have decided to proceed with it.

Stakeholder comments and Ofcom’s decision on technical assignment

- 4.21 We received comments from Nokia and BT/EE on our technical assignment proposals. Specifically:
- a) Nokia⁹⁸ agreed with our proposal to undertake a technical assessment when coordinating Medium/Medium and Medium/Low power licences. Nokia also agreed with our proposal to use an average mobile antenna gain for mobile and non-mobile services, and with our proposed 12 dB worst-case reduction factor. In addition, Nokia suggested a change in relation to our antenna modelling approach, which we consider below;
 - b) BT/EE suggested a change to our coordination filter distances, which we consider below.

Omnidirectional antennas

- 4.22 Nokia⁹⁹ suggested that “for an even more efficient spectrum management and greater spectrum availability (...) in the case that potential licensees don’t wish to provide 3-sector coverage,” they could “notify Ofcom and have their applications considered on a case-by-case basis, using more detailed deployment information, preventing further spectrum

⁹¹ March 2023 Statement and Consultation, paras. A16.14-A16.16 and Table A16.2.

⁹² March 2023 Statement and Consultation, Annex 16, fn. 10.

⁹³ GSMA’s 30 June 2022 research report, “[Vision 2030: mmWave Spectrum Needs](#)”, Table A8.

⁹⁴ Section 12 of TG 5/1 studies, Annex 1, [System parameters and propagation models to be used in sharing and compatibility studies](#), version May 2017

⁹⁵ May 2022 Consultation, para. A6.50 and Figure A6.6

⁹⁶ GSMA’s 30 June 2022 research report, “[Vision 2030: mmWave Spectrum Needs](#)”, Table A8.

⁹⁷ [CONFIDENTIAL ✂].

⁹⁸ Nokia response to the March 2023 Statement and Consultation, p. 3, response to Q. 7.

⁹⁹ Nokia, p. 3, response to Q. 7.

inefficiencies that could be caused through generic assumptions such as the use of Omni antennas”.

- 4.23 We note that we are currently reviewing our antenna modelling approach within our [Shared Access review](#). Once we have completed our Shared Access review, we will consider whether it would be appropriate to apply any changes to our mmWave technical assignment procedure for consistency with the other Shared Access bands.

Coordination filter distances

- 4.24 BT/EE¹⁰⁰ noted that “at Para 10.29 [of the March 2023 Statement and Consultation] a coordination distance of 115 km is proposed for medium power base stations on the basis that it is the same as used for other shared access bands in OfW 590, section A2” and questioned whether shorter re-use distances might be appropriate on the basis that “this reference is in relation to the 1.8 – 4.2 GHz range and that at 26/40 GHz the propagation conditions are very different”.
- 4.25 As BT/EE noted, we proposed to adopt the same coordination filter distances as our existing Shared Access framework¹⁰¹ (20 km at low power and 115 km at medium power). We agree with BT/EE that the filter distances we proposed are likely to be conservative given we proposed to use the same filter distances as those currently in use for sub-6 GHz Shared Access and we expect the sterilisation areas to be smaller at mmWave.
- 4.26 We observe that the practical impact of setting the coordination filter distance too large would be to increase coordination computation time because a larger filter distance will mean coordinating new medium power base stations with more objects in the database. However, we do not currently expect coordination computation times to be a major constraint on how long it takes us to process coordination requests. We have therefore decided to use the coordination filter distances that we proposed which are the same as those under our existing Shared Access framework.

Coordination of Shared Access licensees with other users of the 26 GHz band

Fixed links operating between 24.5 and 26.5 GHz

Our proposals

- 4.27 In the March 2023 Statement and Consultation¹⁰² we proposed to coordinate any new Shared Access low power outdoor and Shared Access medium power deployments with all fixed link licences in the 24.5-26.5 GHz band. We proposed to coordinate within a 200km radius of the Shared Access medium power location or of the site centre for Shared Access low power outdoor.
- 4.28 As per the current framework, we would not coordinate Shared Access low power indoor base stations with existing fixed links. The current method to protect the fixed link receivers

¹⁰⁰ BT/EE, p. 11.

¹⁰¹ Ofcom’s 20 September 2022 OfW 590 “[Technical Frequency Assignment Criteria for Shared Access Radio Services](#)”, Annex 2, Table under para. 8.7.

¹⁰² March 2023 Statement and Consultation, paras. 10.48-10.53.

is described in the [OfW 590 Technical Frequency Assignment Criteria for Shared Access Radio Services \(TFAC\) \(v1.2\)](#).

- 4.29 We proposed that we would not require award winners to coordinate outdoor low power base stations with fixed links and other incumbents because the risk of interference was low. This was different to our proposals for Shared Access outdoor low power base stations which we would coordinate with fixed links and other incumbents because the marginal effort to coordinate them as part of our site-by-site licencing process is low. This is because Shared Access users will be providing us with details of their low power base stations when they apply for a licence (as we need to coordinate Shared Access users with one another), so also coordinating Shared Access low power base stations with fixed links would not be significantly more onerous for us.
- 4.30 For Shared Access low power outdoor and medium power applications, we proposed a minimum separation distance of 200m from a fixed link station. The proposed minimum separation distance of 200m is consistent with the high/low protocol that we used to coordinate 26 GHz fixed links with one-another.¹⁰³ We observed that this distance would be used to protect against inter service FDD/TDD interference,¹⁰⁴ which is consistent with our approach for Shared Access users in the 4 GHz band.
- 4.31 The current detailed technical assignment between fixed systems consists of two tests described below,¹⁰⁵ using propagation model [ITU-R P.452-10](#).¹⁰⁶
- a) **Wanted/Unwanted (W/U) Test 1:** where W/U is applied to the Receiver Sensitivity Level (the fully faded wanted signal) and the median interfering signal level.
 - b) **W/U Test 2:** where W/U is applied to the median wanted signal level (Receive sensitivity level + fade margin) and an enhanced interfering signal level exceeded for p% of time where $p = 100 - \text{availability}$ (associated with the victim receiver).
- 4.32 For mobile base station coordination with fixed links, we proposed to carry out Test 1 only because the risk of interference from mobile base stations to fixed links is likely to be over a distance of a few tens of kilometres and so short-term enhanced interference is not relevant to coexistence. Additionally, we proposed to update our propagation model to use [ITU-R P.452-16](#) as part of our regular updates to our coordination tools.
- 4.33 We proposed to introduce a worst case reduction factor (“ F_{WCR} ”) into the technical assignment method between new mobile users and fixed link incumbents to improve realism in our modelling. We considered that the value of F_{WCR} should be 12 dB.¹⁰⁷

Our decisions

- 4.34 We did not receive any comments regarding our proposals for coordinating Shared Access licensees with fixed links operating in the 24.5-26.5 GHz band. We have decided to proceed with our proposed approach, including updating our propagation model as part of our regular updates to our coordination tools. We are currently considering whether to update

¹⁰³ Ofcom’s 2 August 2022 OfW 446 “[Technical Frequency Assignment Criteria for Fixed Point-to-Point Radio Services with Digital Modulation](#)”, para 2.1.

¹⁰⁴ FDD (Frequency Division Duplex) & TDD, (Time Division Duplex) are duplex methods deployed in telecommunication networks.

¹⁰⁵ OfW 446, para 2.3.

¹⁰⁶ OfW 590, p. 8.

¹⁰⁷ March 2023 Statement and Consultation, paras. A16.18-A16.29.

to ITU-R P.452-16 (as initially proposed) or to ITU-R P.452-18, which we expect to be published soon.¹⁰⁸

Satellite Earth Stations

- 4.35 In the March 2023 Statement and Consultation,¹⁰⁹ we proposed to coordinate any new Shared Access low power outdoor and medium power deployments with all satellite earth stations in the 25.5-26.5 GHz band. Currently, there is only one receive only satellite earth station using this band. However, we will continue to accept future applications for grants of Recognised Spectrum Access for satellite earth stations in the band, but only in low density areas.¹¹⁰ We proposed to coordinate all satellite earth stations within a 200km radius of Shared Access medium power and low power outdoor locations in the 26 GHz band. We proposed not to coordinate Shared Access low power indoor with existing satellite earth stations, as per the current framework.
- 4.36 The current coordination for a satellite earth station consists of two tests described below, using propagation model ITU-R P.452-10:
- a) Test 1: I/N = 0dB and for 0.005% of time
 - b) Test 2: I/N = -10dB and for 20% of time
- 4.37 We proposed to only carry out Test 2. This is because, similar to coexistence with fixed links, we believe there is unlikely to be a risk of interference as a result of short term propagation events. We noted that a worst case reduction factor of 12 dB would also be introduced into the technical assignment method between new mobile users and satellite earth station incumbents. Additionally, we proposed to update our propagation model to use ITU-R P.452-16, as part of our regular updates to our coordination tools.
- 4.38 We also noted that, as the earth stations in the 26 GHz band are receive only, we will not need to carry out any coordination test to protect Shared Access stations from Satellite Earth Stations.
- 4.39 We did not receive any comments on our proposals for coordinating Shared Access licensees with satellite earth stations in the 25.5-26.5 GHz band. We have decided to proceed with our proposed approach, including updating our propagation model as part of our regular updates to our coordination tools. We are currently considering whether to update to ITU-R P.452-16 (as initially proposed) or to ITU-R P.452-18, which is the most up to date version of the propagation model currently available to us.

Radio Astronomy below the 24 GHz band

- 4.40 As we noted in the March 2023 Statement and Consultation,¹¹¹ in the July 2022 Statement [“Protecting passive services at 23.6-24 GHz from future 26 GHz uses”](#) (“**July 2022 Statement on protecting passive services at 24 GHz**”) we decided to apply exclusion zones around the six radio astronomy sites that make up the eMERLIN array, in which we will not allow the deployment of outdoor 26 GHz base stations, in order to protect the following 24 GHz radio astronomy (RAS) sites listed below:

¹⁰⁸ As of the 19 September 2023, P.452-18 was in the final approval stages in ITU SG3.

¹⁰⁹ March 2023 Statement and Consultation, paras. 10.54-10.58.

¹¹⁰ March 2023 Statement and Consultation, para. 6.17.

¹¹¹ March 2023 Statement and Consultation, paras 10.59-10.60.

- Jodrell Bank (SJ 79650 70950)
- Cambridge (TL 39400 54000)
- Darnhall (SJ 64275 62265)
- Defford (SO 90200 44700)
- Knockin (SJ 32855 21880)
- Pickmere (SJ 70404 76945)

4.41 We said that we would use exclusion zones around all six e-MERLIN sites in order to avoid harmful interference from 26 GHz mobile base stations to those sites. We reproduce the exclusion zones distances we calculated below in Table 4.4 for the period after 2024 only, because we will not be making the spectrum available before 2024. These exclusion zones will only have an impact on spectrum availability for Shared Access because none of the high density areas are close enough to radio astronomy sites for them to have an impact on spectrum availability for award winners.

Table 4.4: Radii of exclusion zones around all six e-MERLIN sites

Frequency Range	Radii of exclusion zones
24.25-25.05 GHz	2.5km
25.05-27.5 GHz	1km

Earth exploration satellite service (EESS) below 24 GHz

Ofcom’s decisions (as set out in [Ofcom’s July 2022 Statement](#)) and proposals (as set out in the [March 2023 Statement and Consultation](#))

4.42 In the July 2022 Statement on protecting passive services at 24 GHz,¹¹² we decided to limit the number of outdoor 26 GHz base stations within any 300km² area which can be deployed in the lowest 800 MHz of the 26 GHz band (i.e. 24.25-25.05 GHz) in order to protect the EESS below 24 GHz. The total interference contribution from all individual base stations operating in the lowest 800 MHz (24.25-25.05 GHz) of the 26 GHz band within any 300km² area must be equal to or lower than 0.1432 W/200 MHz.

4.43 In our May 2023 Consultation and Statement,¹¹³ we said that we remained of the view that it was not necessary to include an interference contribution from base stations deployed above 25.05 GHz. We said that this meant that we will need to coordinate Shared Access users in accordance with this density limit, but that award winners in the 26 GHz band will not be subject to this coordination limit because we are awarding the spectrum above 25.1 GHz only.

Calculating the EESS limit

4.44 As set out in the July 2022 Statement on protecting passive services at 24 GHz,¹¹⁴ we will calculate the total interference contribution from all base stations in any 300km² area and compare this with the interference limit.

¹¹² Ofcom’s 4 July 2022 Statement, “[Protecting passive services at 23.6-24 GHz from future 26 GHz uses](#)”.

¹¹³ May 2023 Consultation and Statement, paras. 10.61 – 10.67.

¹¹⁴ July 2022 Statement on protecting passive services at 24 GHz, Equation 2

- 4.45 In the March 2023 Statement and Consultation,¹¹⁵ we proposed to add an apportionment term (“**I_{c_MOD}**”) to take account of our decision to implement a nationwide safeguard of 200 MHz spectrum for Defence use in 24.25-24.45 GHz, as set out below in Equation 4.2.

Equation 4.2

$$\sum_{n=1}^N I_{c,n} + I_{c_MOD} \leq 0.1432 \text{ W/200 MHz}$$

Where:

N is the total number of base stations in the 300km² area

n is the *n*th base station

I_{c,n} is the interference contribution from the *n*th base station as calculated below in Equation 10.4 (in linear units W/200 MHz)

I_{c_MOD} is 0.00317 W/200 MHz for MoD use in the band

- 4.46 We proposed that when we receive a new Shared Access application, our coordination tool would count the number of existing Shared Access users in a 300km² area centred on the new applicant to check whether the new applicant would cause the deployment density limit to be exceeded.
- 4.47 Licensees could deploy more than one base station under the terms of each licence. We proposed to take this into account in our base station density calculation by multiplying all low power outdoor and medium power licences by three. This would then be used to determine the total number of base stations within the 300km² area.
- 4.48 We would then calculate all emissions contributions from each base station using Equation 4.3, including the new Shared Access deployment, then add together all the individual contributions to calculate whether the overall limit has been exceeded.

Equation 4.3

$$I_c = 10 \left(\frac{P_{OOBE_dB} - 2 \left(\frac{\left(f_{centre} - \frac{Ch_{size}}{2} \right) - 24.25}{0.05} \right)}{10} \right)$$

Where:

I_c contribution of single base station in W/200 MHz

P_{OOBR_dB} -39 (dBW/200 MHz)

f_{centre} centre frequency of assigned channel

Ch_{size} channel bandwidth

¹¹⁵ March 2023 Statement and Consultation, paras. 10.61-10.67.

- 4.49 To simplify coordination with MOD use (some of which could be temporary in nature) and to give MOD flexibility, we have agreed with MOD a maximum density limit of 40 MOD base stations per 300km² area. We proposed to add an apportionment of 0.00317 W/200 MHz¹¹⁶ to take account of that potential future MOD use. Any additional MOD use above this limit will be notified to Ofcom by MOD and captured as additional base stations/apportionment in Equation 4.3.
- 4.50 If the total calculated value is equal to or less than 0.1432 W/200 MHz, the new Shared Access deployment would pass the EESS out of band emissions coordination.

Summary of responses

- 4.51 Nokia¹¹⁷ asked us to clarify how we use the 2 dB location variability in our coordination process for low power outdoor base stations and how it relates to our base station density limit for the protection of EESS below 24 GHz.

Ofcom's decision

- 4.52 In regard to Nokia's comment on the 2 dB "location variability" adopted in our coordination procedures for low power base stations, we clarify that this 2 dB is only applied for coordination with other terrestrial users¹¹⁸ and does not apply to how we have calculated the base station density limit for coexistence with EESS below 24 GHz.
- 4.53 We remain of the view that our update to the EESS base station density calculation to include a MOD apportionment term and to limit each low power licence to a maximum of three base stations are appropriate for ensuring coexistence with EESS below 24 GHz and have decided to proceed with it.

26 GHz and 40 GHz: Protection of fixed links in high density areas during the revocation period

Our proposals

- 4.54 In the March 2023 Statement and Consultation, we set out our decisions to begin the statutory process to revoke all of the licences authorising use of fixed links in and around the high density areas in the 26 GHz band, and all of the block assigned licences authorising use of fixed links in the 40 GHz band.¹¹⁹
- 4.55 We have now completed the statutory process to revoke all of the existing 40 GHz licences with 5 years notice¹²⁰ (until 1 June 2028),¹²¹ and we will shortly start the process to revoke the existing 26 GHz fixed link licences with 5 years notice.

¹¹⁶ Derived from 40 base stations operating on frequency 24.35 GHz (200 MHz channel) at the OOB limit -39 dBm / 200 MHz.

¹¹⁷ Nokia, p. 4, response to Q. 7.

¹¹⁸ Ofcom's 25 July 2019 Statement, "[Enabling wireless innovation through local licensing 2019 statement](#)" paras. 3.118-3.127.

¹¹⁹ We said fixed links which are not in or around high density areas in the 40 GHz band would be able to remain in the band, as we would offer to grant individual fixed link licences for each of the fixed links continuing to operate in low density areas, following revocation of the relevant block assigned licences.

¹²⁰ We have offered to allow MBNL to continue to operate up to 500 fixed links until 1 January 2030, subject to a number of conditions.

¹²¹ Ofcom's 30 May 2023 [Update on revoking licences in the 40 GHz band](#).

- 4.56 Accordingly, there will be a period during which award winners and incumbent fixed links will both be authorised to use mmWave spectrum in high density areas. In the May 2022 Consultation, we set out coexistence analysis which showed that award winners wishing to deploy medium power base stations in high density areas in 25.1-26.5 GHz and the 40 GHz band and low power base stations in 40.5-40.75 and 42.0-42.25 GHz before the revocation of existing users' licences has taken effect will need to coordinate with existing fixed services to mitigate the risk of interference.¹²²
- 4.57 We consulted on the following options for coordinating these users during this period:¹²³
- a) **Option 1:** Award winners would be expected to carry out their own coordination, on the basis of coordination procedures set out by Ofcom.
 - b) **Option 2a:** Ofcom would provide detailed maps for award winners, showing where they can deploy.
 - c) **Option 2b:** Ofcom would publish fixed link locations with exclusion zone vectors.
 - d) **Option 3:** Ofcom would coordinate new and incumbent users during the revocation period, using its existing coordination tool (similar to the way Ofcom coordinated users of the 3.6-3.8 GHz band, during the revocation period for fixed links in that band).
 - e) **Option 4:** Award winners would only be allowed to deploy at low power until the end of the revocation period (as low power deployments would not interfere with fixed links).
- 4.58 We said that our provisional view was that one of the options where we carry out the coordination (i.e., Option 2 or 3) would be most likely to result in efficient use of the spectrum. However, we asked for stakeholders' views on this, including as to whether they considered Option 1 would be effective and technically feasible for them, or whether they thought that alternative approaches to coordination would be appropriate.

Summary of responses

- 4.59 BT/EE, H3G, Vodafone, VMO2, National Grid and Nokia all provided responses on this issue:
- a) BT/EE¹²⁴ and Vodafone¹²⁵ expressed a preference for some form of hybrid of Options 2 and 3, whereby if an award winner wishes to deploy during the revocation period, it would first check the spectrum availability using maps of coordination zones published by Ofcom, which would show whether more detailed coordination is necessary. Vodafone suggested Ofcom should ensure these maps are conservative. If the maps showed no potential coordination concerns, the award winner would go ahead and deploy. However, if the maps showed the potential for a coordination problem, the award winner would put in a coordination request to Ofcom before deploying.
 - b) H3G¹²⁶ supported allowing licensees to coordinate themselves (Option 1), with the option to escalate issues to Ofcom as a backup (Option 3). H3G considered that our proposed Options 2 and 3 would be "unnecessarily burdensome on both Ofcom and industry".
 - c) VMO2¹²⁷ was in favour of Option 1 (award winners do the coordination themselves), on the basis that Option 3 would dilute the award winners' deployment rights and slow the

¹²² May 2022 Consultation, paras. A6.92-A6.6.98.

¹²³ March 2023 Statement and Consultation, paras. 10.81-10.100.

¹²⁴ BT/EE, p. 11.

¹²⁵ Vodafone, pp.7-8.

¹²⁶ [H3G response to the March 2023 Statement and Consultation](#), p. 9.

¹²⁷ VMO2, p. 33.

process down. However, like BT/EE and Vodafone, VMO2 was in favour of Ofcom also publishing maps to aid coordination.

- d) National Grid Electricity Distribution,¹²⁸ one of the existing fixed link licensees, was in favour of Option 3, which it thought would best ensure protection of incumbent fixed links.

Ofcom's decision

- 4.60 We have decided to take a different approach to coordination of award winners and incumbent fixed links in the 26 GHz and 40 GHz bands. We explain our decisions in relation to each band below.

The 26 GHz band

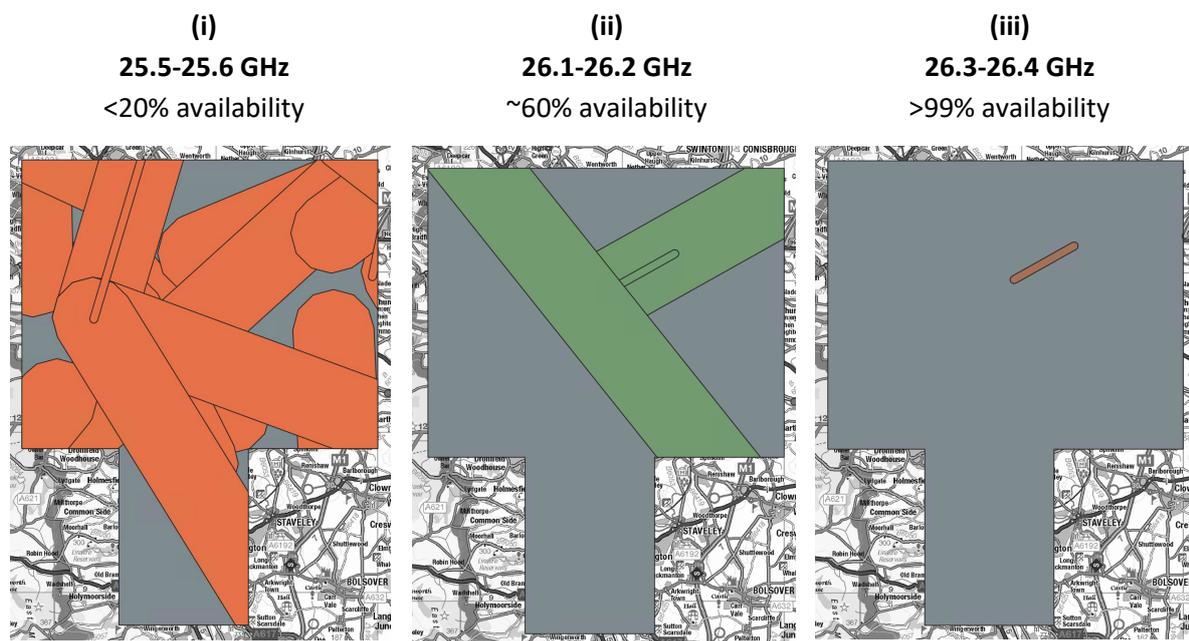
- 4.61 Having considered stakeholders' responses, we have decided to adopt a hybrid approach of Options 2b and Option 3 for coordination between award winners and fixed links in the 26 GHz band during the revocation period. This will mean that award winners will first consult a coordination zones map (see below), to check whether the area in which they want to deploy falls within a coordination zone. If it does, award winners would be required to submit coordination requests to Ofcom for mobile base stations. However, if the location in which they want to deploy is not within a coordination zone, the award winner can deploy without submitting any coordination request to Ofcom.
- 4.62 We consider that this approach will appropriately mitigate the risk of harmful interference to the incumbent fixed links, and will give rise to the following additional benefits:
 - a) It would mean award winners can deploy quickly outside coordination zones, without having to submit a coordination request and wait for a response from Ofcom;
 - b) it would reduce the number of coordination requests that licensees submit to Ofcom, thereby reducing the level of resource required from both Ofcom and the award winners;
 - c) It would enable award winners to immediately see spectrum availability at a high level in an area in any given channel.

Coordination zone maps

- 4.63 In order to implement this, we will generate maps showing coordination zones around incumbent fixed links in the 26 GHz band, for each available channel. We note Vodafone's comments about generating sterilisation areas using conservative assumptions and agree that would be necessary to ensure that award winners deploying outside the coordination zones shown on the maps will not cause harmful interference to fixed links. Based on our earlier analysis of fixed links sterilisation zones, we will represent the coordination zone for a fixed link with a rectangle of fixed width and varying length.
- 4.64 We give an example of what the coordination zones would look like in the figure below. The larger coordination zones are co-channel with a fixed link receiver whilst the smaller coordination zones are in the first adjacent channel to a fixed link receiver.

¹²⁸ [National Grid Electricity Distribution response to the March 2023 Statement and Consultation](#), p. 5.

Figure 4.1: Maps of coordination zones for three 100 MHz channels in Sheffield. The grey areas are outside of the coordination zones



4.65 These map layers can then be combined to obtain a view of the spectrum availability in an area. Alternatively, the map layers can be inspected separately to understand the channel by channel availability within a high density area.

4.66 We will consider whether or not it is necessary to update these maps, and the frequency with which we should do so, in light of (i) the rate with which incumbent fixed links are cleared from the band; and (ii) the rate at which award winners deploy mmWave spectrum during the revocation period.

The 40 GHz band

4.67 H3G¹²⁹ and MBNL¹³⁰ were concerned about revealing publicly the locations of their current fixed links. In this particular case, we have decided to respect their concerns, noting that the period of overlap between deployments of mobile base stations and incumbency of fixed links will be shorter in the 40 GHz band than in the 26 GHz band.

4.68 We have therefore decided to proceed with Option 3 for the 40 GHz band. This means that, to ensure protection of existing fixed links, while also maximising spectrum availability for new users, Ofcom will coordinate all new deployments in the 40 GHz band, until the revocation of the incumbent licensees' licences takes effect (i.e. until June 2028).¹³¹

4.69 As set out in our March 2023 Statement and Consultation,¹³² we will request updated information from the existing 40 GHz licensees (H3G, MBNL and MLL) on any new and

¹²⁹ H3G's 8 September 2023 email to Ofcom regarding the protection of its 40 GHz links during the revocation period.

¹³⁰ MBNL's 4 September 2023 email to Ofcom regarding the protection of its 40 GHz links during the revocation period.

¹³¹ As explained in Section 2, paragraph 2.5, we have offered to allow MBNL to continue to operate up to 500 fixed links until 1 January 2030, subject to a number of conditions. Should MBNL take up this option, we will continue to coordinate deployments around the relevant links until January 2030.

¹³² March 2023 Statement and Consultation, para. 10.98.

removed deployments on a regular basis until the end of the revocation period. However, we will not protect spectrum for planned future deployments. There is a chance that the award winners and the existing users might both deploy sites in the same area between updates to the coordination data. This is unlikely to be a common occurrence. But, if it does happen and both an award winner and an existing user deploy in the same area and either or both of the parties suffers harmful interference, we would expect to work with both parties to resolve any interference.

Implementation in the award winners' licences

- 4.70 We will implement our decisions on coordination in both bands by including a condition in award winners' licences which will require them to comply with specified coordination procedures (shown at Annex 3 of this document).

Protection of the 40 GHz Radio Astronomy site at Cambridge

Our proposals

- 4.71 The 42.5-43.5 GHz block of frequencies has been allocated internationally for radioastronomy. There is currently one grant of Recognised Spectrum Access (“**RSA**”) for radioastronomy use in this part of the band, issued to the Science and Technology Facilities Council (“**STFC**”). In the 42.5-43.5 GHz frequency band, this site is currently protected by a 50km exclusion zone, while a 50km coordination zone (with specified spectrum quality benchmark levels) applies in relation to other frequency bands covered by the same grant of RSA.
- 4.72 In the March 2023 Statement and Consultation,¹³³ we proposed to change how we protect this site in the 42.5-43.5 GHz band after the auction, in order to ensure spectrum around the site could be used efficiently by award winners. In particular, we proposed to protect the radio astronomy site (“**RAS**”) at Cambridge in the 42.5-43.5 GHz band using technical assignment coordination in the following way, instead of the current 50km exclusion zone:
- a) use a 50km coordination zone centred on NGR TL 39400 54000, which would be in line with the size and location of the existing exclusion zone;
 - b) apply a spectrum quality benchmark (SQB) level of -207dBW/500 kHz, which is equivalent to -181 dBW/200 MHz at 42.5-43.5 GHz. This protection level is recommended by the [ITU-R RA.769-2](#); ¹³⁴ and
 - c) apply a F_{WCR} of 12 dB to the coexistence calculation.
- 4.73 For the avoidance of doubt, we would carry out this coordination for any new Shared Access licence in the 40.5-43.5 GHz band, whereas award winners would be expected to carry out this coordination themselves.
- 4.74 We noted that this would affect award winners of the 40.5-42.5 GHz, as well as 42.5-43.5 GHz in Cambridge, as they would have to limit their out-of-block emissions into the Radio Astronomy band (42.5-43.5 GHz) in order to comply with the specified SQB level.

¹³³ March 2023 Statement and Consultation, paras. 10.101-10.104.

¹³⁴ ITU, “[RECOMMENDATION ITU-R RA.769-2, Protection criteria used for radio astronomical measurements \(1992-1995-2003\)](#)”, Table 2.

Summary of responses

- 4.75 VMO2¹³⁵ and Vodafone¹³⁶ agreed with our proposal to protect radioastronomy use in Cambridge in the top 1 GHz of the 40 GHz band.
- 4.76 Vodafone said that it agrees in principle but requested additional information on the implications of our proposals on new mobile licensees, both between 40.5-42.5 GHz, and 42.5-43.5 GHz, as “this may well affect the relative valuation of the frequencies”. In particular, in the March 2023 Statement and Consultation,¹³⁷ we said that all the 40 GHz licensees would need to limit their emissions into 42.5-43.5 GHz and Vodafone asked us to clarify whether the limitation would be uniform across the band or whether it would be more extreme in the upper part. Vodafone also suggested that if the limitation “is more extreme in the upper part”, then this differential may justify different lot types for the 40 GHz band, arguing that Vodafone cannot assess this in the absence of more information.

Ofcom’s decision

- 4.77 In response to Vodafone’s request for clarification, we note that there are six high density areas which intersect with the 50 km exclusion zone, but we note that there is only likely to be a material constraint on deployments in the Cambridge high density area, which is the closest HDA to the Cambridge radio astronomy site.¹³⁸ We consider that award winners operating in the 40.5-43.5 GHz band will have to evaluate the suitability of their equipment and deployment techniques in order to meet the specified SQB level within the proposed 50 km coordination zone. For greater clarity of the deployment risks, we consider various scenarios below.

Outdoor base stations operating co-channel (42.5-43.5 GHz)

- 4.78 As set out in paragraphs A16.59-A16.61 of the March 2023 Statement and Consultation, it may be possible to deploy co-channel (42.5-43.5 GHz) low power base stations in some areas of Cambridge, however, it is likely to be very challenging to deploy medium power base stations in Cambridge and this remains true even for the most optimistic case we considered.¹³⁹ We provided some diagrams showing the co-channel sterilisation for low and medium power outdoor base stations in the March 2023 Statement and Consultation.¹⁴⁰

Outdoor base stations operating in adjacent spectrum (40.5-42.5 GHz)

- 4.79 As set out in paragraphs A16.62-A16.64 of the March 2023 Statement and Consultation, in the first adjacent channel (42.3-42.5 GHz) there is a low risk of interference from outdoor low power mmWave base stations.¹⁴¹ However, the interference risks from medium power mmWave base stations remains substantial across most of the Cambridge high density area because medium power base stations tend to be deployed at greater heights and so will have line-of-sight of the Cambridge radio astronomy site in many circumstances.¹⁴² We therefore consider that there is little constraint on the ability to deploy outdoor low power

¹³⁵ VMO2, p. 34.

¹³⁶ Vodafone, p. 8.

¹³⁷ March 2023 Statement and Consultation, para. 10.103.

¹³⁸ March 2023 Statement and Consultation, paras. 16.67-16.69.

¹³⁹ March 2023 Statement and Consultation, paras. 16.59-16.61.

¹⁴⁰ March 2023 Statement and Consultation, Figures A16.2 and A16.3.

¹⁴¹ March 2023 Statement and Consultation, Figure A16.4.

¹⁴² March 2023 Statement and Consultation, Figure A16.5.

base stations in 40.5-42.5 GHz in the Cambridge high density area, however, outdoor medium power base stations using these frequencies could require additional mitigations, which could include height reduction or additional out-of-block filtering.

- 4.80 We note that our modelling took the regulatory out-of-block limits into account in the first adjacent channel and that real equipment could perform better than this. We note that there are currently uncertainties relating to the out of band emissions of 40 GHz equipment, particularly at larger frequency separations. We also note that SE21 (which is within the ECC Working Group Spectrum Engineering) is seeking to develop measurement methodologies and techniques for measuring unwanted emissions from active antenna systems in the field including those at 40 GHz. We believe that the work from SE21 will be useful to award winners and vendors in determining the unwanted emissions of their equipment. This work is currently due to conclude in Summer 2024 so it will likely be useful for coordination assessments.¹⁴³

Indoor base stations operating across the 40 GHz band

- 4.81 In the March 2023 Statement and Consultation,¹⁴⁴ we said that there is little risk of interference from indoor low power mobile deployments across most of the Cambridge high density area to the Cambridge radio astronomy site, both in-band (42.5-43.5 GHz) and out-of-band (40.5-42.5 GHz). There remains some risk of interference from indoor low power mobile deployments in the areas of the Cambridge high density area which are closest to the Cambridge radio astronomy site. We therefore consider that there is little constraint on the ability of licensees to deploy indoor low power base stations in the Cambridge high density area.

Conclusions

- 4.82 In light of stakeholders' responses, we intend to start the process for varying the Cambridge grant of RSA to (i) include a 50km coordination zone with a SQB level of -207 dBW / 500 kHz applying in the 42.5-43.5 GHz band and (ii), from June 2028 (when revocation of the existing 40 GHz licences takes effect), remove the existing 50km exclusion zone applying in the same band. As part of this variation process, we will give the Science and Technology Facilities Council (which currently holds the grant of RSA in Cambridge) an opportunity to make representations regarding the proposed variation of its grant of RSA.
- 4.83 Further detail about the coordination procedures that we are minded to apply to award winners (subject to the outcome of the variation process) is set out at Annex 3. In addition, we will only grant new 40 GHz Shared Access licences within 50km of the RAS complies where they comply with this SQB limit.
- 4.84 In relation to Vodafone's comment on lot types, we note that we will set out our decisions on the lot categories we will offer in the auction in our next document on auction design.

¹⁴³ [WI SE21 25](#), Measurement methodologies for 5G AAS in the field, ECC WG SE - SE21

¹⁴⁴ March 2023 Statement and Consultation, paras. A16.65 and A16.66

Coordination at the boundary of high and low density areas (Shared Access licensees' and award licensees' deployments)

Our Proposals

Summary

- 4.85 In the March 2023 Statement and Consultation,¹⁴⁵ we set out our decisions to make the top 2.4 GHz of the 26 GHz band (25.1-27.5 GHz) available through auctioned citywide licences, which would authorise use of the relevant spectrum in high density areas, and our proposals to make the whole of the 40 GHz band available in the same way (which we have now confirmed). In low density areas, we decided to make the whole of the 26 GHz band available using our Shared Access licensing framework.
- 4.86 This means it is possible that interference will arise between Shared Access licensees and award winners' deployments at the boundaries of high density areas, as Shared Access licensees will be able to deploy outside high density areas, and award winners will be able to deploy within high density areas, using the same frequencies.
- 4.87 In the March 2023 Statement and Consultation,¹⁴⁶ in order to mitigate this interference risk, we proposed to impose:
- a) a **field strength limit**, at the boundary of any high density areas, on transmissions from all medium power base stations (both those of award licensees, within high density areas, and those of Shared Access licensees, outside high density areas); and
 - b) a **minimum separation distance** between any low power base station (indoor and outdoor) and the boundary of any high density area, as shown in Table 4.5 below.

Table 4.5: Low power base station minimum separation distance from the high density area boundary line in 25.1-27.5 GHz and 40 GHz for both Shared Access and award winners

Authorisation type	Distance
low power indoor	50m
low power outdoor	100m

- 4.88 In relation to the proposed field strength limit,¹⁴⁷ we noted that work was ongoing at ECC PT1¹⁴⁸ on 26 GHz cross-border coordination and that the field strength limits being considered would allow licensees to deploy medium power base stations up to 250m from the boundary of a high density area with some site engineering. We said that this meant that a licensee might need to downtilt base station antennas or point antenna panels away from the boundary line when deploying near the boundary.

¹⁴⁵ March 2023 Statement and Consultation, paras. 10.105-10.109

¹⁴⁶ March 2023 Statement and Consultation, paras. 10.106-10.107.

¹⁴⁷ March 2023 Statement and Consultation, paras. 10.107-10.109

¹⁴⁸ [ECC PT1\(23\)067](#), annex VIII-08

4.89 We proposed to adopt the same field strength limit as ECC PT1 for both the 26 and 40 GHz bands, for both award winners and Shared Access users either side of the high density area boundary, as long as the finalised values did not significantly constrain use in high density areas.

Summary of responses

4.90 We received the following comments from stakeholders:

- a) H3G¹⁴⁹ said that “licen[s]ed use should have absolute priority over Shared Access use, and that in the case of interference the Shared Access user should amend its transmissions to protect the licenced user”. In its view, “[t]his is important to give bidders certainty that they can deploy their mmWave spectrum fully in the HDAs, and therefore derive their valuations appropriately.”
- b) BT/EE¹⁵⁰ had “no objection” to our proposed approach to coordination at the boundary, but reserved its position on this question “until the proposed field strength limits at the boundary are known and assessed”.
- c) Vodafone¹⁵¹ also agreed with our approach, but made the following suggestions: “*in many/most cases spectrum set aside for Shared Access Licences in the high-density area will be available at the boundary so no applicant should be outright excluded. Even where this spectrum has already been used, then if there is an application for a Shared Access Licence in the 50/100m “exclusion” zone, Ofcom could liaise with the high-density award licensees regarding whether they have deployed in the area.*”

Ofcom’s decision

Field strength limit for award winners

4.91 Since the publication of our March 2023 Statement and Consultation, further work has been done within ECC PT1, including further analysis of mobile network to mobile network coexistence. We summarise the values agreed in [ECC Recommendation \(23\)02](#) for 26 GHz in Table 4.6 which the Recommendation notes are *median* field strength values.

Table 4.6: Field strength values at 3m height for unsynchronised operation from ECC Recommendation (23)02.¹⁵² This field strength value is the median value for base stations using AAS.

Unsynchronised operation
All PCIs
62 dBµV/m/(200 MHz) @ 0 km
@ stands for “at a distance from the borderline into the neighbouring country”.
The value of 62 dBµV/m/(200 MHz) corresponds to SSB [synchronisation signal block] field strength level of 52 dBµV/m/(120 kHz) for NR [5G New Radio] considering the SCS [sub-carrier spacing] of 120 kHz

¹⁴⁹ H3G, p. 8.

¹⁵⁰ BT/EE, p. 11,.

¹⁵¹ Vodafone, p. 9.

¹⁵² [ECC Recommendation 23\(02\)](#), 7 July 2023, Annex 1.

- 4.92 In light of H3G's concerns about the certainty of award winners to deploy in high density areas and BT/EE's concerns around the uncertainty about the field strength limit, we have assessed the impact of the field strength limit on the ability of award winners to deploy.
- 4.93 We note that the work for ECC PT1 indicated that the cell radius for a mmWave macrocell was 250m and that the field strength limit was calculated on the basis that macrocells should be able to be deployed 250m from the boundary in a scenario where a base station deployment surrounded by urban clutter with downtilt.¹⁵³ We consider that this approach is also appropriate for the high density areas, which are several kilometres across and so the need to do some site engineering when 250m from high density area boundary does not represent a material constraint on award winners' deployments.¹⁵⁴
- 4.94 We note that the work in ECC PT1 assumed that mmWave macrocell base stations operated with 30.6 dBm / 200 MHz TRP¹⁵⁵¹⁵³ whereas we have now decided to allow medium power base stations to operate up to 36 dBm / 200 MHz TRP (see Section 7). We acknowledge that this will mean that some base stations operating close to the regulatory power limit may require additional site engineering mitigations when deployed close to the high density area boundary. However, we consider that these mitigations should be possible, given the power limit we have adopted is only 5.4 dB higher than the power limit considered in the CEPT work. We therefore consider that the field strength limit is not a material constraint on the ability of award winners to deploy medium power base stations.
- 4.95 With regard to the comment from H3G, we note that the field strength limit we have decided to use is unlikely to materially impact the ability of an award winner to deploy where it needs to in a high density area. We therefore consider it proportionate to apply the same field strength limit to both award winners and Shared Access licensees at the boundary of high density areas.
- 4.96 CEPT currently has no plans for a new recommendation on cross-border coordination at 40 GHz.¹⁵⁶ For the reasons set out above in relation to the 26 GHz band, we consider that the same field strength limit should apply at 40 GHz because the two bands have similar propagation characteristics. Therefore, in line with our proposals, we have decided to adopt the same field strength limit at 40 GHz as with 26 GHz.
- 4.97 In conclusion, we have decided to impose a median field strength limit of 62 dBµV/m/(200 MHz), at the boundary of high density areas, on transmissions from the medium power base stations of award winners. Award winners can, alternatively, use the SSB field strength limit (given in Table 4.6) or the peak field strength limit (the derivation for which is described below in paragraphs 4.101 and 4.102) because we consider these limits to be equivalent to the median field strength limit.

¹⁵³ [CG X-border #36 3 Annex 1 Temporary working doc on 26 GHz x-border rev2](#), Table 1.

¹⁵⁴ We discuss site engineering techniques which could be appropriate in paragraphs A16.67-A16.69 of the March 2023 Statement and Consultation.

¹⁵⁵ [CG X-border #36 3 Annex 1 Temporary working doc on 26 GHz x-border rev2](#), Table 1.

¹⁵⁶ [Draft minutes of the 73rd ECC PT1 meeting](#), para. 11.2.1.3.

Coordination requirements for awards winners accessing spectrum in areas adjacent to high density areas through Shared Access licences

- 4.98 We note Vodafone’s comment, and we acknowledge that it is possible that in some cases allowing new Shared Access licensees to deploy up to the boundary of a high density area would ensure the spectrum is used as efficiently as possible.
- 4.99 We consider that this could be possible in the longer term, but that this would unduly complicate the framework on which we have decided to authorise this spectrum in the medium term. This is because the holder of the citywide licence could change over the course of the licences:
- a) from early 2024, until the date of the auction, we will not know who the holder of the award licence will be;
 - b) between the date of the award and the end of the revocation period for incumbent fixed links, there will be a set of award winners in the 26 GHz band, however, the precise frequencies they hold in the band could change if we implement the proposals set out in paragraphs 9.30-9.42 of the March 2023 Statement and Consultation.
- 4.100 As a result, we have decided to implement Vodafone’s suggestion only where the award winner is the same as the applicant for the Shared Access licence, and only in these time periods:
- a) in the 26 GHz band, we will implement this only once the ‘final’ spectrum holdings for the 26 GHz band are in place;¹⁵⁷ and
 - b) in the 40 GHz band, once Shared Access licences become available in 2028.

Field strength limit calculations for the purposes of Shared Access coordination

- 4.101 For the purposes of Shared Access coordination with the boundaries of the high density areas, we note that the value of 62 dB μ V/m/(200 MHz) from ECC Recommendation (23)02 is a median field strength value¹⁵⁸ and so the peak power of beams pointing towards the border could be substantially higher than this, depending on: network loading; the location of terminals relative to the base station; and beamforming behaviour of the base station. We will be coordinating Shared Access using peak envelope antenna gain and so we need to calculate an equivalent peak field strength value which reflects this. In order to do this we have taken the synchronisation signal block (“SSB”) field strength value of 52 dB μ V/m/(120 kHz) specified in ECC Recommendation (23)02 and calculated the equivalent peak field strength value to be 93 dB μ V/m/(200MHz) using Equation 4.4 below. We consider the SSB field strength value more relevant for calculating the peak envelope power field strength than the median field strength value because SSB beams are subject to less EIRP variability than the traffic beams which dominate the median field strength calculation.¹⁵⁹

¹⁵⁷ i.e. the ‘final 26 GHz allocation’, following rearrangement, if we go ahead with that option (c) on which we consulted in March 2023 Statement and Consultation (para. 9.30) or, if we decide on option (a) or (b), the allocation of the 26 GHz band, which we would not expect to change substantially over the course of the licence term.

¹⁵⁸ [ECC Recommendation 23\(02\)](#), 7 July 2023, p. 5.

¹⁵⁹ Traffic beam field strength will be subject to, amongst other things: network loading; the location of terminals relative to the base station; and beamforming behaviour of the base station.

Equation 4.4

$$FS_{peak} = FS_{SSB} + F_{BWN} + G_{diff}$$

Where:

- FS_{peak} is the calculated peak field strength value in units of dB μ V/m/(200 MHz).
- FS_{SSB} is the SSB field strength which has a value of 52 dB μ V/m/(120 kHz) in ECC Recommendation (23)02.
- F_{BWN} is the bandwidth normalisation factor going from 120 kHz to 200 MHz and has a value of 32 dB.
- G_{diff} is the difference in antenna gain between the SSB beams and the traffic beams. ECC Recommendation (23)02 says that this value is 9 dB.

- 4.102 In conclusion, we have decided to impose a peak field strength limit of 93 dB μ V/m/(200MHz), at the boundary of high density areas, on transmissions from all Shared Access medium power base stations.

Minimum separation distances

- 4.103 We did not receive any comments on our proposals for minimum separation distances for low power base stations from the boundaries of high density areas. In line with our proposals, we have decided to impose the following minimum separation distances between low power base stations and the boundary of high density areas: (i) 50m for low power indoor use and (ii) 100m for low power outdoor use for both Shared Access licensees and award winners.

26 GHz and 40 GHz: International coordination

Our proposals

- 4.104 In the March 2023 Statement and Consultation,¹⁶⁰ we noted that work was ongoing at ECC PT1 to establish the international coordination trigger levels and due to be published Summer 2023. We proposed to establish memoranda of understanding for cross-border coordination with our neighbours which would take the border conditions recommended by ECC into account.
- 4.105 We proposed to include a condition in the award licences for both the 26 GHz and 40 GHz bands, requiring licensees to comply with any such cross-border coordination and sharing procedures as may be notified to them by Ofcom from time to time, which is a standard condition in most award licences.
- 4.106 We noted that in practice, international coordination is unlikely to be a constraint on award winners because the field strength limit at the boundary of high density areas will be a greater constraint on deployment than the field strength limit at international boundaries.

¹⁶⁰ March 2023 Statement and Consultation, para 10.110-10.111

Summary of responses

4.107 Stakeholders (BT/EE,¹⁶¹ VMO2,¹⁶² Vodafone)¹⁶³ generally agreed with our approach to international coordination. Vodafone added that: “[i]n the event that Ofcom becomes aware of circumstances that could affect deployment (e.g. the existence of radio astronomy sites in the low countries), then we would expect that potential bidders are made aware of this at the earliest possible opportunity”.

Ofcom’s decision

- 4.108 We have decided to seek memoranda of understanding at both 26 GHz and 40 GHz as appropriate with our neighbouring administrations, taking the 26 GHz recommendation developed by ECC PT1 (ECC Recommendation 23(02)) into account.
- 4.109 In relation to Vodafone’s comment, we note that Ofcom has mechanisms in place for exchanging information with neighbouring administrations via memoranda of understanding. We also note that so far we have not notified any cross-border coordination and sharing procedures to the current 40 GHz licensees to protect existing radio astronomy in other countries and we do not currently envisage that there will be any new radio astronomy sites operating at 40 GHz near the UK.

Conclusion and next steps

- 4.110 In conclusion, we have decided to coordinate use of mmWave spectrum as proposed. In light of stakeholders’ responses and further development at international level, we have refined our approach to coordination in two areas:
- a) we have decided to adopt a hybrid approach of Options 2b and Option 3 for coordination between award winners and fixed links in the 26 GHz band during the revocation period. In the 40 GHz band, we will do this coordination (Option 3);
 - b) we have decided to set a median field strength limit of 62 dB μ V/m/(200 MHz) on transmissions from all medium power base stations at 3m height at the boundary of high density areas.
- 4.111 As noted above, the coordination procedures that we are minded to apply to protect the radio astronomy site at Cambridge in the 42.5-43.5 GHz band is subject to the outcome of the process for varying the relevant grant of RSA, which we will start shortly.

¹⁶¹ BT/EE, p. 12.

¹⁶² VMO2, p. 34.

¹⁶³ Vodafone, p. 9.

5. Non-technical conditions for the award licences

Summary

- 5.1 Having considered stakeholders' responses, we have decided to include the non-technical licence conditions proposed in the March 2023 Statement and Consultation in the award licences for the 26 GHz and 40 GHz bands. This section does not address the duration of the licences, which is covered in Section 6.
- 5.2 The draft licence shown in Annex 4 reflects the decisions set out in this section and in Section 7.¹⁶⁴

Background

- 5.3 In Section 11 of our March 2023 Statement and Consultation, we consulted on the non-technical licence conditions that we proposed to include in the award licences.
- 5.4 The comments provided by respondents focused on the proposed licence terms concerning (i) the tradability of licences (including leasing) and (ii) spectrum sharing. In summary:
- a) H3G and BT/EE asked that we make the award licences leasable;
 - b) Vodafone reiterated its support for a "club spectrum model" and explained how it could work under the Local Access licensing framework; and
 - c) VMO2 asked that we do not extend the Local Access licensing framework to the auctioned mmWave spectrum.
- 5.5 We also received a couple of comments on roll-out obligations and the payment of licence fees. Below, we address stakeholders' comments before setting out our final decisions.

Trading and leasing

Our proposals

Trading

- 5.6 In the March 2023 Statement and Consultation, we proposed to make the award licences tradable under the [Wireless Telegraphy \(Mobile Spectrum Trading\) Regulations 2011](#) (the "Mobile Trading Regulations").¹⁶⁵ We explained that this would mean that:
- a) licensees could trade the rights and obligations under their award licences with consent from Ofcom.¹⁶⁶ Before giving consent to a trade, among other factors, Ofcom may consider whether competition is likely to be distorted as a result of the trade,^{167,168} and

¹⁶⁴ We have also made some minor editorial changes, such as omitting redundant definitions.

¹⁶⁵ S.I. [2011/1507](#), amended by S.I. [2013/646](#), S.I. [2015/1339](#) and S.I. [2019/951](#).

¹⁶⁶ [Mobile Trading Regulation](#), Regulation 7(3)(a) and 8.

¹⁶⁷ Mobile Trading Regulations, Regulation 8(e).

¹⁶⁸ Our [Trading Guidance Notes](#) provide further detail on this transfer process.

- b) licensees could agree ‘total’ transfers or ‘partial’ transfers.^{169.170}

Leasing

- 5.7 In our [2016 spectrum sharing review](#)¹⁷¹ we said that we would consider extending leasing to mobile licences if there are likely to be net benefits, including sufficient evidence of demand to lease spectrum.¹⁷² In the March 2023 Statement and Consultation,¹⁷³ we considered the potential benefits and downsides of allowing leasing of mmWave spectrum and expressed our provisional view that, on balance, we did not consider that leasing would give rise to net benefits over and above what can already be achieved by trading licences or through our existing Local Access licensing framework. Consequently, we proposed not to make the award licences leasable.

Summary of responses

- 5.8 H3G and BT/EE asked that we make the award licences leasable and provided the following arguments in support of their views:
- a) H3G¹⁷⁴ said that spectrum leasing would provide “a simple market mechanism” to address Ofcom’s concern that over time the allocation of mmWave spectrum from the auction may not be efficient, “if and when it arose”.
 - b) BT/EE¹⁷⁵ said that it did not think that the reasons we had given for not allowing leasing were compelling and provided the following arguments in support of its view:
 - i) BT/EE does not “see availability of Local Access licences as making leasing superfluous” because “commercial leasing that involves a payment to the auction winner rather than a payment to Ofcom might provide more incentive to reach agreements, particularly beyond the 3 year timeframe of a local access licence”.
 - ii) According to BT/EE, “allowing leasing could address some of Ofcom’s concerns around longer licence durations” because it “would give spectrum owners greater flexibility to make commercial use of their licence while retaining ownership of the licence and hence the option to make use of the spectrum later on” and involve a lower risk for lessees, compared to the risk associated with an outright purchase.
 - iii) BT/EE said that “[e]ven if the licensee retains the licence obligations and liability associated with fulfilling the conditions of the licence, back-to-back contracts (common in many commercial environments) should be straightforward to implement, and Ofcom would still be able to enforce against breaches by pursuing the licensee not the lessee”.
 - iv) BT/EE referred to leasing agreements in the USA, Sweden and Germany as “examples of where mobile spectrum leasing has been successful”.
 - v) Finally, BT/EE highlighted that “leasing is permitted in the current 40 GHz licences and in some other licences such as 28GHz and 32 GHz licences”.

¹⁶⁹ Mobile Trading Regulations, Regulation 5.

¹⁷⁰ Trading Guidance Notes, para 3.8.

¹⁷¹ Ofcom’s 14 April 2016 Statement, [“A framework for spectrum sharing”](#), para 6.18.

¹⁷² We reiterated that position in Ofcom’s 13 March 2020 Statement [“Award of the 700 MHz and 3.6 GHz spectrum bands”](#), paras. 8.17-8.19.

¹⁷³ March 2023 Statement and Consultation, paras. 11.11-11.19.

¹⁷⁴ [H3G response to the March 2023 Statement and Consultation](#), p. 8.

¹⁷⁵ [BT/EE response to the March 2023 Statement and Consultation](#), pp. 12-13.

Ofcom's response

Benefits of leasing

- 5.9 We acknowledge BT/EE's comment that some entities might prefer to solely enter into a commercial agreement with another entity to access spectrum without the additional step of applying for a Local Access licence. However, we have not seen evidence to suggest that applying for a Local Access licence, including paying a licence fee, disincentivises entities from seeking or taking opportunities to share spectrum where possible.¹⁷⁶
- 5.10 BT/EE also suggested that leasing would support spectrum access "beyond the 3 year timeframe of a local access licence". However, we note that while the Local Access licence framework provides for an initial 3-year term, these licences are flexible and will reflect the agreement reached between the two parties. This means that if the parties make an agreement for more than three years, provided it is within the term of the licence, the Local Access licence can be issued for, or later extended to, that longer term.¹⁷⁷ As such, we do not consider that less favourable terms apply in relation to the Local Access licence framework, than if a user were to enter into a commercial lease agreement.
- 5.11 In relation to BT/EE's preference for "flexibility to make commercial use of [its] licence while retaining ownership of the licence..." and mitigating the risk of being left with a stranded asset, we consider that if the spectrum is not being used, and the existing licensee wishes to monetise its spectrum licence, it can be traded. Alternatively, if spectrum is unused, it can be made accessible by Ofcom to a third party through the existing Local Access licensing framework.¹⁷⁸
- 5.12 H3G raised a similar point, suggesting that having the flexibility to lease spectrum would mitigate certain inefficiencies if they were to materialise. While this might be the case, our view is that the flexibility and options for licensees to react to changing circumstances are also achievable through spectrum trading, and under the Local Access framework.

Ofcom's concerns about enforcement

- 5.13 BT/EE noted the concern we set out in the March 2023 Statement and Consultation that leasing can give rise to difficulties relating to enforcement of licence terms because "the burden of compliance would continue to fall primarily onto the licensee".¹⁷⁹ BT/EE did not consider this to be a significant downside, as it considered that "back-to-back contracts (common in many commercial environments) should be straightforward to implement, and Ofcom would still be able to enforce against breaches by pursuing the licensee not the lessee." BT/EE said that we should further consider what the obstacles and risks of leasing are, in light of BT/EE's submissions on the likely benefits.
- 5.14 Having considered BT/EE's comments, we remain of the view that all of the main benefits of leasing are achievable through Local Access licensing.
- 5.15 In addition, we continue to be concerned about the practical difficulties associated with enforcement against leaseholders, if we made the award licences leasable. In that case, Ofcom would not have a direct relationship with the leaseholder, and so any enforcement may be more difficult in practice than enforcing against a licensee (even in a case where the

¹⁷⁶ Ofcom has issued 36 Local Access licences – see Ofcom's [Annual report and accounts 2022/2023](#), p. 167.

¹⁷⁷ Ofcom's [Local Access Licence Guidance](#), para. 1.10.

¹⁷⁸ Spectrum licences authorise access to the relevant spectrum, they do not guarantee exclusive use.

¹⁷⁹ March 2023 Statement and Consultation, paras. 11.17-11.18.

licence-holder has entered into a “back to back” contract with the leaseholder, as BT/EE suggested). We note that, in line with our [Trading Guidance Notes](#),¹⁸⁰ the licensee would be expected to act as first port of call to resolve complaints from its leaseholders, or complaints received as a result of the behaviour of its leaseholders, and would remain ultimately responsible for all obligations under the licence (even though we might consider it appropriate to act directly against the leaseholder in certain circumstances). This means that any enforcement would either be (i) indirect enforcement, via the licensee or (ii) enforcement directly against a leaseholder with whom we do not have a relationship, and which could prove impractical.

- 5.16 Leasing is a contractual matter between the parties and does not involve Ofcom; there is no need to notify us of leases. Conversely, where we grant a Local Access licence, its holder becomes directly responsible for the obligations under the Local Access licence. This means that we can enforce the terms of a Local Access Licence directly against the licensee, with whom we would have a direct relationship.

Leasing in other mobile bands and other countries

- 5.17 In response to BT’s comment that “leasing is permitted in the current 40 GHz licences and in some other licences such as 28GHz and 32 GHz licences”, we note that our current position is that leasing is generally not allowed for the ‘Spectrum Access’ licences covered by the Mobile Trading Regulations.^{181,182} The terms of the current ‘Spectrum Access’ licences for the 28 GHz, 32 GHz and 40 GHz bands mean that in practice they can only be used to provide fixed services, and do not permit mobile use. Therefore, permitting leasing in relation to these licences is consistent with our current position, i.e. that leasing is not allowed in mobile bands but is allowed in some fixed bands. Following licence award, it is our intention to make the 40 GHz band available for new uses including mobile and make the award licences tradable under the Mobile Trading Regulations. Consequently, also not permitting leasing in relation to the 40 GHz award licences will be consistent with our general position on leasing.
- 5.18 BT/EE also noted that in other countries (USA, Sweden and Germany) mobile spectrum leasing is allowed and has been used successfully. While this may be the case, we note that there are differences between the UK and these countries, both in terms of the regulatory landscape and the availability of spectrum. For example, in the UK, the licences that we issue are non-exclusive, unlike in the USA, and therefore Ofcom can authorise other users in the band (as we did through our Local Access licensing framework in 2019). We also note that in Sweden, Finland and Denmark, where leasing has been allowed in a particular band/sub-band, the conditions in the licence that permit leasing are specific to providing support for private/vertical networks. Through our Local and Shared Access licensing regimes, we have been able to provide spectrum to support these sectors as well as other sectors.
- 5.19 In conclusion, having considered stakeholders comments, we are not convinced that there are net benefits to be gained from spectrum leasing, over and above those that can already be achieved by trading licences or through our existing Local Access licensing framework. In addition, as set out above, we continue to be concerned about the practical difficulties

¹⁸⁰ Ofcom’s [Trading Guidance Notes: OfW513](#), 13 March 2020, paras. 4.17-4.19.

¹⁸¹ Ofcom’s [Trading Guidance Notes: OfW513](#), 13 March 2020, para. 4.4.

¹⁸² UK Broadband’s 3.6 GHz licence, which represented an exception to our general policy, was aligned to the other mobile licences in October 2022, when we removed the licence term permitting spectrum leasing (Ofcom’s 10 October 2022 Statement “[Aligning licence terms in the 3.4-3.8 GHz band](#)”, para. 3.22).

associated with enforcement against leaseholders, if we made the award licences leasable. We have therefore decided not to permit leasing in the mmWave award licences.

Spectrum sharing

Our proposals

- 5.20 In the March 2023 Statement and Consultation,¹⁸³ we noted that the award licences will not guarantee exclusive use of the spectrum awarded. We said that in the future, we may grant additional authorisations to allow the use of all, or part, of the spectrum, including the 26 GHz and 40 GHz spectrum. In particular, we proposed to allow access to spectrum in the 26 GHz and 40 GHz bands following award using our Local Access licensing framework.
- 5.21 We also noted that Local Access licensing allows access to spectrum without the need to enter into a commercial agreement with the existing licensee. Rather, following the process set out in Ofcom's [Local Access Licence Guidance](#), the potential user makes an application to Ofcom to access the spectrum held (but not used) by someone else for up to three years.¹⁸⁴ We added that this would be a further mitigation against the potential risk of spectrum lying fallow for periods of time, if it is not being used by the licensee in particular areas.

Summary of responses

- 5.22 We received the following comments from stakeholders:
- a) Vodafone¹⁸⁵ said that it was “disappointed at Ofcom’s apparent unwillingness to embrace the club spectrum model” but it also considered that “a club model can readily work within the existing framework”. Specifically, Vodafone suggested that “those award licensees who choose to cooperate could provide deployment information to a neutral third party, who (in a competition compliant manner) could indicate to deployers where additional spectrum beyond their licence was unused/not planned to be used”, so that “[t]he deployer could then apply to Ofcom for a Local Access licence, and under a pre-agreed MoU, the cooperating licensee would consent to this being awarded”.
 - b) On the other hand, VMO2¹⁸⁶ said that it strongly disagrees with Ofcom’s proposed extension of the existing Local Access licensing framework and that it has “serious concerns” that such extension “acts as a further disincentive to acquire mmWave spectrum at auction, due to the impact on rights to deploy, the introduction of delay, and associated complexity”. VMO2¹⁸⁷ also said that given Ofcom’s proposal “to set aside 650 MHz of mmWave spectrum ... using it’s Shared Access licensing framework”, it does not “see a further need to enable access to auctioned spectrum through extending the Local Access licensing framework, as the shared access spectrum acts an effective substitute.”

¹⁸³ March 2023 Statement and Consultation, paras 11.21-11.24.

¹⁸⁴ With the licensees’ consent, this period of three years can be extended.

¹⁸⁵ [Vodafone response to the March 2023 Statement and Consultation](#), pp. 9-10.

¹⁸⁶ [VMO2 response to the March 2023 Statement and Consultation](#), pp. 34-36.

¹⁸⁷ VMO2, pp. 35-36.

Ofcom's decision

- 5.23 We have considered VMO2's concerns about us making the 26 GHz and 40 GHz bands available in high density areas through our Local Access licensing framework. We do not consider that VMO2's concerns about certainty of the award winners' access to its spectrum are warranted. We also do not agree with VMO2 that Local Access licensing is unnecessary as we are already making 650 MHz of spectrum available in high density areas on a Shared Access basis.
- 5.24 We envisage that the Shared Access licences will be the primary way for local users to access the newly awarded spectrum in high density areas. On the other hand, a Local Access licence is a mechanism that enables the shared use of spectrum which is already licensed to MNOs, in locations where a particular frequency is not being used.
- 5.25 However, as set out in our [Local Access Licence guidance document](#),¹⁸⁸ we would not expect access to newly awarded bands to be possible straight away (and possibly not for some considerable time), as the licensees will need time to decide where they intend to use the frequencies themselves. Before issuing a Local Access licence, Ofcom would engage with the relevant MNO, and, if they raise a reasonable objection (e.g. they have deployments in the area requested, plans to deploy in that area or the proposed application would cause harmful interference to existing local deployments), then the application would be declined.
- 5.26 We do therefore consider that both Local Access and Shared Access licences are valuable for this spectrum because they meet different needs:
- a) Local Access may be valuable where an operator wishes to share the spectrum, or to enable Ofcom to ensure efficient use of spectrum which is unused for a significant period of time; and
 - b) Shared Access licences will enable access to this spectrum for users whose use cases do not require a wide area licence.

Roll-out obligations (“use it or lose it”)

Our proposals

- 5.27 Roll-out obligations and/or a ‘use it or lose it’ condition would require licensees to make use of the relevant spectrum (or deploy specified services) within a specified time period, or risk revocation of the licences if these obligations are not met (i.e. ‘use-it-or-lose-it’). In the March 2023 Statement and Consultation,¹⁸⁹ we acknowledged that in theory such conditions could help to ensure efficient use of spectrum, but proposed not to include such conditions in the award licences for the following reasons specific to the current case:
- a) there may be entirely legitimate reasons for spectrum remaining unused – the licensee may be waiting for a suitable commercial opportunity or until the technology it wishes to use is ready;
 - b) imposing such an obligation has the potential to distort and/or chill the incentives to invest in the spectrum, and so reduce the benefits for consumers and citizens which the award would otherwise create; and

¹⁸⁸ Ofcom's Local Access Licence Guidance document, paras 3.9-3.10.

¹⁸⁹ March 2023 Statement and Consultation, paras. 11.27-11.29.

- c) such conditions might also be difficult to make workable in practice because of the problem of defining what constitutes ‘use’ and therefore what the trigger for a licence revocation would be.

5.28 In addition, we noted that we were minded to award 15 year fixed term licences, which would enable us to reallocate the spectrum to ensure it is efficiently used at the end of the licence term. This would reduce the need to include a power for us to take back the spectrum if it is unused.

Summary of responses

5.29 Qualcomm¹⁹⁰ said that “in order to assure that no market distortion is artificially created, and spectrum hoarding is not encouraged, specific obligations may be considered such as a commitment to deploy in a given period (e.g., 12-18 months from the licensing moment), “use-it-or-lease-it” or “use-it-or-loose-it”, etc.”. It added that “[i]n case such conditions are included, the regulator should also make sure that the secondary market is sufficiently established to allow for efficient spectrum trading and/or leasing to take place”.

Ofcom’s decision

5.30 Although we agree that ‘use-it-or-lose it’ conditions could discourage spectrum hoarding, we remain of the view that the difficulties associated with ‘use it or lose it’ conditions, which we outlined in the March 2023 Statement and Consultation, outweigh the potential benefits.

5.31 We also consider that spectrum hoarding, and other spectrum allocation inefficiencies, can be resolved without the need for ‘use it or lose it’ conditions. These include that:

- a) it will be possible to trade award licences to a third party;
- b) if spectrum remains unused and there are no immediate plans to use it in certain areas, if there is demand, we are able to issue licences under our Local Access licensing framework; and
- c) as set out in Section 6, we have decided to award fixed term licences with a 15 year term, which we consider will support efficient use of the spectrum.

5.32 For the reasons set out above, we have decided not to include any roll-out obligations in the award licences.

Payment of licence fees

Our proposals

5.33 In the March 2023 Statement and Consultation,¹⁹¹ we proposed not to include a provision enabling us to impose ongoing fees after the end of the licence term because we proposed to award fixed term licences which would expire at the end of a 15 year term.

¹⁹⁰ [Qualcomm response to the March 2023 Statement and Consultation](#), pp. 2-3.

¹⁹¹ March 2023 Statement and Consultation, para. 11.7.

Summary of responses

- 5.34 BT/EE¹⁹² asked that we award indefinite licences, instead of fixed-term licences, and said that in its view “it makes more sense to remove (or lower) ALFs than propose shorter duration licences”. We received no further comments from stakeholders in relation to our proposals for the payment of licence fees.

Ofcom’s decision

- 5.35 Given that we have decided to award fixed-term licences, the award licences will not include a provision enabling Ofcom to impose ongoing fees at the end of the licence term.

Other conditions

- 5.36 In the March 2023 Statement and Consultation, we also set out proposals in relation to the following licence conditions:
- a) Licence commencement
 - b) Territorial extent of licences
 - c) Roaming
 - d) Access and inspection
 - e) Modification, restriction and closedown
 - f) Record-keeping and provision of information to facilitate optimal spectrum use
- 5.37 We did not receive any specific comments from stakeholders, and have decided to implement our proposals in relation to these licence conditions. For ease of reference, the approach that we have decided to take in relation to these conditions is set out below.

Licence commencement

- 5.38 The award licences will commence on the date they are issued, shortly after the award. However, as noted in Section 4, for the first 4-5 years (i.e. until completion of the relevant revocation process), licensees will be required to co-ordinate their use with the use of the same frequencies by the existing licence-holders.
- 5.39 As set out in Section 6, we have decided to award fixed-term licences with a 15 year duration.

Migration and co-ordination in the 26 GHz band

- 5.40 In Section 9 of the March 2023 Statement and Consultation,¹⁹³ we proposed to offer two different lot categories in the 26 GHz band (one covering the bottom of the band, which is encumbered by fixed links until their revocation takes effect, the other covering the top of the band, which is already clear of fixed links). We said we would invite principal stage bidders who win spectrum in both lot categories to bid in three separate assignment stage rounds: the first two would determine specific frequencies bidders would hold in each lot category while the spectrum remains encumbered by fixed links during the revocation period; the third would determine the contiguous frequency assignment bidders would hold once the notice period for revoking the fixed link licences in and around high density areas

¹⁹² BT/EE response to the March 2023 Statement and Consultation, p. 17.

¹⁹³ March 2023 Statement and Consultation, paras. 9.30-9.43.

ends. We also proposed that any award winners having to change the frequencies they are using once the notice period ends would have 6 months for migrating to the new frequencies.

- 5.41 This would mean we would need to license any relevant award winners to use different frequencies before and after the migration period. We will set out our decisions on this in our next document on the design of the auction and implement our final decision in the relevant award licences.

Territorial extent of licences

- 5.42 The award licences will authorise licensees to use the relevant frequencies within the 26 GHz and 40 GHz bands in the designated high density areas.
- 5.43 The geographic scope of these licences will therefore be limited to the high density areas. The boundaries of each high density area will be defined in a separate booklet, available on Ofcom's website, and shown at Annex 10 of this document.

Roaming

- 5.44 We have decided not to include any roaming obligations in licences for mmWave spectrum. Although there may be a case for roaming obligations where they would enable more consistent coverage of traditional voice/data mobile services, it is less clear at this stage whether such obligations would be appropriate for innovative services which may emerge using mmWave spectrum, particularly given that the specific characteristics of mmWave spectrum mean it is not suitable for providing wide area coverage.
- 5.45 However, we do not rule out the possibility of looking to impose roaming conditions, as appropriate, in these licences in the future. Any future proposals would be subject to analysis and consultation at the time, in line with our general approach.

Access and inspection

- 5.46 In accordance with our standard spectrum licence conditions, licensees will be required to permit any person authorised by Ofcom to access and inspect the radio equipment specified in the licence at all reasonable times.

Modification, restriction and closedown

- 5.47 In line with our standard spectrum licence conditions, the award licences will include a licence provision enabling Ofcom to require that the radio equipment (or any part of it) be modified, restricted in use or temporarily or permanently closed down if: (i) a licensee breaches the terms of its licence; (ii) the use of radio equipment is or may be causing or contributing interference to the operation of other authorised radio equipment; or (iii) it appears necessary or expedient in the event of a national or local state of emergency.

Record-keeping and provision of information to facilitate optimal spectrum use

- 5.48 In line with our duty to ensure optimal use of spectrum, the award licences will include a condition in the licences requiring licensees: (i) to compile and maintain accurate written records of certain details relating to the radio equipment (specified in the licence), (ii) to

produce these records if requested by Ofcom and (iii) to provide, on request, such general information regarding their equipment and use of frequencies, or the roll-out of their network, as Ofcom may reasonably request. Consistent to the other mobile licences, the award licences will specify that the record-keeping conditions do not apply in respect of licence exempt radio equipment.¹⁹⁴

- 5.49 As we said in the March 2023 Statement and Consultation,¹⁹⁵ we note that we have powers under both the [Communications Act 2003](#) (section 135 to 145) and the [Wireless Telegraphy Act 2006](#) (sections 32 to 34) to require the provision of information in certain circumstances. However, we consider that there remains a benefit in requiring licensees to compile and maintain basic details relating to the radio equipment that they are using pursuant to the licence so that it is readily available in the event that it is needed, for example, in cases of alleged interference.

Conclusion and next steps

- 5.50 After careful consideration of stakeholders' responses, we have decided to include the non-technical licence conditions we proposed in the March 2023 Statement and Consultation in the mmWave award licences.

¹⁹⁴ As noted by BT/EE (BT/EE, p.12), we inadvertently omitted this specification in the Draft Award Licence annexed to the March 2023 Statement and Consultation. We have now corrected this error in the Sample Award Licence set out in Annex 4. BT/EE also said that Ofcom should commit to making licence-exempt regulations for "devices used by the general public when connected to the 26 GHz or 40 GHz network of a national public mobile network" prior to the auction. As set out above (para. 1.25), next year we will consult on proposed statutory instruments, including regulations to exempt the use of relevant terminal equipment from the need to hold a licence.

¹⁹⁵ March 2023 Statement and Consultation, para. 11.33.

6. Award licence duration

Summary

- 6.1 We have decided to award licences with a 15-year fixed term. We expect to consult on our approach to reallocating the spectrum after this term expires in advance of the end of the licence term.

Background

Award licences

- 6.2 In the auction, we will award spectrum licences authorising use of 25.1-27.5 GHz (the “**26 GHz band**”) and 40.5-43.5 GHz (the “**40 GHz band**”) in the 68 high density areas that we have identified.

The May 2022 and March 2023 consultations

- 6.3 The spectrum licences we have previously awarded by auction¹⁹⁶ for mobile bands have:
- an indefinite term (i.e. they continue in force until revoked by Ofcom, subject to a notice period, or surrendered by the licensee); and
 - an initial term of 20 years during which Ofcom cannot revoke the relevant licences for spectrum management reasons or charge additional licence fees.
- 6.4 In Section 10 of the May 2022 Consultation, we noted that the still emerging potential of new uses for mmWave spectrum gives rise to a risk that the initial allocation of citywide mmWave licences would not reflect the most efficient allocation of mmWave spectrum in the longer term. In light of this risk, we set out our provisional view that it may be appropriate to adopt alternative approaches to the duration of the new licences we would award via auction in the 26 GHz and 40 GHz bands. We said that alternatives could involve the following high-level options:
- A fixed term licence with a 20-year term.
 - A fixed term licence with a shorter term, e.g. 5, 10 or 15 years.
 - An indefinite licence with a shorter initial term, e.g. 5, 10 or 15 years (with annual licence fees potentially being imposed under [section 12](#) of the Wireless Telegraphy Act 2006 after the initial term).
- 6.5 We said that we were minded to adopt fixed term licences with a term between 10 and 15 years and sought early views from stakeholders on all possible alternative options.
- 6.6 In Section 12 of the March 2023 Statement and Consultation, having considered stakeholders’ responses, we said that we were minded to conclude that fixed term licences are more likely than indefinite licences to support our objectives for the award¹⁹⁷ and that a

¹⁹⁶ 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).

¹⁹⁷ [March 2023 Statement and Consultation](#), paras. 12.15-12.18.

15 year licence term would be appropriate.¹⁹⁸ We also specified that, if we decided to award fixed term licences, we would expect to consult on our approach to ensuring an efficient allocation (once the licence term has expired) in advance of the end of the licence term.¹⁹⁹ For the avoidance of doubt, in relation to those 26 GHz licensees migrating to new frequencies after the revocation period, our proposed fixed licence term of 15 years referred to their overall licence duration, including both their initial and their final frequency assignments.²⁰⁰

Summary of responses

- 6.7 Six stakeholders responded to our March 2023 proposals on licence duration: BT/EE, H3G, VMO2, Vodafone, Nokia and Ericsson. In summary:
- a) BT/EE,²⁰¹ H3G²⁰² and Vodafone²⁰³ asked us to award indefinite licences with an initial term of 20 years during which Ofcom would not be able to revoke such licences for spectrum management reasons;²⁰⁴
 - b) VMO2²⁰⁵ asked for “20 years licences with expectation of renewal for a fee”;
 - c) Nokia²⁰⁶ proposed “indefinite or 20-year licences with renewal possibilities”; and
 - d) Ericsson²⁰⁷ proposed “a 20 year term”.
- 6.8 Below, we consider stakeholders’ comments in more detail, and set out the reasoning for our decision. We consider in turn:
- a) whether to award fixed term or indefinite licences; and
 - b) the appropriate licence duration.

Fixed term vs indefinite licences

Our proposal

- 6.9 As set out above, in the March 2023 Statement and Consultation²⁰⁸ we provisionally concluded that fixed term licences are more likely than indefinite licences to support our objectives for this award.

¹⁹⁸ March 2023 Statement and Consultation, paras. 12.19-12.23.

¹⁹⁹ March 2023 Statement and Consultation, para. 12.28.

²⁰⁰ March 2023 Statement and Consultation, para. 12.23 and footnote 636.

²⁰¹ [BT/EE response to the March 2023 Statement and Consultation](#), p. 13.

²⁰² [H3G response to the March 2023 Statement and Consultation](#), p. 8.

²⁰³ [Vodafone response to the March 2023 Statement and Consultation](#), p. 12.

²⁰⁴ The licences could be revoked after this 20 years’ initial period on spectrum management grounds, provided Ofcom had given licensees 5 years’ notice, meaning that Ofcom could give licensees notice of revocation after 15 years at the earliest.

²⁰⁵ [VMO2 response to the March 2023 Statement and Consultation](#), pp. 3 and 36.

²⁰⁶ [Nokia response to the March 2023 Statement and Consultation](#), p. 5, response to Q. 14.

²⁰⁷ [Ericsson response to the March 2023 Statement and Consultation](#), p.2.

²⁰⁸ March 2023 Statement and Consultation, paras. 12.15-12.18.

Summary of responses

- 6.10 While Ericsson²⁰⁹ expressed a preference for “a 20 year term”, the other respondents all preferred indefinite or renewable licences. In particular:
- a) BT/EE²¹⁰ said that “Ofcom should opt for indefinite licences, with a 20 year initial term coupled with greater support for market mechanisms, including voluntary (commercial) leasing”. Likewise, H3G²¹¹ said that “Ofcom should award perpetual, tradable licences instead of fixed-term licences, with an initial term of 20 years, and allow licences to be leasable”.
 - b) Vodafone²¹² said that “licences should be perpetual”. In its view, “Ofcom should (...) stress the importance of the clause in [indefinite] licences that allows it to revoke them for spectrum management purposes” and, based on the assumption that the licences have a 20-year initial term, carry out a review “at the 15-year point (...) to consider if there is evidence that the spectrum hasn’t been used efficiently”.
 - c) VMO2²¹³ asked for “20 years licences with expectation of renewal for a fee”.
 - d) Nokia²¹⁴ suggested “indefinite or 20-year licences with renewal possibilities”.
- 6.11 Most of the comments we received in response to the March 2023 Statement and Consultation focussed on two main issues: (i) the impact of licence duration on investment certainty, and (ii) the ability of spectrum trading/leasing to secure an ongoing efficient allocation of spectrum. We summarise responses in each area below.

Investment certainty

- 6.12 In general, respondents expressed concerns that our proposed 15-year fixed term licences would not allow licensees to recover their investment, with BT/EE arguing that our approach would “further exacerbate” the gap between current investment and future mobile data demand. Specifically:
- a) Vodafone²¹⁵ said that “[a] 15-year fixed-term (...) compounded by a spectrum band with uncertain deployment economics and an inability to deploy for 5 years in many locations, (...) risks rendering the spectrum worthless”. Vodafone said that [CONFIDENTIAL ✕].²¹⁶
 - b) H3G²¹⁷ said that “Ofcom must consider the need for potential bidders to have certainty and a sufficient period over which to recover their investments”.
- 6.13 BT/EE²¹⁸ said that “current investment levels are insufficient to meet future mobile data demand in the UK” and that “[t]he early licensing of spectrum, and the longer licensing period would enable investment in and experimentation with use cases, which are likely to take time to generate returns to shareholders”. It considered that “[s]hort fixed term

²⁰⁹ Ericsson said that it “would recommend that licences have a 20 year term to ensure a period of certainty that is needed for operators to invest, expand, and upgrade networks”.

²¹⁰ BT/EE, p. 2.

²¹¹ H3G, p. 1.

²¹² Vodafone, p. 10, response to Q. 14.

²¹³ VMO2, pp. 3 and 37 (response to Q. 14).

²¹⁴ Nokia, response to Q. 14.

²¹⁵ Vodafone, p. 10, response to Q. 14.

²¹⁶ Vodafone confidential response to the March 2023 Statement and Consultation, p. 10.

²¹⁷ H3G, p. 8.

²¹⁸ BT/EE, pp. 2 and 15.

licences will further exacerbate this emerging investment gap". In support of this view, BT/EE argued that:

- i) "[l]imiting the timeframe of the licence to 15 years is likely to reduce incentives for those purchasing the spectrum to invest in new use cases simply because of the risk that they may run out of time in monetising the investment";
 - ii) "(...) at best, only c.10 years [after the revocation period] is available for some deployments" and "the frequencies authorised at 26 GHz may change after the first five years, which could drive extra costs";
 - iii) "confidence and willingness to invest in further deployments will diminish" closer to the end of the fixed term; and
 - iv) Ofcom has not provided any evidence in relation to mmWave to show that "shorter planning horizons do not necessarily imply lower investments".
- b) Nokia,²¹⁹ which suggested the adoption of "indefinite or 20-year licences with renewal possibilities", said that "[l]onger (...) licence durations and transparent and well-in-advance communication on the renewal conditions will create the necessary certainty for licensees to invest in their infrastructure and networks, enabling in parallel suitable conditions that promote further the ecosystem development".
- c) VMO2²²⁰ said that, while it had initially "expressed comfort with a fixed term licence term of 15 years covering the period 2028-43", a 15 year fixed term licence starting in Q1 2024/2025 would be "a very poor fit with the anticipated investment cycle for mmWave, which is likely to involve only modest activity this side of 2030 and (hopefully) accelerated deployment thereafter". VMO2 also specified that even if the award was delayed until 2025/2026, "an extra year is not nearly enough to align with the investment cycle".

Ensuring an efficient allocation of spectrum

6.14 Respondents submitted that (i) enabling trading and leasing of mmWave spectrum would be preferable to awarding fixed term licences to ensure an ongoing efficient allocation of the spectrum, and (ii) awarding fixed term licences could reduce licensees' incentives to trade the spectrum.

6.15 Vodafone, VMO2, BT/EE and H3G made submissions relating to spectrum trading. In particular:

- a) Vodafone²²¹ said that the proposal for a fixed term licence demonstrated that Ofcom "lacks confidence in the auction delivering the most efficient outcome, and in the ability of the market to trade spectrum thus addressing any changes in valuation that might occur".
- b) VMO2²²² was concerned that fixed term licences could reduce licensees' incentives to trade spectrum, especially as it expected that demand for trading would "be strongest in the early 2030s" at which point "there would only be 6-8 years left of the licence term", deterring efficient trades. It said that "[t]he longer licence term is necessary to avoid a situation where the licences expire in the 2030s, which (...) is likely to weaken incentives for efficient trades necessary to address anticipated changes in the dynamic efficiency of mmWave spectrum allocation over time". VMO2 also said that it has "low confidence that

²¹⁹ Nokia, p. 4, response to Q. 14.

²²⁰ VMO2, p. 29.

²²¹ Vodafone, p. 10.

²²² VMO2, p. 29-30

an MNO that acquired an unduly large share of mmWave spectrum in 2024 would subsequently sell excess spectrum to a rival operator that could use it better”.

- c) BT/EE²²³ and H3G²²⁴ argued that we should rely on trading, rather than imposing fixed-term licences, to ensure the efficient allocation and use of mmWave spectrum over time. In particular, H3G said that “for spectrum that is freely tradable, trading ensures the efficient allocation and use of spectrum over time”. BT/EE²²⁵ said that “Ofcom should focus on making market mechanisms work rather than relying on regulation as a first port of call”.

- 6.16 In addition, both BT/EE²²⁶ and H3G²²⁷ suggested that, if we awarded indefinite licences, spectrum leasing would address any concern that the allocation of mmWave spectrum immediately after the auction may become inefficient over time. In particular, H3G²²⁸ said that “the ability to lease spectrum provides a simple market mechanism to address this [concern], if and when it arose”. Likewise, BT/EE²²⁹ said that “leasing could mitigate the risk of longer duration licences as it would provide licensees with additional commercial flexibility to entirely giving up a future option to use the spectrum”.

Ofcom’s decision

- 6.17 We recognise that the MNOs, who are likely to participate in the award, have all expressed a preference for indefinite (or effectively indefinite) licences. However, for the reasons set out below, we remain of view that in this specific case fixed term licences are more likely to support our objectives for this award than indefinite licences. We have therefore decided to award fixed term licences to authorise use of mmWave spectrum in high density areas.

- 6.18 In considering options for licence duration, we have had regard to our policy objectives for mmWave spectrum, as set out in the March 2023 Statement and Consultation,²³⁰ which derive from our statutory duties. In particular, we have sought to balance our objectives of:

- a) encouraging investment and innovation in new uses, including by providing future licensees the certainty they need to invest;
- b) ensuring timely availability of spectrum, by taking a proactive approach which will make mmWave spectrum available for new uses at an early date; and
- c) achieving an efficient allocation of spectrum, including by retaining the flexibility to meet changing spectrum needs in future, particularly given our expectation that mass market applications will continue to develop across a range of users.

Investment certainty

- 6.19 We recognise that prospective licensees place a high value on the likelihood of being able to continue to use the same frequencies after the end of an initial term, which can encourage investment in the band, and that indefinite licences would give licensees greater certainty

²²³ BT/EE, pp. 16-18.

²²⁴ H3G, p. 8.

²²⁵ BT/EE, p. 14.

²²⁶ BT/EE p. 18.

²²⁷ H3G, p. 8.

²²⁸ H3G, p. 8.

²²⁹ BT/EE, p. 18.

²³⁰ March 2023 Statement and Consultation, paras. 2.30-2.43.

than fixed term licences (albeit that indefinite licences can be revoked for spectrum management reasons, as we discuss below).

- 6.20 We also recognise that our decision on licence duration necessarily entails a degree of regulatory judgement. There is limited empirical research available on the interaction between licence duration (including licences with indefinite duration) and the mobile operators' investment levels, and the available data has limitations.²³¹ In February we published [analysis on this topic](#), commissioned from Charles Rivers Associates ("CRA") and based on an international assessment, alongside a [Discussion Paper](#). As explained in more detail in our discussion paper, CRA's study did not find a statistically significant relationship between longer licence duration and higher investment levels.²³² BT/EE appears to suggest that such a relationship may exist in the context of mobile use of mmWave. However, mobile use of mmWave is in its early stages internationally, so mobile investment in mmWave spectrum has either not yet begun or is still emerging. As a result we do not currently have evidence in either direction on this question, and we remain of the view that the CRA's analysis is relevant to our assessment.
- 6.21 We have considered stakeholders' arguments that indefinite licences would provide greater investment certainty. However, we note that there is still uncertainty associated with indefinite licences as Ofcom retains the power to revoke them for spectrum management reasons, if objectively justified and proportionate.²³³ Our indefinite licences have always had an explicit power for Ofcom to revoke after the initial term, subject to the minimum notice period specified in the relevant licences. To the extent that fixed term licences create a less certain investment environment for licensees than indefinite licences, in our view this reflects the inherent risk arising from the fact that use cases for mmWave spectrum are still emerging, and the future optimal use of the spectrum remains uncertain.
- 6.22 As set out in our March 2023 Statement and Consultation,²³⁴ we would expect an operator making effective use of spectrum to be in a strong position to acquire or reacquire the spectrum it needs in a reallocation process, such as an auction, at the end of the term.²³⁵ We will consult on our approach to reallocating the spectrum in advance of the end of the licence term in order to give licensees certainty about the future of their licence prior to its expiry.

Ensuring an efficient allocation of spectrum

- 6.23 Several known applications for mmWave already exist, including mobile hotspots, fixed wireless access, integrated access and backhaul, and mobile private networks. We expect both that new use cases will emerge over time, and that a range of potential users of mmWave will emerge, including the MNOs, regional fixed wireless access providers, and localised industrial users.²³⁶

²³¹ March 2023 Statement and Consultation, footnote 634

²³² March 2023 Statement and Consultation, footnote 634.

²³³ BT/EE has told us that, "Ofcom's recent approach to the 40 GHz MBNL licence exacerbates the above dynamics because it illustrates that, even when using spectrum efficiently, licensees cannot rely on being able to continue to use it" (BT/EE, p. 16).

²³⁴ March 2023 Statement and Consultation, para. 12.26.

²³⁵ We do not consider that the reallocation of the 26 GHz band will result in licensees incurring substantial costs as we expect that they will be able to retune their radio equipment remotely.

²³⁶ March 2023 Statement and Consultation, para. 2.46.

- 6.24 In exercising our spectrum management functions, we must have regard not only to current demand, but also to “the demand that is likely to arise in future for the use of the spectrum for wireless telegraphy”.²³⁷ We consider that it is important to mitigate the risk that the initial allocation of mmWave spectrum for new uses may become inefficient over the longer term and that with the potential emergence of a range of users and use cases, there is a risk of such an outcome in the case of mmWave spectrum. For example, new users who may have a high value for the spectrum in future may not participate in the initial auction.
- 6.25 As the MNOs have submitted, it is possible that trading or leasing could address inefficient allocations over the longer term. However, in practice we consider that there is a risk that trading or leasing will not lead to an optimal outcome. In particular:
- a) We have seen very few instances of trading of mobile spectrum to date, for a range of reasons.²³⁸
 - b) The geographic scope of the citywide licences is based on our current expectations of demand, and may not support an optimal allocation in future, even if they can be traded to higher-value users.
 - c) Similarly, if we were to allow leasing, it would have to operate within the configuration of licences as we have designed them, based on current expectations of demand, which may not apply in future. We explain in more detail why we have decided not to allow leasing of mmWave spectrum in Section 5.
- 6.26 We acknowledge that fixed term licences could reduce the likelihood of spectrum trades occurring towards the end of the licence term. However, we consider that this would have a limited effect on the efficiency of the spectrum allocation since spectrum could be reallocated at the end of the licence term and, as we have noted, trading of mobile spectrum has been limited to date.
- 6.27 We have also considered Vodafone’s suggestion that we could rely on our licence revocation powers, rather than awarding fixed term licences, to ensure efficient allocation of spectrum. Fixed term licences provide clarity as to when spectrum will become available for a new allocation and new potential users.²³⁹ In our view, in the present circumstances fixed term licences have an advantage over indefinite licences, in that they set expectations both for those acquiring the licences and for others who may wish to use the spectrum in future. If we awarded indefinite licences, any new spectrum allocation would depend on (i) the incentives of each individual licensee to trade their licences and/or (ii) the completion of a statutory process for revoking each individual licence.
- 6.28 We have also considered BT/EE’s suggestion that Ofcom should focus on making market mechanisms, such as trading and leasing, work “rather relying on regulatory action as the first port of call”. We do not agree with BT/EE’s characterisation of our approach as relying on regulation rather than the market. Use of fixed term licences creates an opportunity to test the market by re-awarding the spectrum at the end of the licence term and, as we have previously noted, auctions are one of the market mechanisms we use to support effective spectrum management.

²³⁷ Section 3(1)(c) of the [WT Act 2006](#)

²³⁸ Excluding divestment of spectrum in the T-Mobile / Orange merger, and like-for-like swaps of spectrum licences to achieve contiguity, only two trades of mobile spectrum have occurred, and only one in which the seller was an MNO.

²³⁹ The entirety of both mmWave bands will become available for reallocation at the same time as all of the award licences will expire at the end of their licence term.

Taking a proactive approach

- 6.29 As we have previously noted,²⁴⁰ we consider that there are benefits to taking a proactive approach in making this spectrum available for new uses at a time when mass market applications for mmWave spectrum are still at an early stage worldwide. We consider that it is important to ensure that spectrum availability is not a barrier to innovation in this band.²⁴¹ However, we recognise that taking a proactive approach and awarding the spectrum before new uses have necessarily emerged means that there is more uncertainty at the time of the award, compared to awarding at a later date when use cases are established (at which point indefinite licences could be appropriate).
- 6.30 On balance, our view is that in these specific circumstances it is appropriate to take a proactive approach to making mmWave spectrum available for use while mitigating the risk of an enduring inefficient allocation through the use of fixed term licences.
- 6.31 In light of the above, we consider that fixed term licences are more appropriate than indefinite licences in the case of mmWave spectrum.

Duration of the fixed term licence

Our proposal

- 6.32 In the March 2023 Statement and Consultation,²⁴² we said that our provisional view was that a 15-year term would be appropriate for award licences.

Summary of responses

- 6.33 All of the stakeholders who responded to this question said that the licences should have:
- an initial term of 20 years in the case of an indefinite licence; or
 - a duration of 20 years in the case of a fixed-term licence.
- 6.34 Specifically, respondents which expressed a clear preference for indefinite licences provided the following arguments in favour of a 20-year initial term:
- H3G²⁴³ said that “the initial period should be 20 years, consistent with other recent spectrum awards, e.g. 700MHz”, in order to give bidders certainty and time to recover their investments.
 - Vodafone²⁴⁴ said that “the inflection point should be 20 years after the award, rather than 15 years, given the delayed availability of the spectrum (or, to put it another way, 15 years after most of the spectrum becomes available for usage).”
 - BT/EE²⁴⁵ said that we have not provided evidence “for why 20 years would be too long”. BT/EE added that, if Ofcom considered “that the risk of market mechanisms failing is too high with indefinite licences of 20 years initial term”, it should “grant at a minimum indefinite licences with an initial term of 15 years with an explicit condition in the licence that allows Ofcom to revoke it at any point after 15 years with 5 years notice should it

²⁴⁰ May 2022 Consultation, Overview.

²⁴¹ May 2022 Consultation, para. 7.2.

²⁴² March 2023 Statement and Consultation, paras. 12.19-12.24.

²⁴³ H3G, p. 8.

²⁴⁴ Vodafone, p. 10.

²⁴⁵ BT/EE, pp. 13-14.

have clear evidence of inefficient use”. It also considered that the regulatory uncertainty of a fixed term licence without renewal opportunities “is unlikely to facilitate efficient investment”, making a “longer licence duration more desirable”.²⁴⁶

- 6.35 As set out above, other respondents provided the following submissions in favour of a 20-year licence:
- a) VMO2,²⁴⁷ which asked for a 20-year renewable licence, expressed concerns that a 15-year fixed term licence starting before 2028 “would create undue uncertainty for investment and is likely to weaken incentives for efficient trades (...)”. It also considered that a 20-year licence with renewal for a fee would provide licensees with “certainty that they will be able to retain access to a critical mass of spectrum” in the 26 GHz band, supporting its development into “an established part of the mobile ecosystem during the 2030s”.
 - b) Nokia,²⁴⁸ which suggested the adoption of “indefinite or 20-year licences with renewal possibilities”, said that this “will create the necessary certainty for licensees to invest in their infrastructure and networks (...)”.
 - c) Ericsson,²⁴⁹ which recommended a “20 year term”, said that this would “ensure a period of certainty that is needed for operators to invest, expand, and upgrade networks”.

Ofcom’s decision

- 6.36 We have decided to award fixed term licences with a 15-year duration, as proposed in the March 2023 Statement and Consultation.
- 6.37 Taking all the relevant factors in the round, we consider that a 15-year duration is long enough to provide investment certainty for licensees to invest in and deploy mmWave spectrum, while also being short enough to mitigate the risk of an enduring inefficient allocation.
- 6.38 We acknowledge that a 20-year duration would be more in line with both previous licences awarded by Ofcom and the preferences expressed by stakeholders in response to the March 2023 Statement and Consultation. However, for the reasons set out below, we consider that a 15-year duration is long enough to provide investment certainty for licensees to invest in and deploy mmWave spectrum, despite the concerns raised by some respondents around (i) its shorter duration compared to other auctioned licences, (ii) the current status of equipment ecosystems and (iii) the existence of fixed links in some parts of both mmWave bands.

Duration compared to other auctioned licences

- 6.39 We acknowledge that a 20-year duration aligns with other auctioned licences in the UK. However, in previous awards of mobile spectrum, in our view there has been greater clarity about the highest-value use case after the end of the initial term of the licence compared to mmWave spectrum. For example, the 800 MHz band was seen as key to delivering next generation mobile broadband services throughout the UK,²⁵⁰ while the 700 MHz band was well suited for providing coverage over wide areas and indoors, and the 3.6-3.8 GHz band

²⁴⁶ BT/EE, p. 18.

²⁴⁷ VMO2, p. 30.

²⁴⁸ Nokia, p. 4, response to Q. 14.

²⁴⁹ Ericsson, p.2.

²⁵⁰ Ofcom’s 22 March 2011 Consultation “[Assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues](#)”, para. 1.4.

had been identified as the primary band for 5G services in Europe.²⁵¹ Given the nature and purpose of these bands, we considered that national (rather than region-specific) licences would continue to be suitable in future. In contrast, as discussed above, we consider that the use cases for mmWave spectrum are still emerging, and there is less certainty as to whether the geographic configuration of licences will remain optimal in the long term.

The equipment ecosystem

- 6.40 VMO2's view is that the mmWave investment cycle will begin around 2030, and that as such we should award licences with a longer term. However, we have not seen clear evidence of this.
- 6.41 The mmWave ecosystem is developing at pace, with 26 GHz spectrum now available for mobile in six European countries,²⁵² as well as the United States, and auctions planned for the near future in at least six European countries. We consider that the UK's and other countries' planned awards of this spectrum will help drive the mmWave ecosystem,²⁵³ and we therefore expect there to be significant developments in the mmWave ecosystem in the coming years, including the materialisation of new technologies and services which use mmWave spectrum. We also note that in June 2022 the GSMA²⁵⁴ reported that "the mmWave 5G ecosystem is maturing as roll-outs gather pace and mmWave devices proliferate and reach scale". It also stated that "[o]ver a 15-year period from 2020 – 2034 \$565 billion in global GDP can come from mmWave 5G services". While there is some uncertainty in these broad estimates, they do suggest that mmWave is developing as a mobile band at a significant rate.
- 6.42 We therefore consider that 15 years is long enough for new technologies and services using mmWave spectrum to materialise and find success. In this regard, we note that mobile technology has developed significantly in the last 15 years: the first iPhone was released 16 years ago in 2007, and the UK's 4G roll out began 11 years ago in 2012.
- 6.43 We have also considered BT's suggestion that a longer licence duration would allow experimentation with use cases. However, we do not have clear evidence on the timescale of such experimentation, and in particular that a 15 year, rather than a longer or indefinite, licence duration would be an obstacle to such experimentation.
- 6.44 We consider that the expected technological developments in the mmWave bands mean that a 15-year licence duration will enable investment while mitigating the risk of an enduring inefficient allocation and that, conversely, a 20-year duration may be too long.
- 6.45 Finally, following H3G and Vodafone's announcement that they intend to seek regulatory approval for a merger of their UK businesses, we have decided to delay the auction until the CMA has taken its decision on the proposed merger. This means that the 15-year term will start later than previously envisaged.

²⁵¹ Ofcom's 13 March 2020 Statement "[Award of the 700 MHz and 3.6-3.8 GHz spectrum bands](#)", para. 1.2.

²⁵² Estonia, Spain, Slovenia, Denmark, Greece and Finland

²⁵³ As set out in the March 2023 Statement and Consultation, we consider that making this spectrum available in the UK may help to bring forward deployment timelines by providing additional incentives for manufacturers to develop equipment. In particular, we consider that it has the potential to encourage other administrations to consider authorising 40 GHz for new uses earlier, supporting the development of the 40 GHz ecosystem.

²⁵⁴ GSMA's 30 June 2022 research report, "[Vision 2030: mmWave Spectrum Needs](#)".

The existence of fixed links in both mmWave bands

6.46 We have considered some respondents' concerns regarding the existence of fixed links in both mmWave bands. However, we remain of the view that a 15-year licence is appropriate, having regard to the presence of fixed links in some parts of the band.

- a) Most of the fixed links which are likely to suffer from harmful interference from new mobile uses operating in and around high density areas in the 40 GHz band will be cleared by June 2028, and any remaining links will be cleared by 1 January 2030;²⁵⁵ and
- b) We will shortly start the statutory revocation process for clearing the fixed links which are likely to suffer from harmful interference from new mobile uses operating in and around high density areas in the 26 GHz band. We are proposing to give 5 years' notice.

6.47 This means that both bands are likely to be clear of fixed links less than 5 years after the award. In addition, we note that:

- a) As set out in Section 4, we will coordinate new and incumbent users during the revocation period for existing licensees, to enable the new licensees to begin to deploy spectrum in many areas from the date that licences are awarded.²⁵⁶
- b) Large parts of both the 26 and 40 GHz bands in high density areas are already clear of fixed links and so can be used for new mobile deployments as soon as we award new licences.
- c) As noted above, our decision to delay the auction in light of H3G and Vodafone's proposed merger of their UK businesses will reduce the period during which new and current users are sharing the spectrum, particularly as we have already revoked 40 GHz licences and will soon start revoking 26 GHz licences where needed.

End of the licence term

Our proposal

6.48 In the March 2023 Statement and Consultation,²⁵⁷ we said that, should we decide to award fixed term licences, we would expect to consult on our approach to ensuring an efficient allocation (once the licence term has expired) in advance of the end of the licence term.

Summary of responses

6.49 Generally, stakeholders considered that if Ofcom were to award indefinite licences, then these would involve an annual licence fee after the initial term ended. However, BT/EE²⁵⁸ considered that it would make "more sense to remove (or lower) ALFs than propose shorter duration licences", as this would remove barriers to trading.

6.50 As set out above, BT/EE, Nokia and VMO2 proposed renewable licences. In particular:

²⁵⁵ Ofcom's 30 May 2023 [Update on revoking licences in the 40 GHz band](#).

²⁵⁶ In some areas of the country, and using some frequencies (e.g. the top 1 GHz of the 26 GHz band, and large portions of the 40 GHz band, and for example, Exeter and Swindon in the 26 GHz band), the spectrum will be completely available from the date of the award.

²⁵⁷ March Statement and Consultation, para. 12.28.

²⁵⁸ BT/EE, p. 17.

- a) BT/EE²⁵⁹ said that “if Ofcom persists in its proposal for a fixed licence duration it should at a minimum provide certainty that it would expect to renew the licence unless there is evidence of materially inefficient use”. It also described its preferred approach of awarding indefinite licences with a 20 years’ initial term as allowing for revocation “if Ofcom saw a strong case for reassignment after 15 years”.
- b) VMO2²⁶⁰ asked for “20 years licences with expectation of renewal for a fee”.
- c) Nokia²⁶¹ stated that, if indefinite licences were not awarded, there should be renewal possibilities for licensees with “well-in-advance communication on the renewal conditions” to create investment certainty for licensees.

Ofcom’s decision

- 6.51 As set out in the March 2023 Statement and Consultation,²⁶² we consider that allowing licence holders to apply to Ofcom for a renewal or extension at the end of the fixed term (or allowing for an ‘automatic’ renewal or extension, provided certain conditions are met) would be similar in effect to awarding an indefinite licence or a licence with a longer licence duration. We have therefore decided not to include any provision for a licence renewal or extension and, accordingly, we will not include a power to charge fees after the end of the term.
- 6.52 Given the particular characteristics of mmWave spectrum and the uncertainty about spectrum requirements for future use cases, we do not consider that we have sufficient information or evidence at this stage to decide how we will reallocate the spectrum at the end of the licence term. However, we expect to consult on our approach to reallocating the spectrum (once the licence term has expired) in advance of the end of the licence term, with the result that licensees will have certainty about the future of the band in advance of the licence expiration.

Conclusion and next steps

- 6.53 Following the award of the 26 GHz and 40 GHz bands, we will issue fixed term licences with a 15-year term.
- 6.54 As set out in paragraph 6.6, in relation to those award licensees migrating to new frequencies within the 26 GHz band after the revocation period, this fixed licence term of 15 years refers to their overall licence duration, including both their initial and their final frequency assignments and includes a 6-month migration period.
- 6.55 We expect to consult on our approach to reallocating the spectrum in advance of the end of the licence term.

²⁵⁹ BT/EE, pp. 2 and 13.

²⁶⁰ VMO2, pp. 3, 30 and 36.

²⁶¹ Nokia, p. 4.

²⁶² March 2023 Statement and Consultation, para. 12.26.

7. Technical licence conditions for award licences and Shared Access licences

Summary

- 7.1 We have decided to implement the technical licence conditions for the award licences and the Shared Access licences in the 26 GHz and 40 GHz bands that we proposed in the March 2023 Statement and Consultation (Section 13) with changes relating to (i) the in-block maximum power for medium power base stations and (ii) antenna pointing, which are described below.

Background

The 26 and 40 GHz bands are harmonised for mobile broadband services

- 7.2 As set out in the [March 2023 Statement and Consultation](#),²⁶³ harmonised technical conditions for the 24.25-27.5 GHz band have been set out in European Commission Decision 2019/784, as amended by Decision 2020/590 (the “**26 GHz Decision**”), which continues to have effect in domestic UK law.²⁶⁴ The harmonised technical conditions have been established to ensure coexistence between licensees within the mmWave bands, as well as with the services that operate in adjacent bands. In particular, the conditions set out in the 26 GHz Decision include limits on out-of-band emissions from future deployments in the 26 GHz band to ensure the protection of Radio Astronomy Service and Earth Explorations Satellite Service (passive) in the 24 GHz band. In July 2022, we decided to implement those limits as well as additional protective measures consisting of a density limit on the number of outdoor base stations and exclusion zones around six radio astronomy sites.²⁶⁵
- 7.3 In 2022, the harmonised technical conditions for the 40.5-43.5 GHz band were approved in a ECC Decision (“**ECC Decision (22)06**”)²⁶⁶ and a CEPT report (“**CEPT Report 82**”).²⁶⁷ CEPT Report 82 specifies the out-of-block emissions required for coexistence. As set out in the March 2023 Statement and Consultation,²⁶⁸ we consider it appropriate to authorise spectrum use of the relevant frequencies on the basis of technical conditions reflecting the CEPT harmonisation (to which the UK has contributed) because the adoption of harmonised conditions is likely to facilitate more efficient spectrum use.

²⁶³ [March 2023 Statement and Consultation](#), paras. 13.5-13.8.

²⁶⁴ See this [unofficial consolidated version of Decision 2019/784, as amended by Decision 2020/590](#). The UK version of this legislation is set out in S.I. [784/2019](#) and [S.I. 590/2020](#).

²⁶⁵ Ofcom’s 4 July 2022 Statement “[Protecting passive services at 23.6-24 GHz from future 26 GHz uses](#)”.

²⁶⁶ [ECC Decision \(22\)06](#).

²⁶⁷ [CEPT Report 82](#). CEPT Report 82 will form the basis of a harmonising Commission Decision, which is currently in draft form. A [draft of the Commission Implementing Decision](#), dated 7 December 2022, is available.

²⁶⁸ March 2023 Statement and Consultation, para. 2.16.

- 7.4 In addition to the out-of-band emission restriction in the 26 GHz band set out above, there is also a restriction on the elevation of active antenna systems of base stations in the 26 GHz band and in 42.5-43.5 GHz in order to protect satellite receivers.²⁶⁹
- 7.5 In block power levels and other deployment conditions like base station height limits are not harmonised and so we need to set the level which we consider necessary to enable mobile licensees to make optimal use of the spectrum, while also ensuring the prevention of harmful interference where appropriate.

Stakeholders' responses

- 7.6 In summary, we received the following comments from stakeholders:
- a) Cambridge Broadband Networks Group²⁷⁰ agreed with our proposals and Vodafone²⁷¹ said that they “appear reasonable”;
 - b) BT/EE,²⁷² Ericsson,²⁷³ Nokia²⁷⁴ and VMO2²⁷⁵ proposed increased power limits for the auctioned licences;
 - c) Nokia questioned the need for our proposed antenna height limit for outdoor low power equipment, while BT/EE and Vodafone sought clarifications about it;
 - d) a confidential respondent [CONFIDENTIAL X]²⁷⁶ said that [CONFIDENTIAL X];
 - e) BT/EE, Nokia and Vodafone preferred no mandated synchronisation;
 - f) BT/EE, Vodafone and VMO2 agreed with our proposal to impose a less stringent requirement on antenna elevation in order to enable use of this spectrum for integrated access and backhaul (“IAB”); and
 - g) A confidential respondent [CONFIDENTIAL X]²⁷⁷ was concerned about exposure to electromagnetic fields and said that we should not make the spectrum available.
- 7.7 Below, we discuss responses to the consultation in detail and set out our final decisions.

General technical conditions

Transmission power limits

Our proposals

- 7.8 In the March 2023 Statement and Consultation,²⁷⁸ we set out the following proposals in relation to the transmission power limits of the award and Shared Access licences in the 26 GHz and 40 GHz bands:

²⁶⁹ [ECC Decision \(22\)06](#), p. 6, para. (aa).

²⁷⁰ [Cambridge Broadband Networks Group response to the March 2023 Statement and Consultation](#), p. 2, response to Q. 15.

²⁷¹ [Vodafone response to the March 2023 Statement and Consultation](#), pp. 10-11.

²⁷² [BT/EE response to the March 2023 Statement and Consultation](#), p. 19.

²⁷³ [Ericsson response to the March 2023 Statement and Consultation](#), p. 2.

²⁷⁴ [Nokia response to the March 2023 Statement and Consultation](#), p. 6, response to Q. 15.

²⁷⁵ [VMO2 response to the March 2023 Statement and Consultation](#), p. 37.

²⁷⁶ [CONFIDENTIAL X] response to the March 2023 Statement and Consultation, response to Q. 15 and Q. 16.

²⁷⁷ [CONFIDENTIAL X] response to the March 2023 Statement and Consultation.

²⁷⁸ March 2023 Statement and Consultation, paras. 13.9-13.29.

- a) In line with our existing Shared Access framework,²⁷⁹ we proposed to license two classes of base station in the mmWave bands: (i) low power and (ii) medium power.
- b) We proposed to require the holders of award licences to identify and record whether their base stations are indoor low power, outdoor low power, or medium power because we proposed that different coordination rules will apply based on station type.²⁸⁰
- c) We proposed to state power levels in total radiated power (“TRP”), instead of effective isotropic radiated power (“EIRP”), because 5G mmWave systems are likely to use active antenna systems (“AAS”) for which units of TRP are more appropriate.
- d) We proposed that outdoor low power base stations will have both height and in-block power limits, whereas medium power and indoor low power base stations will have in-block power limits, but no height limit. Specifically, we proposed the following **in-block power limits**:
 - i) a maximum TRP of 25 dBm/200 MHz for low power base stations; and
 - ii) a maximum TRP of 30 dBm/200 MHz for medium power base stations.
- e) We proposed a maximum power of 23 dBm TRP for all **terminal stations**, including mobile, nomadic, fixed and installed terminals.
- f) We proposed the **out-of-block power limits** set out in the table below,²⁸¹ noting that the proposed limits would be in line with those set out in the 26 GHz Decision²⁸² for the 26 GHz band, which are also reflected in the ECC Decision (22)06 for the 40 GHz band.²⁸³

Table 7.1: Out-of-block power limits for 26 and 40 GHz

Frequency Range	Maximum TRP	
	26 GHz	40 GHz
Transitional regions 0 to 50 MHz below or above an assigned block	12 dBm/50 MHz	12 dBm/50 MHz
Baseline region	4 dBm/50 MHz <i>within 24.25 – 27.5 GHz</i>	4 dBm/50 MHz <i>within 40.5 – 43.5 GHz</i>

²⁷⁹ Ofcom’s 20 September 2022 Guidance Document “[Shared Access Licence](#)”, paras. 2.9-2.20.

²⁸⁰ For the avoidance of doubt, this record-keeping requirement is not necessary for Shared Access licensees because they will be required to specify which type of base station they intend to operate when they apply for their Shared Access licence.

²⁸¹ As explained in the March 2023 Statement and Consultation (para. 13.26 and Figure 13.1), “block edge masks” define the out-of-block emission limits for a given frequency range relative to the edge of a block of awarded spectrum to ensure coexistence with other licence holders in the band. A block edge mask consists of the emission limits for a transitional region, which is the spectrum adjacent to the assigned block, and a baseline region, which is the spectrum within the operating band (i.e., 24.25-27.5 GHz or 40.5-43.5 GHz) excluding the assigned block and the transitional regions.

²⁸² [26 GHz Decision](#), Annex, Tables 2 and 3.

²⁸³ [ECC Decision \(22\)06](#), Annex 2, Tables 2 and 3.

Stakeholders' responses

7.9 In summary, BT/EE, Ericsson, Nokia and VMO2 proposed increased power limits for the auctioned licences. Specifically, we received the following comments:

- a) BT/EE²⁸⁴ proposed these increases powers limits:
 - i) A higher in-band limit of 36 dBm TRP per 200 MHz (instead of 30 dBm TRP per 200 MHz) for medium power base stations authorised under the auction licences, on the basis that our proposed limits “could constrain certain use cases and prevent the full benefits of future available equipment deployments to be fully realised”. According to BT/EE, “[s]ince Ofcom anyway proposes a field strength limit at the boundary of the auction areas, it’s unclear why an in-band power limit is needed”. BT/EE also referred to the higher limits applying in the USA and the absence of any such limit in Finland.
 - ii) An increased power for the customer premises equipment used for fixed wireless access, which would be closer to the value of 35 dBm TRP set out in the 3GPP specification for “Class 1 (FWA) equipment”.²⁸⁵ BT/EE said that our proposed limit “is much less than the 35dBm/5MHz EIRP limit for fixed terminal installations in 3.6 GHz licences”.
- b) Ericsson²⁸⁶ proposed “minimum TRP levels of 33dB/200MHz for medium power and 28 dBm/200 MHz for low power” on the basis that “many mmWave deployments in cities will be on rooftops” and “the current proposed TRP limits could be restrictive” where service providers choose to deploy narrow channels. Ericsson also said that “FWA deployments will benefit from higher TRP limits to deliver longer mmWave cell ranges”.
- c) Nokia²⁸⁷ agreed with our proposal to express the power limits in TRP (rather than EIRP) and asked us to consider “higher TRP levels, at least for medium power BS” on the basis that: (i) “the difference between medium and low power BS as proposed by Ofcom is only 5 dB”; (ii) “the difference between the proposed EIRP (per 100 MHz) of medium power licences in the 26 GHz and 40 GHz band and the EIRP of the existing medium power licences in the 3.8-4.2 GHz band is only 6 dB, while admittedly the mmWave signals will attenuate significantly more than the 6dB difference in power for the same distance”;
- d) VMO2²⁸⁸ said that “Ofcom’s proposed level is about 10 dB lower than where it should be, in terms of transmit power limits”. VMO2 provided the following arguments in support of its view: (i) “there is a 30 dB (x1000) difference in transmitted power spectral density between this mmWave spectrum and existing 3.4 GHz spectrum used today, that is a very big difference”; (ii) “the difference between ‘medium-power’ and ‘low-power’ as set out by Ofcom, is only 5 dB”; (iii) referring to the analysis set out in paragraphs 13.22 of the March 2023 Statement and Consultation, VMO2 questioned why we assumed a representative value of 65 dBm/800 MHz EIRP and a peak antenna gain of 29 dBi.

²⁸⁴ [BT/EE response to the March 2023 Statement and Consultation](#), p. 2, para. 5; pp. 18-19.

²⁸⁵ BT/EE referred to “3GPP specification TS 38.101-2 Table 6.2.1.1-2” (BT/EE, fn. 25).

²⁸⁶ [Ericsson response to the March 2023 Statement and Consultation](#), p. 2.

²⁸⁷ [Nokia response to the March 2023 Statement and Consultation](#), p. 6, response to Q. 15.

²⁸⁸ [VMO2 response to the March 2023 Statement and Consultation](#), pp. 36-37.

Ofcom's decision

Medium power base stations

- 7.10 As several respondents asked for higher power for medium power base stations we have examined this issue further. Increasing the power limit for mmWave base stations would increase the Signal to Interference plus Noise Ratio (“**SINR**”) received at terminals, and therefore improve the potential downlink throughput and capacity of the new mmWave services we aim to enable. On the other hand, it could lead to greater spectrum sterilisation, with the result that (i) we would need to clear more fixed links around high density areas, and (ii) we would be able to authorise fewer Shared Access licences in any given area. We therefore need to strike an appropriate balance, taking into account our view that the future of these bands is for new mobile services.
- 7.11 To inform our assessment in light of consultation responses, we have sought information from three equipment vendors [CONFIDENTIAL ✂] about the maximum power levels their mmWave base stations are likely to support.²⁸⁹
- 7.12 We have also modelled the potential impact of increasing the power limits on sterilisation of spectrum for (i) shared access base stations, and (ii) fixed links:
- i) Our Shared Access sterilisation analysis showed that increasing the power limit by 6 dB did not substantially increase the sterilisation area of medium power base stations.
 - ii) Our fixed link sterilisation analysis shows that the power increase would moderately increase the number of fixed links *around* high density areas which would be at risk of receiving interference from mobile deployments operating in high density areas. Specifically, the number of links around high density areas in the 26 GHz band would increase by 18, and the number of links around high density areas in the 40 GHz band would increase by 164 (from 900 to 1064).²⁹⁰ Therefore, the power increase would result in fewer than 200 additional links to be cleared from the mmWave bands. Since there are nearly 4,000 fixed links in total to be cleared from the mmWave bands, we consider this increase in sterilisation (caused by increasing the power limit by 6 dB) relatively small in this context.
- 7.13 In response to VMO2 saying that our proposed level is about 10 dB lower than where it should be, we do not consider that we need to increase the power limit by more than 6 dB because in response to our statutory information request, the vendors told us that [CONFIDENTIAL ✂]²⁹¹

²⁸⁹ We requested this information on 1 August 2023, using our statutory information gathering powers under s.32A of the Wireless Telegraphy Act 2006.

²⁹⁰ We note that these numbers include only the fixed links which are *outside* high density areas but nonetheless at risk of interference from new mobile base stations operating in those areas. As set out in the March 2023 Statement and Consultation, we also consider it appropriate to clear the fixed links which are *in* high density areas, the number of which remain unchanged by the increase in power level. As set out in Section 3, paragraphs 3.28-3.30, although the increase in permitted power levels for mmWave base stations has the effect of increasing the number of fixed links to be cleared from the 26 GHz and 40 GHz bands, the impact of correcting the implementation error, as well as the reduction in the number of fixed links operating in both bands, means that we are still expecting to clear fewer links than we originally estimated in the March 2023 Statement and Consultation.

²⁹¹ [CONFIDENTIAL ✂]

- 7.14 We have therefore decided to increase the maximum permitted power for medium power base stations from 30 to 36 dBm / 200 MHz TRP for award winners and Shared Access.

Low power base stations

- 7.15 We have decided to maintain the maximum power level that we proposed for low power base stations (i.e., a maximum TRP of 25 dBm/200 MHz) because our proposals were based on the TRP for the IMT-2020 Outdoor hotspot BS used in [ECC Report 307](#)^{292,293} and we have not seen any new evidence that our proposed low power limit is overly restrictive. In addition, award winners, and Shared Access licensees in low density areas, will have the option to deploy at medium power.²⁹⁴

Terminals

- 7.16 We have also decided to maintain the maximum power limit that we proposed for terminals (i.e., a maximum power of 23 dBm TRP) because we do not currently intend to coordinate terminals and the risk of interference from high power fixed terminals to fixed links could be similar to the risk of interference from medium power base stations if those fixed terminals are installed at a high height and with high gain.²⁹⁵ We note that we may consider increasing the power limit for licensed terminals in the high density areas once the fixed links have been cleared from those areas. This is because the fixed links and new Shared Access users outside high density areas will coexist with medium power base stations in high density areas. Therefore higher power terminals that follow the same coordination procedures as medium power base stations (i.e. complying with the high density area boundary field strength limit) will pose no greater risk of interference to users outside high density areas than medium power base stations.

Out-of-block emissions

- 7.17 We received no comments on our proposed out-of-block emissions so we have decided to implement them in the technical licence conditions with no changes.

Antenna height limit for outdoor low power equipment

Our proposals

- 7.18 In the March 2023 Statement and Consultation,²⁹⁶ we proposed a height limit of 10m for outdoor low power base stations authorised under the Shared Access licences or the award licences. We did not propose any antenna height restrictions on indoor low power and outdoor medium power base stations on the basis that (i) building entry loss will mitigate the risk of interference from low power indoor base stations to other users and (ii) medium power licences will be coordinated to take into account the increased risk of interference when operating at above 10m.

²⁹² [ECC Report 307](#), p. 12, Table 2.

²⁹³ March 2023 Statement and Consultation, para. 13.21.

²⁹⁴ For context, we note that award licensees will be authorised to transmit at medium power (and the concept of 'low power' for award winners is only relevant to coordination, see the coordination notice at Annex 3).

²⁹⁵ For example, the Nokia FastMile 5G PoC CPE has a high gain (27 dBi) 360° antenna. (Nokia's 25 June 2023 press release, "[Nokia hits extended range mmWave 5G speed record in Finland](#)").

²⁹⁶ March 2023 Statement and Consultation, paras. 13.12-13.17.

Stakeholders' responses

- 7.19 Nokia²⁹⁷ said that “the limitation of antenna height for the outdoor low power BS of the award licences doesn’t seem to have any reasonable justification” because: (i) “award licences will have their spectrum acquired through auction”, (ii) “there will be no availability of low power shared access licences in the 25.1 – 27.5 GHz in high-density areas”, (iii) “medium power licences are also available for award licensees in high density areas” and (iv) “Ofcom proposes limits applicable at the border of low and high density areas”.
- 7.20 BT/EE and Vodafone sought the following clarifications:
- BT/EE²⁹⁸ asked us to clarify whether “the base station would be coordinated and no height limit would apply” where “a licensee chooses to use a power somewhere between low and medium power”.
 - Vodafone²⁹⁹ asked us to clarify that our proposed technical conditions would not preclude the operation of (i) “a mast on a low power basis (e.g. serving a stadium) which exceeds 10m” or (ii) “a Shared Access Licence site operating at low power levels with antennas above 10m”. In its view, in both cases the site should be authorised and treated as a medium power station “for the purposes of licensing, coordination and fees”.

Ofcom's decision

- 7.21 In light of stakeholders' comments, we clarify that low power outdoor deployment is for deployments up to 10m only. Outdoor base stations with a height exceeding 10m, regardless of the in-block transmit power, will be counted as medium power deployment and therefore require coordination. There is no height limit on indoor low power base stations.³⁰⁰
- 7.22 We have decided to maintain our proposed height limit of 10m for outdoor low power base stations authorised under the Shared Access licences in order to maintain consistency with the terms of existing Shared Access licences in other bands.
- 7.23 We have also decided to include this same height limit in the award licences' coordination procedures. This height limit reduces the risk of interference to other users, which enables us to impose simpler coordination requirements than we do for medium power base stations. In particular, it enables us to simplify the coordination of low power outdoor deployments by (i) not requiring coordination of such deployments with fixed links, and (ii) requiring a 100m minimum separation distance from the high density area boundary (as opposed to a field strength calculation).

Synchronisation

Our proposals

- 7.24 Synchronisation is a mitigation technique which helps to reduce the interference between different time division duplex (“TDD”) networks which are not isolated from each other. When networks are synchronised, all base stations are either transmitting or receiving at the same time, so there are no simultaneous uplink and downlink transmissions. When there is

²⁹⁷ Nokia, p. 6, response to Q. 15.

²⁹⁸ BT/EE, p. 19.

²⁹⁹ Vodafone, pp. 10-11.

³⁰⁰ Our definition of ‘indoor’ is set out in the draft licences as well as the draft coordination procedures, see Annexes 3, 4 and 5 of this document.

no synchronisation, one base station may be receiving whilst a nearby base station may be transmitting, potentially resulting in interference at the receiving base station.

- 7.25 Given the use case uncertainty and the lower propagation distance associated with mmWave spectrum, we proposed not to mandate synchronisation.³⁰¹ We also specified that if harmful interference occurred and licensees were not able to agree appropriate measures to mitigate the interference between their networks (e.g., by agreeing on a common frame structure),³⁰² we would consider whether it would be appropriate to impose additional technical conditions by issuing a coordination notice.

Stakeholders' responses

- 7.26 BT/EE,³⁰³ Vodafone³⁰⁴ and Nokia³⁰⁵ agreed with our proposed approach.

Ofcom's decisions

- 7.27 In light of stakeholders' comments, which supported our preferred option, we have decided not to mandate synchronisation.

Antenna elevation

Our proposals

Shared Access Licences

- 7.28 We proposed to include the following condition in all Shared Access licences in the 26 GHz and 40 GHz bands:³⁰⁶

"When deploying Active Antenna System (AAS) outdoor base stations, licensees transmitting in either 24.45-27.5 GHz or 42.5-43.5 GHz, shall ensure that each antenna is normally transmitting only with main beam pointing below the horizon and in addition the antenna shall have mechanical pointing below the horizon except when the base station is only receiving."

Award licences

26 GHz

- 7.29 In line with the [26 GHz Decision](#),³⁰⁷ which is now part of UK law, we proposed to include the condition set out above. However, we acknowledged that a restriction on antenna pointing could restrict licensees' ability to use the spectrum for integrated access and backhaul ("IAB"), which could be an important use case for mmWave spectrum.
- 7.30 We said that if we could enable this type of use while ensuring compliance with the relevant framework and appropriate protection of satellite services, we would consider making an exception to this restriction on antenna pointing for IAB, in line with our proposals for the 42.5-43.5 GHz band (see below). In this regard, we noted that the [Retained EU Law \(Revocation and Reform\) Bill](#) was going through Parliament and might result in a change to the legal status of the 26 GHz Decision. We also noted our initial view that applying a less

³⁰¹ March 2023 Statement and Consultation, paras. 13.30-13.35.

³⁰² Frame structures are used to synchronise networks by enabling licensees to agree on specific time periods to allocate for uplink and downlink transmissions.

³⁰³ BT/EE, p. 19.

³⁰⁴ Vodafone, p. 10.

³⁰⁵ Nokia, p. 6, response to Q. 15

³⁰⁶ March 2023 Statement and Consultation, para. 13.36.

³⁰⁷ [26 GHz Decision](#), Annex, Table 5.

stringent requirement to UK licensees where they use the relevant spectrum for providing backhaul between fixed stations, including in IAB configurations, could enable this type of use while ensuring appropriate protection of satellite services.

40.5-42.5 GHz

7.31 We did not propose to include any restrictions on antenna pointing in licences authorising use of 40.5-42.5 GHz, because we did not consider this is necessary to protect any satellite services.

42.5-43.5 GHz

7.32 We noted that ECC Decision (22)06 (for the 40 GHz band) recommends that a similar condition on antenna pointing to the one discussed in paragraph 7.28 above should be included in licences authorising use of 42.5-43.5 GHz. However, we also proposed a less stringent requirement than the one set out above on UK licensees where they use the relevant spectrum for providing backhaul between fixed stations (including in IAB configurations), on the basis that it could enable this type of use while ensuring appropriate protection of satellite services. We said that we would consider adopting the same approach for the award licences in the 26 GHz band, if the Retained EU Law (Revocation and Reform) Bill resulted in a change to the legal status of the 26 GHz Decision.

Stakeholders' responses

7.33 We received the following comments from stakeholders:

- a) BT/EE³⁰⁸ welcomed our proposal of a less stringent requirement on antenna elevation in allowing IAB, noted that it sees IAB “as a useful future capability” and asked Ofcom to “indicate in its statement that it would be favourably disposed to developing suitable technical conditions on request with a view to including these in future licence variations if requested” if the deployment of IAB is not immediately allowed under the auction licences;
- b) Vodafone³⁰⁹ said that it “accepted” our proposed restriction on antenna pointing below the horizon as a “starting position” and added that “the situation should be kept under review” depending on the availability of IAB devices;
- c) VMO2³¹⁰ agreed with our initial view that applying a less stringent requirement relating to antenna elevation could enable IAB. It said that it would be appropriate to enable this use case to the extent that compliance with the relevant framework and protection of satellite services could be ensured. It also said that “Ofcom must ensure that any exceptions that it makes to licence conditions, do not inadvertently enable current incumbent licensees to ‘game’ the system and replicate their existing fixed point-to-point links” on the basis that “Ofcom has clearly stated that mobile is the optimal future use of the bands”; and
- d) a confidential satellite earth station respondent [CONFIDENTIAL ✂]³¹¹ said that [CONFIDENTIAL ✂]. The confidential respondent also said that [CONFIDENTIAL ✂].

³⁰⁸ BT/EE p. 19.

³⁰⁹ Vodafone, p. 11.

³¹⁰ VMO2, p. 37.

³¹¹ [CONFIDENTIAL ✂] response to the March 2023 Statement and Consultation, response to Q. 16.

Ofcom's decisions

- 7.34 Given that the [Retained EU Law \(Revocation and Reform\) Act 2003](#) has not resulted in a change to the legal status of the 26 GHz Decision, and stakeholders' responses suggest that there is not an urgent need to allow for more flexibility, we have decided to impose the antenna pointing restriction in all mmWave award licences and Shared Access licences. However, in light of stakeholders' comments that it may be beneficial to vary the award licences in future to enable licensees to use the spectrum to provide IAB (though not backhaul more generally), we will keep this under review.
- 7.35 In response to the comments from the confidential respondent, the proposed restriction is not intended to ensure coexistence between mobile base stations and satellite earth stations by itself. We set out in Section 4 how we have decided to ensure protection of satellite earth stations through coordination.

Provisions relating to electromagnetic fields (EMF)

Our proposals

- 7.36 In the March 2023 Statement and Consultation,³¹² we proposed to include our standard licence condition requiring licensees to comply with the ICNIRP general public limits, referring to Ofcom's [Update of 1 March 2021](#) for further detail about our standard EMF licence condition.

Stakeholders' responses

- 7.37 A confidential respondent [CONFIDENTIAL \times]³¹³ said that "the ICNIRP guidelines do not apply to a large proportion of UK residents with any form of metal in their bodies" and this is "an acute safety issue". In support of their view, the respondent referred to some published articles³¹⁴ and quoted the following statement from ICNIRP guidelines: "(...) *some exposure scenarios are defined as outside the scope of these guidelines. Medical procedures may utilize EMFs, and metallic implants may alter or perturb EMFs in the body, which in turn can affect the body both directly (via direct interaction between field and tissue) and indirectly (via an intermediate conducting object)*".

Ofcom's decisions

- 7.38 We have decided to include our standard licence condition requiring licensees to comply with the ICNIRP general public limits. As set out in our March 2023 Statement and Consultation,³¹⁵ the UK Health and Security Agency ("**UKHSA**")³¹⁶ takes the lead on public health matters associated with EMF and has a statutory duty to provide advice to Government on any health effects that may be caused by exposure to EMF. UKHSA's main advice is that EMF exposure should comply with the internationally agreed limits in the ICNIRP Guidelines. UKHSA's view is that "the overall exposure [from all mobile network EMFs, including 5G] is expected to remain low relative to [the ICNIRP] guidelines and, as such, there should be no consequences for public health."³¹⁷

³¹² March 2023 Statement and Consultation, paras. 13.44-13.47.

³¹³ Name Withheld 1 [CONFIDENTIAL \times] [to the March 2023 Statement and Consultation](#).

³¹⁴ See articles referred in the [confidential response from Name Withheld 1](#).

³¹⁵ March 2023 Statement and Consultation, para. 13.45.

³¹⁶ [UKHSA](#) took over these responsibilities from Public Health England (PHE) on 1 October 2021.

³¹⁷ UK Government's webpage "[5G technologies: radio waves and health](#)", published 3 October 2019.

Technical licence conditions for coexistence with passive services

7.39 As explained in the [July 2022 statement, “Protecting passive services at 23.6-24 GHz from future 26 GHz uses”](#),³¹⁸ and noted in the March 2023 Statement and Consultation,³¹⁹ we are required to implement the following limits on out-of-band emissions from use of 26 GHz spectrum, in order to protect the passive services operating in the 23.6-24 GHz band from interference from wireless deployments in 24.25-27.5 GHz.

Table 7.2: Maximum emissions into the 23.6-24.0 GHz band

Frequency range	Station Type	Maximum TRP
Within 23.6-24.0 GHz	Base Station	-39 dBW/200 MHz
	Terminal Station	-35 dBW/200 MHz

7.40 To implement these restrictions, we proposed to include the maximum TRP limits set out in the table above in the award licences and Shared Access licences that we will make available in the 26 GHz band.³²⁰ As noted in the March 2023 Statement and Consultation,³²¹ the table above only considers the out-of-band emission limits which will be applicable from 2024 onwards, since we do not anticipate awarding the licences before 2024.

Stakeholders’ responses

7.41 We did not receive any specific comments on the technical licence conditions that we proposed for coexistence with passive services.

Ofcom’s decisions

7.42 We have decided to implement the out-of-band emission limits stated above by including the relevant maximum TRP limits in the award licences and Shared Access licences that we will make available in the 26 GHz band, in line with the technical licence conditions that we proposed in the March 2023 Statement and Consultation.

Block-assigned area boundary conditions

Our decision

7.43 Licensees will be required to coordinate at the boundaries of high density areas. Please see paragraphs 4.91-4.102 of Section 4 for more details.

³¹⁸ July 2022 Statement on protecting passive services at 24 GHz, paras. 2.14-2.19.

³¹⁹ March 2023 Statement and Consultation, paras. 13.48-13.49.

³²⁰ See: (i) Schedule 1, para. 13 of the Draft Auction Licence set out in Annex A10 to the March 2023 Statement and Consultation and (ii) Schedule 3, para. 1 of the Draft Shared Access Licences set out in Annex A11 to the March 2023 Statement and Consultation.

³²¹ March 2023 Statement and Consultation, paras. 13.48-13.49.

Cross-border coordination

Our decision

7.44 We will require licensees to coordinate at international boundaries. More detail on our decisions on this is set out in Section 4.

Conclusion and next steps

- 7.45 In conclusion, we have decided to implement the technical licence conditions that we proposed in the March 2023 Statement and Consultation, with the following changes:
- a) We have decided to set an increased in-block maximum power for medium power base stations (i.e. 36 dBm/200 MHz rather than 30 dBm/200 MHz); and
 - b) We have also decided not to set a less stringent requirement in relation to antenna pointing where licensees use the relevant spectrum for Integrated Access and Backhaul. However, we will keep the availability of equipment for IAB under review.
- 7.46 We have reflected these changes in the draft licences annexed to this Statement.

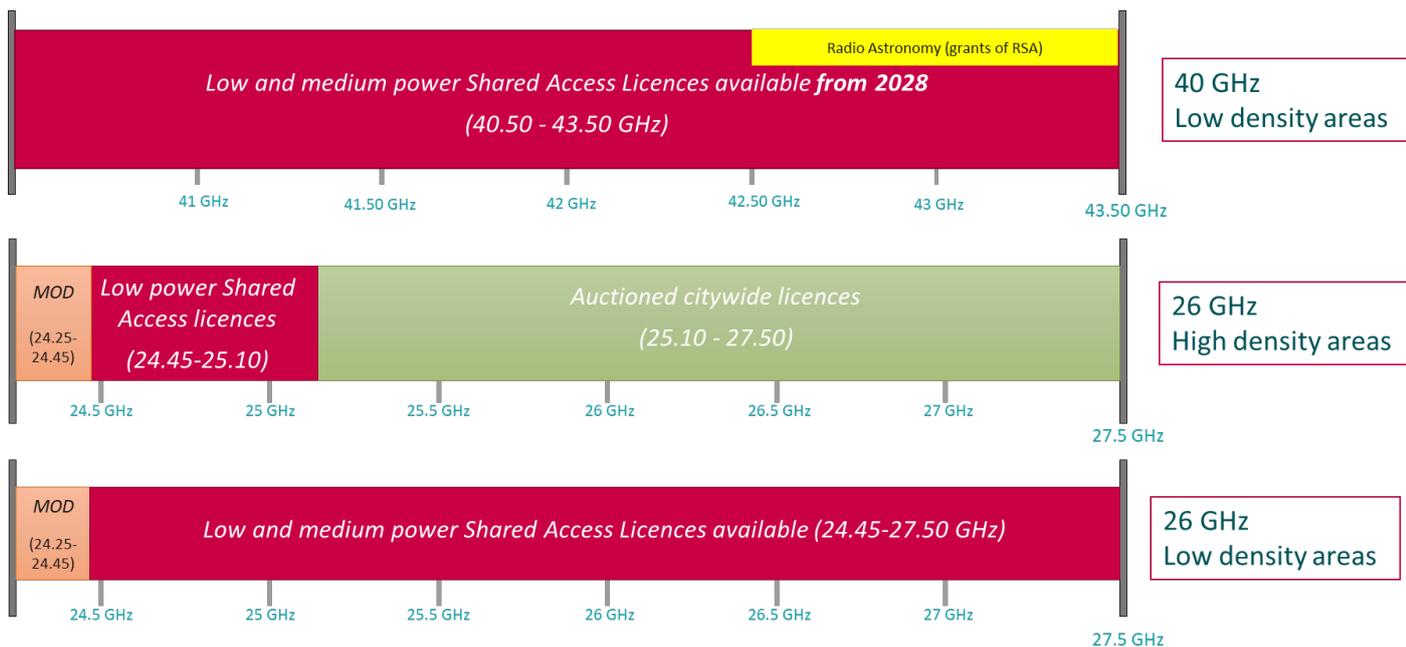
8. Shared Access licences

Summary

- 8.1 In summary, the new Shared Access licences will be available in:
- i) the 68 high density areas which we have designated, where 650 MHz of the 26 GHz band (24.45-25.1 GHz) will be available for low power use; and
 - ii) in the rest of the country, where the 26 GHz (24.45-27.5 GHz) and 40 GHz (40.5-43.5 GHz) bands will be available for low power and medium power use on a coordinated basis with incumbent users.
- b) available from:
- i) early 2024 for the 26 GHz band (24.45-27.5 GHz); and
 - ii) 1 June 2028 for the 40 GHz band (40.5-43.5 GHz).
- c) offered in channel sizes of 50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz;
 - d) subject to a limit of maximum three outdoor base stations per low power outdoor Shared Access licence operating in the 24.45-25.05 GHz band;
 - e) subject to an annual fee of £320 per 400 MHz (pro rata for different bandwidth options within a minimum cost of £80 for bandwidths up to 100 MHz);
 - f) subject to the same non-technical licence terms and conditions as existing Shared Access licences.³²²
- 8.2 As set out in section 7, the new Shared Access licences will have a maximum total radiated power (TRP) transmission limit of:
- a) 25 dBm / 200 MHz for low power base stations;
 - b) 36 dBm / 200 MHz for medium power base stations; and
 - c) 23 dBm for terminal stations.

³²² Ofcom's 20 September 2022 Guidance document "[Shared Access Licence](#)".

Figure 8.1 – Shared access licences available in the 26 and 40 GHz bands



Background

- 8.3 Ofcom introduced Shared Access licences in 2019, to meet the emerging demand for localised mobile deployments to support private networks and other users. 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. Shared Access licences currently permit access to one of four frequency bands (the “**Shared Access bands**”).³²³
- 8.4 The Shared Access licensing framework allows users to apply to Ofcom for coordinated, local access to the Shared Access bands on a first come, first served basis. Successful applicants have the right to use their designated frequency and bandwidth in a specific location and must pay a licence fee that reflects the costs of issuing the licence.
- 8.5 There are two types of Shared Access licence, distinguished primarily by the power levels they permit, to cater for different types of potential uses: **low power** and **medium power** licences. Low power licences authorise **multiple base stations**, in an area with a 50m radius around a given point provided to Ofcom by the user. Connected terminals may be located outside the licensed area. Medium power licences are issued on a **per base station basis**, as they have higher power limits and are not subject to antenna height restrictions.
- 8.6 In Section 8 of the May 2022 Consultation, we sought stakeholders’ views on our high-level proposal to extend the Shared Access licensing framework to the 26 GHz and 40 GHz bands, applying the same standard non-technical licence conditions as in other Shared Access bands and taking a similar approach to setting the annual fee.³²⁴ We also sought views on our

³²³ 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).

³²⁴ [May 2022 Consultation](#), para. 8.22.

proposed high-level approach to coordination between existing users and new Shared Access licensees.³²⁵

- 8.7 In the March 2023 Statement and Consultation,³²⁶ we said that we were minded to make low and medium power Shared Access licences available in both the 26 GHz and 40 GHz bands and to apply the same standard non-technical licence conditions as the Shared Access licences available in other bands. We also consulted further on specific proposals regarding (i) the channel bandwidths we planned to make available, (ii) the coordination approach we would adopt to protect the earth exploration satellite services (“EESS”) from the risk of harmful interference by limiting the deployment of outdoor base stations within any 300km² area in the bottom 650 MHz of the 26 GHz frequency band (24.45-25.05 GHz) and (iii) the level of fee we would charge for a Shared Access licence.
- 8.8 Our decisions relating to the technical licence conditions for the proposed citywide licences and Shared Access licences are set out in Section 7. Our decisions for coordination of existing users and new Shared Access licensees are set out in section 4.

Availability of Shared Access licences in the 26 GHz and 40 GHz bands

Our proposals

- 8.9 In the March 2023 Statement and Consultation,³²⁷ we said that we had provisionally decided to extend the Shared Access licensing framework in the 26 GHz and 40 GHz bands and that the new Shared Access licences would enable the following indoor and outdoor uses of mmWave spectrum on a Shared Access basis:
- a) in high density areas, in the 650 MHz of the 26 GHz band (24.45-25.1 GHz), for low power use only;
 - b) in low density areas, in the 24.45-27.5 GHz band, for low power and medium power use; and
 - c) in low density areas, in the entire 40.5-43.5 GHz band, for low power and medium power use, but only from the date the revocation of the existing 40 GHz licences takes effect.

Summary of responses

- 8.10 We received the following comments:
- a) BT/EE³²⁸ agreed “that where the spectrum is not auctioned the shared access licensing framework could be adapted to authorise use of 26 GHz and 40 GHz outside of those areas”.
 - b) A confidential respondent [CONFIDENTIAL ✕] stated that the low power licensing approach adopted by Ofcom would be suitable for some localised deployment scenarios but a 50m radius area would be “far too excessive” for some very short range high data

³²⁵ [May 2022 Consultation](#), para. 8.32-8.37.

³²⁶ March 2023 Statement and Consultation, paras. 14.2 and 14.69.

³²⁷ March 2023 Statement and Consultation, paras. 14.10-14.26.

³²⁸ [BT/EE response to the March 2023 Statement and Consultation](#), p. 20.

requirements.³²⁹ This respondent added that flexibility should be provided for extremely high (excess of 1 GHz) short range indoor solutions.

Ofcom's decision

- 8.11 In response to the issue raised by the confidential respondent, we note that the majority of respondents to our May 2022 Consultation agreed with our Shared Access licensing approach.³³⁰ We remain of the view that it is more appropriate to extend the current Shared Access licensing framework than creating a new licence product or fundamentally change the existing licensing approach. This is because Ofcom's existing Shared Access licensing framework contributes to our objectives for making mmWave spectrum available: it is a local licence which enables us to coordinate new and incumbent users, and promote innovation. Using our existing framework would also minimise disruption to existing 26 GHz indoor Shared Access licensees.
- 8.12 As set out below, we consulted on allowing bandwidths up to 800 MHz. Licensees that wish to use larger continuous blocks of spectrum can apply for multiple Shared Access licences at that location.
- 8.13 We are currently considering responses to our [Call For Inputs on the Evolution of the Shared Access Licence Framework](#) (the "Shared Access CFI") and will consider any evidence provided on the licensing framework that we have adopted and any changes that should be made to it, as part of the review of Shared Access which we are undertaking throughout 2023/24.
- 8.14 In light of the above, we have decided to make Shared Access licences available in the 26 GHz and 40 GHz band as proposed in the March 2023 Statement and Consultation.

Channel bandwidth and allocation policy

Our proposals

- 8.15 In the March 2023 Statement and Consultation,³³¹ we made the following proposals:
- a) We proposed to make available channel sizes of 50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz in both the 26 GHz and 40 GHz bands.
 - b) We proposed to locate channels based on the following order in the 26 GHz band:
 - i) in both high and low density areas we would allocate Shared Access licences starting with the first available channel from 25.10 GHz, and going down the band to 24.45 GHz, unless the prospective licensee requests specific frequencies; and
 - ii) in low density areas, once 25.10-24.45 GHz is full, we would start allocating additional Shared Access licences at the first available channel above 25.10 GHz, and work up the band, unless the prospective licensee requests specific frequencies.
 - c) For the 40 GHz band, we proposed to allocate the first available channel from 43.5 GHz down the band to 40.5 GHz.

³²⁹ Name Withheld 2 [CONFIDENTIAL ✕] [response to the March 2023 Statement and Consultation](#), pp. 5 and 8 (response to Q. 17).

³³⁰ March 2023 Statement and Consultation, para. 14.14.

³³¹ March 2023 Statement and Consultation, paras. 14.43-14.48.

Summary of responses

- 8.16 We received the following responses from stakeholders:
- a) VMO2,³³² Vodafone,³³³ Cambridge Broadband Networks Group Ltd (CBNG)³³⁴ and Nokia³³⁵ said that they agree with our proposal to make available channel sizes of 50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz.
 - b) A confidential respondent [CONFIDENTIAL ✕] made comments concerning the amount of spectrum available for Shared Access and the licence structure. We respond to those comments in paragraph 8.11 above.

Ofcom's decision

- 8.17 In light of stakeholders' comments, we have decided to make available channel sizes of 50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz, as set out in the March 2023 Statement and Consultation. We have also decided to proceed with our proposed approach in relation to the order for allocating channels in the 26 GHz and 40 GHz bands on a first come for served basis, noting that we did not receive any comments about it.

Limiting the density of low power outdoor deployments in the 24.45-25.05 GHz band

Our proposals

- 8.18 In the July 2022 statement, "[Protecting passive services at 23.6-24 GHz from future 26 GHz uses](#)",³³⁶ we decided to limit the number of outdoor 26 GHz base stations which can be deployed within any 300km² area in the lowest 800 MHz of the 26 GHz band (i.e. 24.25-25.05 GHz), in order to protect the EESS. In particular, we decided that the total interference contribution from all individual base stations operating in the lowest 800 MHz (24.25-25.05 GHz) of the 26 GHz band within any 300km² area must be equal to or lower than 0.1432 W/200 MHz.
- 8.19 In the May 2022 Consultation,³³⁷ we initially proposed to limit the number of outdoor base stations that could be deployed under each low power outdoor Shared Access licence in the bottom 800 MHz of the 26 GHz band to a maximum of two base stations.
- 8.20 In the March 2023 Statement and Consultation,³³⁸ we proposed to increase this limit from two to three outdoor base stations³³⁹ per low power outdoor Shared Access licence operating in the 24.45-25.05 GHz band on the basis that we expected: (i) a greater use of bandwidths of 200 MHz and above for Shared Access that we initially anticipated, and (ii) a smaller density of MOD deployments, relative to Shared Access deployment, across any

³³² [VMO2 response to the March 2023 Statement and Consultation](#), p. 37.

³³³ [Vodafone response to the March 2023 Statement and Consultation](#), p. 11.

³³⁴ [CBNG response to the March 2023 Statement and Consultation](#), p. 2, response to Q. 17.

³³⁵ [Nokia response to the March 2023 Statement and Consultation](#), pp. 6-7, response to Q. 17.

³³⁶ Ofcom's 4 July 2022 Statement "[Protecting passive services at 23.6-24 GHz from future 26 GHz uses](#)", para. 4.13 and Table 6.

³³⁷ [May 2022 Consultation](#), para. 8.18.

³³⁸ March 2023 Statement and Consultation, paras. 14.49-14.55.

³³⁹ A base station in this context would be a single sector antenna.

300km² area in the bottom 200 MHz of the band (24.25-24.45 GHz).³⁴⁰ We also noted that, if we found that the outdoor deployment densities were significantly lower than we had proposed or that licensees were only deploying a low number of transmitters, then we would look to review the limit.³⁴¹

Summary of responses

- 8.21 Vodafone, Cambridge Broadband Networks Group (CBNG) and Nokia expressed support for our proposed limit. Specifically:
- a) Vodafone³⁴² said that our proposal to limit low power outdoor deployments in 24.45-25.05 GHz to a maximum of three base stations per low power outdoor Shared Access licence operating in the 24.45-25.05 GHz band “strikes the right balance between rights of Shared Access Licence holders and incumbent EESS users”.
 - b) CBNG³⁴³ said that our proposal “seems to be a sensible approach”.
 - c) Nokia³⁴⁴ welcomed our revised proposal and agreed “with Ofcom that this condition should be monitored and revised to a higher number if necessary in the future, if it is found to create significant coverage obstacles for licensees in the band”. Nokia also noted that this condition, “together with the way Ofcom proposes to calculate the levels to protect the EESS operation in each 300km² will eventually act as setting up an indirect upper limit of the total number of Shared Access BSs [base stations] that can be deployed in each 300km² in the 24.45-25.05 GHz”, which “may also reduce or cap the availability of licences in specific areas in the long term”.

Ofcom’s decision

- 8.22 In light of the support for our revised proposal, we have decided to permit a maximum number of three outdoor base stations per low power outdoor Shared Access licence operating in the 24.45-25.05 GHz band. As set out in the March 2023 Statement and Consultation,³⁴⁵ any stakeholders wishing to deploy greater numbers of outdoor transmitters can do so by either:
- a) applying for another licence at the same location and frequency;
 - b) in a low density area, applying for a licence above 25.05 GHz where there are no deployment restrictions; or
 - c) in a high density area, applying for a licence of no more than 50 MHz in the 25.05-25.10 GHz band where there are no deployment restrictions.

³⁴⁰ March 2023 Statement and Consultation, para. 14.52.

³⁴¹ March 2023 Statement and Consultation, para. 14.55.

³⁴² Vodafone, p. 11.

³⁴³ CBNG, p. 3, response to Q. 18.

³⁴⁴ Nokia, p. 7, response to Q. 18.

³⁴⁵ March 2023 Statement and Consultation, para. 14.54.

Fees

Our proposals

- 8.23 In the May 2022 Consultation,³⁴⁶ we proposed that we would adopt a cost-based approach to setting licence fees, but that, as with some other cost-based licences, fees would also reflect the amount of spectrum allocated (in this case by setting the fee on a per-MHz basis).³⁴⁷
- 8.24 In the March 2023 Statement and Consultation,³⁴⁸ we confirmed that our provisional view was to adopt the existing approach for setting fees under our current Shared Access licensing framework (i.e., cost-based fees varying in proportion to the amount of spectrum requested by the applicant) and consulted on the precise fee level. Assuming that the average bandwidth requested for the Shared Access licences would be 400 MHz, we proposed to set the fee for 400 MHz of 26 GHz and 40 GHz spectrum at £320 per year (i.e., £80 per 100 MHz). Table 8.1 below sets out the fees we proposed in the March 2023 Statement and Consultation.

Table 8.1: The cost-based fees per annum we proposed in March 2023

Bandwidth	Fee
50 MHz	£40
100 MHz	£80
200 MHz	£160
400 MHz	£320
800 MHz	£640

Summary of responses

- 8.25 We received the following responses from stakeholders:
- A confidential respondent [CONFIDENTIAL ✕]³⁴⁹ said that “[c]osting should be maintained to realistic administrative values in order to allow neutral hosts to run their business with feasible expenditure” and that “[t]he larger ends of the spectrum at 400MHz and 800 MHz are arguably more costly than necessary in this regard”.
 - Vodafone³⁵⁰ said that it has no further comments on the level of the fees and referred to its comments in response to Question 7 of Ofcom’s March 2023 [Call for Inputs on Shared Access licensing](#), (“**Shared Access CFI**”) regarding the need for “bulk invoicing”.³⁵¹ In this response Vodafone said that as the volume of Shared Access licences increases, having

³⁴⁶ May 2022 Consultation, paras. 8.29-8.31.

³⁴⁷ In the 1800 MHz, 2300 MHz and 3.8-4.2 GHz bands, fees are charged by spectrum allocated. In the 26 GHz band, there is currently a standard annual fee of £320 per licence, regardless of spectrum requested up to the 200 MHz limit.

³⁴⁸ March 2023 Statement and Consultation, paras. 14.66-14.68.

³⁴⁹ Name Withheld 2 [CONFIDENTIAL ✕], p. 8, response to Q. 19.

³⁵⁰ Vodafone, p. 11.

³⁵¹ [Vodafone’s response to the Shared Access CFI](#), p. 4.

an annual invoice for each licence is inefficient for both Ofcom and licensees. It suggested a single annual invoice for all licences, as is the case with Fixed Links licences.

Ofcom's decision

- 8.26 In relation to the confidential respondent's concern that the fees for larger bandwidths (i.e., £320 for 400 MHz and £640 for 800 MHz) would be "more costly than necessary", we believe that the level of fee we proposed is appropriate. Based on the limited information currently available for the 26 GHz and 40 GHz bands, we consider it reasonable to assume that the average bandwidth would be 400 MHz (as proposed in the March 2023 Statement and Consultation).³⁵² We believe that the fee of £320 for 400 MHz is cost-reflective and that this amount is reflective of our average incurred direct and system development costs.³⁵³ We believe that the £640 per annum cost for an 800 MHz channel is unlikely to deter deployment of neutral hosts as we believe most licensees will not have a requirement for such large channel sizes.
- 8.27 As set out in Table 8.1 above we proposed that a 50 MHz channel would cost £40. We have however decided to implement a minimum fee of £80 for all licences. A fee lower than this may not sufficiently recover the costs incurred to Ofcom of processing an application. As a result of this licences with bandwidths of 100 MHz or less will cost £80. This is consistent with the current fee regime for Shared Access licences.
- 8.28 We are in the process of reviewing aspects of our Shared Access licensing approach, in light of responses to Shared Access CFI, which highlighted the issues surrounding fees.³⁵⁴ As set out in the March 2023 Statement and Consultation,³⁵⁵ if we do find that there is a need to amend the fee level for the Shared Access licences, we will consult on any proposals for revised fees for 26 GHz and 40 GHz alongside other proposed changes to the fees in the other Shared Access bands.

Non-technical licence conditions

- 8.29 In the March 2023 Statement and Consultation,³⁵⁶ we said that we were minded to apply the standard non-technical licence conditions for the Shared Access framework (which are described in our [guidance document](#)) to the Shared Access licences that we would make available in 26 GHz and 40 GHz bands. Having received no further comments on such conditions, we have decided to apply them. For ease of reference, we set out these conditions below.

Licence duration

- 8.30 In accordance with the other Shared Access licences, the Shared Access licences for the 26 GHz and 40 GHz band will be issued for an indefinite duration, subject to the payment of an annual licence fee and a revocation period of one month. Short-term licences for less

³⁵² March 2023 Statement and Consultation, para. 14.66.

³⁵³ The fee level of £80 per 100 MHz that we have decided to apply to the Shared Access licences in the 26 GHz and 40 GHz bands is lower than the fee level applying to most of the other Shared Access licence bands.

³⁵⁴ Shared Access CFI, paras. 3.7-3.8.

³⁵⁵ March 2023 Statement and Consultation, para. 14.68.

³⁵⁶ March 2023 Statement and Consultation, paras. 14.27-14.42.

than one year will be permitted and will be charged on a pro-rata basis subject to a minimum fee of £80 per licence.

Revocation for spectrum management reasons

8.31 Ofcom can revoke a Shared Access licence for spectrum management purposes, subject to a minimum revocation notice period of one month. Should we consider repurposing the band for an alternative use, we will give all licensees a reasonable notice period of our intention to do so. 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.³⁵⁷

‘Use it or lose it’ clause

8.32 Licensees are required to start transmission within six months of the issue of their licence and remain operational thereafter.³⁵⁸

Access and inspection

8.33 In accordance with our standard spectrum licence conditions, the new Shared Access licences will include a condition giving Ofcom the power to access and inspect the licensee’s radio equipment. This is so we can check the licensee’s compliance with the terms of its licence, if necessary.³⁵⁹

Modification, restriction and closedown

8.34 The new Shared Access licences will also include a condition that gives Ofcom the power to require the licensee to modify, restrict or close down the use of its radio equipment, should we have reasonable grounds to believe that the licensee has breached the terms of its licence, or we consider this necessary in the event of a national or local state of emergency being declared.³⁶⁰

Geographical boundaries

8.35 We plan to allow use of equipment within the United Kingdom and its territorial seas. The new authorisation could also extend to the Channel Islands and the Isle of Man, subject to further discussions with the relevant authorities. In most cases, low power licensees will be able to deploy any number of base stations within a 50m radius from the licensed location. However, licensees in operating in the 24.45-25.05 GHz band will be restricted to three outdoor base stations.

Provision of information and record-keeping condition

8.36 The new Shared Access licences will include standard conditions to require licensees to provide us, on request, with general information regarding their equipment and use of frequencies, or the rollout of their network. Licensees will be required to maintain a record of the address and certain transmitter parameters for all base station or fixed terminal deployments.³⁶¹

³⁵⁷ September 2022 Guidance Document, para. 5.12.

³⁵⁸ September 2022 Guidance Document, para. 5.11.

³⁵⁹ September 2022 Guidance Document, para. 5.19.

³⁶⁰ September 2022 Guidance Document, paras. 5.19-5.21.

³⁶¹ September 2022 Guidance Document, paras. 5.16-5.18.

Changing transmission frequencies

8.37 Licensees could also be required to change their transmission frequency, as notified by Ofcom from time to time. Licensees should ensure their equipment can operate using a range of frequencies when requesting channels in the relevant band.³⁶²

Trading

8.38 In line with our Shared Access licensing framework,³⁶³ we have decided to allow licensees to trade their spectrum rights under the Shared Access licences for the 26 GHz and 40 GHz bands. We would only permit trades of the entire licence, either outright to another party or concurrently with the licence being jointly held by the licensee and another party. Partial trades of spectrum would not be permitted.

Conclusion and next steps

8.39 Having considered stakeholders' comments, we have decided to make low and medium power Shared Access licences available in both the 24.45-27.5 GHz band (with effect from early 2024) and the 40.5-43.5 GHz band (with effect from June 2028) and to apply the same standard non-technical licence conditions as the Shared Access licences.

8.40 Taking into account the decisions relating to the technical licence conditions (Section 7) and coordination requirements (Section 4), we have summarised the licence conditions which we will apply to the Shared Access licences for the 26 GHz (Table 8.2) and 40 GHz (Table 8.3) bands. A draft of the Shared Access licences, which reflects our decisions, is provided in Annex 5.³⁶⁴

Table 8.2: High level summary of the conditions for Shared Access in the 26 GHz band

Parameters	Low power	Medium power
Non-technical terms and conditions	Same as existing Shared Access licences issued in other frequency bands.	Same as existing Shared Access licences issued in other frequency bands.
Frequency	24.45-27.5 GHz	24.45-27.5 GHz
Permitted locations	Low density areas High density areas only in 24.45-25.1 GHz	Low density areas only
Permitted deployment	24.45-27.5 GHz Indoor / Outdoor	24.45-27.5 GHz Indoor / Outdoor
Authorised channel sizes	50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz	50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz
Fees	£80 per 100 MHz	£80 per 100 MHz

³⁶² September 2022 Guidance Document, paras. 5.22-5.23.

³⁶³ September 2022 Guidance Document, paras. 5.14-5.15.

³⁶⁴ We have also made some minor editorial changes, such as omitting redundant definitions.

Parameters	Low power	Medium power
Maximum device power (TRP)	Base station: 25 dBm/200 MHz Terminal station: 23 dBm	Base station: 36 dBm/200 MHz Terminal station: 23 dBm
Maximum TRP out of band limits	Up to 50 MHz below or above an assigned block: 12 dBm/50 MHz Within 24.45-27.5 GHz: 4 dBm/50 MHz Within 23.6-24.0 GHz: -39 dBW/200 MHz (Base station) -35 dBW/200 MHz (Terminal station)	Up to 50 MHz below or above an assigned block: 12 dBm/50 MHz Within 24.45-27.5 GHz: 4 dBm/50 MHz Within 23.6-24.0 GHz: -39 dBW/200 MHz (Base station) -35 dBW/200 MHz (Terminal station)
Other conditions	When deploying Active Antenna System (AAS) outdoor base stations, Licensees transmitting in 24.25-27.5 GHz shall ensure that each antenna is normally transmitting only with main beam pointing below the horizon and in addition the antenna shall have mechanical pointing below the horizon except when the base station is only receiving. Deployments in 24.45-25.05 GHz restricted to 3 outdoor base stations (sector antenna equates to a base station) per licence. Outdoor antennas limited to 10 metres height above ground.	When deploying Active Antenna System (AAS) outdoor base stations, Licensees transmitting in 24.25-27.5 GHz shall ensure that each antenna is normally transmitting only with main beam pointing below the horizon and in addition the antenna shall have mechanical pointing below the horizon except when the base station is only receiving.

Table 8.3: High level summary of the conditions for Shared Access in the 40 GHz band

Parameters	Low power	Medium power
Non-technical terms and conditions	Same as existing Shared Access licences issued in other frequency bands.	Same as existing Shared Access licences issued in other frequency bands.
Frequency	40.5-43.5 GHz	40.5-43.5 GHz
Permitted locations	Low density areas only	Low density areas only
Permitted deployment	Indoor or outdoor	Indoor or outdoor

Parameters	Low power	Medium power
Authorised channel sizes	50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz	50 MHz, 100 MHz, 200 MHz, 400 MHz and 800 MHz
Fees	£80 per 100 MHz	£80 per 100 MHz
Maximum device power (TRP)	Base station: 25 dBm/200 MHz Terminal station: 23 dBm	Base station: 36 dBm/200 MHz Terminal station: 23 dBm
Maximum TRP out of band limits	Up to 50 MHz below or above an assigned block: 12 dBm/50 MHz Within 40.5-43.5 GHz: 4 dBm/50 MHz	Up to 50 MHz below or above an assigned block: 12 dBm/50 MHz Within 40.5-43.5 GHz: 4 dBm/50 MHz
Other conditions	When deploying Active Antenna System (AAS) outdoor base stations, Licensees transmitting in 42.5-43.5 GHz shall ensure that each antenna is normally transmitting only with main beam pointing below the horizon and in addition the antenna shall have mechanical pointing below the horizon except when the base station is only receiving. Outdoor antennas limited to 10 metres height above ground.	When deploying Active Antenna System (AAS) outdoor base stations, Licensees transmitting in 42.5-43.5 GHz shall ensure that each antenna is normally transmitting only with main beam pointing below the horizon and in addition the antenna shall have mechanical pointing below the horizon except when the base station is only receiving.

9. Other comments

Summary

- 9.1 In this Section we summarise and respond to the comments we received in response to the March 2023 Statement and Consultation which were outside the scope of our specific consultation questions.

Competition Assessment

Our decision

- 9.2 In Section 8 of the March 2023 Statement and Consultation we set out our decision not to impose any competition measures (e.g. spectrum caps) in the mmWave auction. We reached a decision on this in our March 2023 Statement and Consultation, having taken account of stakeholders' responses to the May 2022 Consultation.

VMO2's comments

- 9.3 In its response to our March 2023 Statement and Consultation, VMO2³⁶⁵ reiterated that we should impose a precautionary cap of 1 GHz per operator per band in the auction of citywide licences. VMO2³⁶⁶ had previously supported such a cap in its response to the May 2022 Consultation.
- 9.4 We have considered VMO2's further submission on the need for a precautionary cap. We do not consider that any of VMO2's comments provide a basis for revisiting our decision on this point since VMO2 has not raised any new material issue which we had not already considered in our March 2023 Statement and Consultation.

Timing of the Award

Our decisions

- 9.5 We set out in the March 2023 Statement and Consultation³⁶⁷ that we intend to hold the auction in Q1 of FY 2024/25 and for Shared Access licences in the 26 GHz band to be available at the same time.

Summary of responses

- 9.6 Stakeholders expressed mixed views in relation to the timing of the award:
- a) BT/EE³⁶⁸ said that it "supports Ofcom's plans to enable use of mmWave spectrum for mobile in 2024" and is "content with Ofcom's timetable";

³⁶⁵ [VMO2 response to the March 2023 Statement and Consultation](#), pp. 5-10.

³⁶⁶ [VMO2 response to the May 2022 Consultation](#), pp. 27-28.

³⁶⁷ [March 2023 Statement and Consultation](#), para. 1.35.

³⁶⁸ [BT/EE response to the March 2023 Statement and Consultation](#), p. 2.

- b) H3G³⁶⁹ said we should delay the auction until mmWave requirements are clearer to ensure an efficient outcome, in particular because bidders do not yet have a clear view on their mmWave requirements, and the 40 GHz ecosystem is unclear.
- c) [CONFIDENTIAL ✂]³⁷⁰
- d) VMO2³⁷¹ said that if the Vodafone/H3G merger is announced, delaying the auction for “[a]llowing for a merger clearance” would be “acceptable”, “especially given that this spectrum allocation will not have any near-term impact on competition, and a delay will give MNOs more time to study the emerging ecosystem”;
- e) Qualcomm³⁷² said we should aim to make the spectrum available earlier, in 2023.
- f) Ericsson³⁷³ said that “[it] might be difficult for service providers to make an informed judgement on the availability of 40GHz spectrum band given the immaturity of the supporting eco-system”.
- g) Nokia³⁷⁴ said that “while making the 40 GHz band available at the same time as the 26 GHz band would be good to have to promote innovation”, “the 26 GHz band should, at this stage, be the priority band since the ecosystem around it is more mature”.

Ofcom’s decision

- 9.7 In June 2023, H3G and Vodafone announced their intention to merge their UK operations, subject to regulatory approvals. The CMA’s decision on the proposed merger is expected in September 2024.
- 9.8 After careful consideration, given these specific circumstances, to avoid the risk of an inefficient allocation of spectrum, we have decided to delay commencing the auction process. Therefore, we will not commence the auction process until the CMA has taken its decision on the proposed merger. We therefore do not expect the award process to begin before Q3 FY 2024/25.
- 9.9 Notwithstanding our decision to delay the auction, we plan to make Shared Access licences available in the 26 GHz band early next year.

High density areas

Ofcom’s decision

- 9.10 In Section 4 of the March 2023 Statement and Consultation, we decided to designate 68 cities, major towns and transport hubs as ‘high density areas’. We made this decision in light of stakeholders’ comments on our initial proposals, on which we consulted in May 2022, to designate only 40 high density areas.

Stakeholders’ comments

- 9.11 Although we had concluded our considerations on the definition of high density areas in our March 2023 Statement and Consultation, and therefore did not ask for further comments on

³⁶⁹ [H3G response to the March 2023 Statement and Consultation](#), pp. 3-4.

³⁷⁰ [CONFIDENTIAL ✂]

³⁷¹ VMO2, pp. 3-4.

³⁷² [Qualcomm response to the March 2023 Statement and Consultation](#), p. 1.

³⁷³ [Ericsson response to the March 2023 Statement and Consultation](#), p. 2.

³⁷⁴ [Nokia response to the March 2023 Statement and Consultation](#), p. 2, response to Q. 1.

this subject, H3G³⁷⁵ nevertheless argued in its response that we should increase the number and size of high density areas and make them larger, [CONFIDENTIAL ✕].

- 9.12 Similarly, VMO2³⁷⁶ said that our designated high density areas excluded “several ‘large urban’ areas and important locations”, including several dense urban areas, 3 of the top 19 airports, the top 13 ports, and key ‘staycation’ areas.
- 9.13 We have reviewed H3G’s and VMO2’s comments on the areas we have decided to designate as high density areas. We do not consider that any of H3G’s or VMO2’s comments provide a basis for revisiting our decision on this point since they have not raised any new material issue which we had not already considered in our March 2023 Statement and Consultation.

Authorisation and use cases

- 9.14 A confidential respondent [CONFIDENTIAL ✕]³⁷⁷ commented on the characteristics and use cases of mmWave spectrum, and highlighted his views on the five most useful applications for mmWave spectrum: ‘Giga Zones’, ‘Fast Kiosk Download Stations’, ‘Local Level Multicast solutions, backhaul/fronthaul with fixed links, and backhaul in rail transportation’. This respondent’s view was that these use cases should rely on a neutral host, or at least some substantial degree of shared network infrastructure and spectrum.
- 9.15 We set out our decisions on how we would authorise use of the 26 GHz band in Section 3 of the March 2023 Statement and Consultation, and our decisions on the authorisation of the 40 GHz band are set out in Section 2 of this document. We note that we do not authorise specific use cases, and so our decisions on how to make this spectrum available do not preclude any of the use cases specified by this respondent. In addition, we note that we are making spectrum available on both a Shared Access basis, and through our Local Access licensing framework, as well as auctioned citywide licences. This is in order to enable a variety of different users to access this spectrum.

³⁷⁵ H3G, p. 1.

³⁷⁶ VMO2, p.11.

³⁷⁷ Name Withheld 2 [CONFIDENTIAL ✕] [response to the March 2023 Statement and Consultation.](#)

A1 Legal framework

A1.1 Ofcom's statutory powers and duties in relation to spectrum management are set out primarily in the [Communications Act 2003](#) (the "2003 Act") and the [Wireless Telegraphy Act 2006](#) (the "WT Act").

Duties under the Communications Act 2003

A1.2 Our principal duties under the 2003 Act, when carrying out our functions and exercising our powers, are to further the interests of citizens and consumers, where appropriate by promoting competition. In doing so, we are also required (among other things) to secure the optimal use of spectrum and the availability throughout the United Kingdom of a wide range of electronic communications services.

A1.3 We must also have regard to: (i) the desirability of promoting competition in relevant markets; (ii) the desirability of encouraging investment and innovation in relevant markets; (iii) the desirability of ensuring the security and availability of public electronic communications networks and services; (iv) the different needs and interests, so far as the use of the electro-magnetic spectrum for wireless telegraphy is concerned, of all persons who may wish to make use of it; and (v) the different interests of persons in the different parts of the United Kingdom, of the different ethnic communities within the United Kingdom and of persons living in rural and in urban areas.

A1.4 In performing our duties, we are required under section 3(3) of the 2003 Act to have regard in all cases to the principles under which regulatory activities should be transparent, accountable, proportionate, consistent and targeted only at cases in which action is needed, and any other principles appearing to Ofcom to represent the best regulatory practice.

A1.5 In carrying out certain regulatory functions, including Ofcom's spectrum management functions, section 4 of the 2003 Act requires Ofcom to act in accordance with the following requirements: a) to promote competition in communications markets; b) to promote the interests of all members of the public in the United Kingdom; c) to act in a manner which, so far as practicable, is technology neutral;³⁷⁸ d) to encourage, to the extent Ofcom considers it appropriate, the provision of network access and service interoperability for the purpose set out in s.4(8);³⁷⁹ e) to encourage such compliance with certain international standards as is necessary for the purposes set out in s.4(9);³⁸⁰ and f) to promote connectivity and access to very high capacity networks by members of the public and businesses in the United Kingdom.

³⁷⁸ According to s.4(6A) of the 2003 Act, this requirement does not apply to the imposition, in relation to a wireless telegraphy licence, of a limitation of a kind falling within section 9ZA(1) of the WT Act; or (b) the review, variation or removal of such a limitation.

³⁷⁹ The purpose of securing: (i) efficiency and sustainable competition, (ii) efficient investment and innovation, and (iii) the maximum benefit for the customers of communications providers and of persons who make associated facilities available.

³⁸⁰ For facilitating service interoperability, end-to-end connectivity, the changing by end-users of their communications provider, the retention by end-users of their telephone numbers after a change of communications provider; and securing freedom of choice for the customers of communications providers.

Duties under the Wireless Telegraphy Act 2006

- A1.6 Additionally, in carrying out our spectrum functions we have a duty under section 3 of the WT Act to have regard in particular to: (i) the extent to which the spectrum is available for use, or further use, for wireless telegraphy; (ii) the demand for use of that spectrum for wireless telegraphy; and (iii) the demand that is likely to arise in future for such use.
- A1.7 We also have a duty to have regard to the desirability of promoting: (i) the efficient management and use of the spectrum for wireless telegraphy; (ii) the economic and other benefits that may arise from the use of wireless telegraphy; (iii) the development of innovative services; and (iv) competition in the provision of electronic communications services.

Harmonised technical conditions

The 26 GHz band

- A1.8 Certain European decisions continue to have effect in domestic UK law, following the UK's exit from the EU, by virtue of section 3 of The European Union (Withdrawal) Act 2018. These include, in particular, the Implementing Decision issued by the European Commission in 2019 to open up the 26 GHz band for wireless broadband under harmonised technical conditions, which was then amended in 2020 (the “**26 GHz Decision**”).³⁸¹
- A1.9 The 26 GHz Decision harmonises the essential technical conditions for the availability and efficient use of the 24.25-27.5 GHz frequency band (the “**26 GHz band**”) in the European Union for terrestrial systems capable of providing wireless broadband electronic communications services (Art. 1) and requires the UK (and the EU Member States) to designate and make available on a non-exclusive basis that frequency band for such systems by 30 June 2020 (Art. 2). Alongside this requirement, Art. 54(1)(b) of the European Electronic Communications Code (EECC)³⁸² requires Member States to make at least 1 GHz of the 26 GHz spectrum available by 31 December 2020, provided that there is clear evidence of market demand and of the absence of significant constraints for migration of existing users or band clearance. However, in light of Ofcom making the lower 26 GHz band (24.25-26.5 GHz) available for Shared access licences for low power indoor use,³⁸³ art. 54(1)(b) of the EECC was not transposed into UK law.³⁸⁴
- A1.10 The 26 GHz Decision also contains provisions about the co-existence between terrestrial systems for wireless broadband and other spectrum users. In particular:
- a) it should be analysed at national level whether it is necessary to impose additional technical conditions to ensure appropriate co-existence with other services in the band (Art. 2);
 - b) terrestrial systems for wireless broadband must appropriately protect other spectrum users operating in the same band or adjacent bands, including certain earth exploration

³⁸¹ See this [unofficial consolidated version of Decision 2019/784, as amended by Decision 2020/590](#). The UK version of this legislation is set out in S.I. [784/2019](#) and S.I. [590/2020](#)

³⁸² A consolidated version of the European Electronic Communications Code is available [here](#).

³⁸³ Ofcom's 25 July 2019 Statement “[Enabling wireless innovation through local licensing](#)”, para 5.3.

³⁸⁴ DCMS's 22 July 2020 “[Government response to the public consultation on implementing the European Electronic Communications Code](#)”, pp. 35-36.

- satellite services, radio astronomy services, space research services and satellite systems (Art. 3);
- c) fixed links may be allowed to continue to operate within the band, if the terrestrial systems for wireless broadband can co-exist with them through managed shared spectrum use (Art. 4);
 - d) the number and locations of new earth stations must be determined so as not to impose disproportionate constraints on terrestrial systems for wireless broadband. Subject to market demand, the continued deployment of earth stations must be made possible for certain uses within the 26 GHz band (Art. 5); and
 - e) the progress on co-existence should be monitored, and the findings reported to the European Commission to allow for a timely review of the 26 GHz Decision (Art. 7).
- A1.11 Cross-border coordination agreements should be facilitated to enable the operation of terrestrial systems for wireless broadband (Art. 6).

The 40 GHz band

- A1.12 In April 2020, the European Commission issued a mandate to the European Conference of Postal and Telecommunications Administrations (“CEPT”), asking CEPT to develop least restrictive harmonised technical conditions allowing use of the 40.5-43.5 GHz band for terrestrial wireless systems capable of providing wireless broadband electronic communications services.³⁸⁵ On 18 November 2022, CEPT published a report (“CEPT Report 82”) in response to that mandate and the Electronic Communications Committee (“ECC”) published a decision (“ECC Decision (22)06”)³⁸⁶ reflecting CEPT’s harmonised conditions.³⁸⁷
- A1.13 CEPT Report 82 will form the basis of a harmonising Commission Decision, which is currently in draft form.³⁸⁸ For the avoidance of doubt, any final Commission Decision will not be part of UK law. However, Ofcom may consider it appropriate to authorise spectrum use of the relevant frequencies on the basis of technical conditions reflecting the CEPT harmonisation (to which the UK has contributed).

Ofcom’s licensing framework

- A1.14 Ofcom is responsible for authorising use of the radio spectrum. We permit the use of the radio spectrum either by granting wireless telegraphy licences under the WT Act or by making regulations exempting the use of particular equipment from the requirement to hold such a licence. It is unlawful and an offence to install or use wireless telegraphy apparatus without holding a licence granted by Ofcom, unless the use of such equipment is exempted.³⁸⁹
- A1.15 The decisions set out in this document concern (among other things) our approach to existing users of the 26 GHz and 40 GHz bands and the licence conditions to be included in any future licence authorising use of these bands for 5G and other wireless services. Below

³⁸⁵ [CEPT Report 78, annex 1.](#)

³⁸⁶ [ECC Decision \(22\)06.](#)

³⁸⁷ [CEPT Report 82.](#)

³⁸⁸ A [draft of the Commission Implementing Decision](#), dated 7 December 2022, is available. Discussions as to potential harmonisation measures and timescales are still ongoing in the EU.

³⁸⁹ Section 8 of the WT Act.

we explain the legal framework under which we can impose conditions in new spectrum licences and revoke or vary existing licences.

Licence conditions

A1.16 A wireless telegraphy licence may be granted subject to such terms, provisions and limitations as Ofcom think fit (WT Act, s. 9(1)). However, this power is subject to certain constraints. In particular:

- a) the terms, provisions and limitations of a spectrum licence must not duplicate the obligations already imposed on the licensee by the general conditions set by Ofcom under section 45 of the Communications Act 2003 (WT Act, s. 9(6));³⁹⁰ and
- b) Ofcom may only impose terms, provisions and limitations which are: a) objectively justified in relation to the network and services to which they relate; b) not unduly discriminatory; c) proportionate to what they are intended to achieve; and d) transparent in relation to what they are intended to achieve (WT Act, s. 9(7)).

A1.17 Section 9(4) of the WT Act sets out a non-exhaustive list of the terms, provisions and limitations that Ofcom may impose.

A1.18 Examples of conditions that we may impose in spectrum licences under s.9 WT Act include:

- a) limitations as to the position and nature of a station (s.9(2)(a));
- b) limitations as to the apparatus that may be installed or used (s.9(3)); and
- c) terms, provisions and limitations as to strength or type of signal, as to times of use and as to the sharing of frequencies (s.9(4)(a)).

Ofcom's powers to vary or revoke licences granted under the WT Act

A1.19 Ofcom has a broad discretion under paragraph 6 of Schedule 1 of the 2006 Act to vary or revoke licences, subject to certain limitations. Specifically, the legislation provides that Ofcom may not vary or revoke a licence unless the proposed variation or revocation is objectively justifiable (WT Act 2006, para. 6A of Sch. 1). 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 (2003 Act, s.3(3)). Ofcom must act in accordance with its statutory duties and general legal principles, including the duties to act reasonably and rationally when making decisions and to take account of any legitimate expectations.³⁹¹

A1.20 Schedules 1 of the WT Act set out the process which Ofcom must follow where it proposes to vary or revoke a wireless telegraphy licence. In summary, Ofcom is required to take the following steps (WT Act, para. 7 of Sch. 1):

- a) notify the licensee of the reasons for the proposed variation or revocation;
- b) specify a period of at least 30 days in which the licensee may make representations about the proposal; and

³⁹⁰ Ofcom's webpage "[General Conditions of Entitlement](#)".

³⁹¹ Further potential limitations may derive from (i) any UK obligations under international agreements, particularly where use of spectrum has been harmonised, and (ii) any ministerial direction under section 5 of the 2003 Act or section 5 of the WT Act.

- c) decide whether or not to vary or revoke the licence within one month of the end of that period.
- A1.21 Where a proposal to vary or revoke a wireless telegraphy licence is made with the consent of the licensee, Ofcom is not required to follow the above process.
- A1.22 Ofcom may include in a wireless telegraphy licence terms restricting the exercise of its power to revoke or vary licences (WT Act, para. 8 of Sch. 1), such as requiring a certain notice period for revoking a licence for spectrum management reasons. However, Ofcom may at any time revoke or vary a licence if it appears to be necessary or expedient in the interests of national security, or for the purpose of securing compliance with an international obligation (WT Act, para. 8(5) of Sch. 1).

Licence awards

- A1.23 Ofcom may allocate spectrum by way of auctions having regard to the desirability of promoting the optimal use of spectrum (WT Act, s. 14). In making auction regulations, Ofcom must satisfy itself that the criteria for spectrum allocation are:
 - A1.24 objectively justifiable in relation to the frequencies to which they relate;
 - A1.25 not such as to discriminate unduly against particular persons or against a particular description of persons;
 - A1.26 proportionate to what they are intended to achieve; and
 - A1.27 in relation to what they are intended to achieve, transparent (WT Act, s.14(3B)).
- A1.28 Auction regulations may make provisions with respect to the grant of the relevant licences and also the terms, provisions and limitations subject to which such licences are granted (WT Act, s. 14(2) and s. 14(3)(h)). When designing competitive awards, Ofcom may impose a specified level of use requirement if doing so would promote the optimal use of spectrum (WT Act, s.14(3C)).

A2 Fixed links in the 26 GHz band for revocation

- A2.1 In the March 2023 Statement and Consultation (section 5), we decided that we would start the process to revoke fixed links which are authorised to use the 26 GHz band, and which operate (a) in high density areas (i.e., any link where either station, or any part of the link pathway, overlaps with any high density area), or (b) around high density areas such that they are likely to receive interference from new mobile users operating in high density areas. We proposed a method (which we detailed in [annex 16](#) of that document)³⁹² for identifying the fixed links around high density areas which would be likely to receive harmful interference.
- A2.2 In Annex A18 to the March 2023 Statement and Consultation, we provided an initial list of:
- The fixed links operating in the 26 GHz band in high density areas.
 - The fixed links operating in the 26 GHz band outside of high density areas, which our initial coexistence analysis suggested would be likely to receive interference from new mobile users operating in high density areas.
- A2.3 Having now decided to proceed with our proposed method for identifying which links around high density areas are likely to receive harmful interference (with the changes described in section 3), we set out below an updated list of the fixed links operating in the 26 GHz band (as of 10 July 2023) that we consider likely to receive harmful interference from new mobile users in high density areas. This revised list takes account of (i) the fixed links that have been removed from the 26 GHz band since January 2023, which we have now omitted, and (ii) the changes to our method for identifying which links around high density areas are likely to receive harmful interference described in section 3.
- A2.4 We will begin the statutory process to revoke the point-to-point fixed link licences authorising use of these links shortly.

Table A2.1: 26 GHz fixed links operating in high density areas, i.e. where either base station or any part of the link pathway overlaps with a high density area

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
1149788/1	12H AG	SU 94760 81382	SU 98194 79795
0497880/3	Airwave Solutions Limited	SK 50350 43550	SK 49300 39736
0498836/4	Airwave Solutions Limited	TL 56275 29927	TL 56090 23517
0502181/3	Airwave Solutions Limited	SP 31420 83180	SP 33575 80940
0508330/3	Airwave Solutions Limited	SP 75681 60723	SP 75216 57393
0508914/3	Airwave Solutions Limited	NJ 86297 13645	NJ 91072 08073
0508921/2	Airwave Solutions Limited	SP 56732 10510	SP 49868 13043
0509041/3	Airwave Solutions Limited	NS 52380 56761	NS 48850 59001
0509579/3	Airwave Solutions Limited	SE 04413 30690	SE 07795 25380
0509610/3	Airwave Solutions Limited	SO 95674 85947	SO 96065 78568
0509613/2	Airwave Solutions Limited	SO 91641 85633	SO 90080 84620

³⁹² March 2023 Statement and Consultation, paras. A16.34–A16.49.

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
0509807/4	Airwave Solutions Limited	NT 27106 65189	NT 24960 69480
0509808/4	Airwave Solutions Limited	NT 27106 65189	NT 22188 61934
0509809/3	Airwave Solutions Limited	NT 38165 71355	NT 30860 70820
0509821/4	Airwave Solutions Limited	NT 25681 73468	NT 24960 69480
0510215/3	Airwave Solutions Limited	SP 56800 10300	SP 54449 06173
0511197/3	Airwave Solutions Limited	SK 26799 94025	SK 30768 95256
0511201/3	Airwave Solutions Limited	SE 33020 21195	SE 29261 25868
0511380/3	Airwave Solutions Limited	SE 15580 28780	SE 18364 30586
0511381/4	Airwave Solutions Limited	SE 13350 34590	SE 17367 32258
0511382/4	Airwave Solutions Limited	SE 16400 37400	SE 15281 40035
0511383/4	Airwave Solutions Limited	SE 20315 40250	SE 15281 40035
0512183/2	Airwave Solutions Limited	TQ 03684 75569	TQ 01850 67501
0512220/5	Airwave Solutions Limited	TQ 07416 76034	TQ 07286 78420
0512222/4	Airwave Solutions Limited	TQ 18998 85563	TQ 15625 88130
0512341/6	Airwave Solutions Limited	TQ 19747 65958	TQ 20419 66893
0513313/2	Airwave Solutions Limited	TQ 29700 90100	TQ 30685 90110
0526467/3	Airwave Solutions Limited	SE 19337 34525	SE 23720 35070
0533382/3	Airwave Solutions Limited	SD 31836 11119	SD 31265 12276
0533384/2	Airwave Solutions Limited	SD 31836 11119	SD 30874 08213
0533390/3	Airwave Solutions Limited	SJ 35812 88824	SJ 35312 81754
0567039/2	Airwave Solutions Limited	SE 07605 13839	SE 08502 16420
0578151/1	Airwave Solutions Limited	TQ 58140 94810	TQ 59744 94020
0578153/2	Airwave Solutions Limited	TQ 58140 94810	TQ 59114 91527
0612151/1	Airwave Solutions Limited	SJ 80390 84900	SJ 75890 78960
0612857/1	Airwave Solutions Limited	SD 69560 06490	SD 66000 14900
0613538/1	Airwave Solutions Limited	SD 98710 05015	SD 97196 06508
0621321/2	Airwave Solutions Limited	TQ 32785 80840	TQ 33460 84860
0734798/1	Airwave Solutions Limited	SE 10200 21675	SE 07795 25380
0782833/1	Airwave Solutions Limited	SJ 46805 93643	SD 52232 01849
0810901/1	Airwave Solutions Limited	TQ 29700 90100	TQ 24750 96340
0817910/2	Airwave Solutions Limited	TQ 31679 79756	TQ 28966 81542
0830150/1	Airwave Solutions Limited	TQ 36180 85750	TQ 36675 83799
0830152/1	Airwave Solutions Limited	TQ 28025 81725	TQ 27110 81760
0836489/2	Airwave Solutions Limited	SP 01055 85318	SO 96065 78568
0841433/1	Airwave Solutions Limited	TQ 40087 81635	TQ 38620 83880
0841870/1	Airwave Solutions Limited	TQ 40820 91734	TQ 42829 93015
0885331/1	Airwave Solutions Limited	SE 11078 14090	SE 08502 16420
0888826/1	Airwave Solutions Limited	SE 16439 37437	SE 15141 37774
0987931/2	Airwave Solutions Limited	SJ 96567 52771	SJ 90728 54316
0987933/1	Airwave Solutions Limited	SJ 85755 52021	SJ 90728 54316
0987935/2	Airwave Solutions Limited	SJ 85755 52021	SJ 87186 48455
0987970/2	Airwave Solutions Limited	SD 60759 06533	SD 58080 05680
0988406/2	Airwave Solutions Limited	SE 26052 37025	SE 25491 39904
0988408/1	Airwave Solutions Limited	SE 30896 39493	SE 35180 37405
0988420/1	Airwave Solutions Limited	SE 23052 39458	SE 25490 39903
0990374/1	Airwave Solutions Limited	SJ 38399 96699	SJ 38309 91819
0990378/2	Airwave Solutions Limited	SJ 38436 96749	SJ 36390 92770
0990388/2	Airwave Solutions Limited	SJ 80798 89431	SJ 76027 87856

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
0990420/2	Airwave Solutions Limited	SO 96769 99486	SP 01610 98499
0990422/2	Airwave Solutions Limited	SK 00460 03145	SK 04311 00630
0990426/2	Airwave Solutions Limited	SK 00460 03145	SP 01610 98499
0997734/2	Airwave Solutions Limited	SO 96766 88724	SO 92430 91844
0997736/2	Airwave Solutions Limited	SO 88670 89552	SO 92430 91844
0997739/2	Airwave Solutions Limited	SO 96771 88728	SO 92552 87619
0997745/3	Airwave Solutions Limited	SO 96766 88724	SO 98170 95027
0997789/4	Airwave Solutions Limited	SP 24513 89805	SP 17673 86930
0997814/3	Airwave Solutions Limited	TQ 35048 73475	TQ 39040 75220
0997818/1	Airwave Solutions Limited	SU 63615 51725	SU 61586 50238
0997837/7	Airwave Solutions Limited	TQ 33940 71230	TQ 40060 69330
0997841/4	Airwave Solutions Limited	TQ 37289 66653	TQ 40060 69330
0997843/6	Airwave Solutions Limited	TQ 37284 66646	TQ 32460 66660
1003719/1	Airwave Solutions Limited	SU 68351 09497	SU 66526 06463
1003721/4	Airwave Solutions Limited	SU 72181 07421	SU 66527 06464
1003728/4	Airwave Solutions Limited	SU 64627 01956	SU 66527 06464
1003773/1	Airwave Solutions Limited	SZ 01969 91239	SY 99795 96613
1003900/4	Airwave Solutions Limited	TQ 18777 78293	TQ 23680 77980
1003915/1	Airwave Solutions Limited	TQ 79565 11055	TQ 84320 12210
1003917/2	Airwave Solutions Limited	TQ 80087 08827	TQ 84310 12216
1004063/3	Airwave Solutions Limited	SP 75904 60415	SP 77170 64634
1004065/1	Airwave Solutions Limited	TL 06534 26506	TL 05250 21742
1004067/2	Airwave Solutions Limited	TL 06112 28319	TL 05251 21743
1004776/2	Airwave Solutions Limited	TQ 80089 13153	TQ 84310 12216
1006916/2	Airwave Solutions Limited	SK 16405 04360	SK 20950 04265
1006940/3	Airwave Solutions Limited	NZ 45530 16150	NZ 48579 14034
1006943/2	Airwave Solutions Limited	NZ 45530 16150	NZ 42299 21063
1006975/1	Airwave Solutions Limited	SJ 30593 88097	SJ 30744 91874
1006979/2	Airwave Solutions Limited	SJ 22470 86298	SJ 27034 89577
1006981/2	Airwave Solutions Limited	SJ 31462 86777	SJ 30745 91875
1006983/2	Airwave Solutions Limited	SJ 28770 91936	SJ 27034 89577
1007068/3	Airwave Solutions Limited	TQ 51400 88230	TQ 51885 92950
1007094/5	Airwave Solutions Limited	NJ 93677 06711	NJ 94281 02533
1007145/2	Airwave Solutions Limited	TM 10353 46162	TM 15787 44794
1007256/2	Airwave Solutions Limited	SO 97835 86665	SP 00799 90880
1007270/2	Airwave Solutions Limited	SO 96771 88728	SP 00799 90880
1007297/3	Airwave Solutions Limited	TQ 17943 80920	TQ 23265 86543
1007302/3	Airwave Solutions Limited	TQ 17943 80920	TQ 22346 82870
1009809/1	Airwave Solutions Limited	NZ 36861 63919	NZ 30901 64189
1009892/1	Airwave Solutions Limited	SP 84496 40164	SP 82120 35622
1010579/3	Airwave Solutions Limited	SK 97468 72055	SK 97991 65205
1010584/1	Airwave Solutions Limited	SX 49620 51726	SX 47274 56430
1010589/1	Airwave Solutions Limited	SX 51416 59907	SX 53133 55545
1010637/3	Airwave Solutions Limited	NZ 29917 56231	NZ 28698 51800
1016701/2	Airwave Solutions Limited	NZ 26597 66911	NZ 27869 71370
1016717/1	Airwave Solutions Limited	SE 08026 16447	SE 08033 22062
1016721/1	Airwave Solutions Limited	SE 15816 11819	SE 15356 07695
1016724/2	Airwave Solutions Limited	SE 15816 11819	SE 13557 06980

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
1016742/2	Airwave Solutions Limited	SE 10356 30083	SE 10923 26925
1016890/1	Airwave Solutions Limited	SK 35629 87694	SK 33334 90560
1016900/1	Airwave Solutions Limited	SP 33109 78359	SP 36929 82379
1016933/1	Airwave Solutions Limited	SX 48184 54709	SX 53133 55545
1016940/2	Airwave Solutions Limited	SU 41879 11899	SU 46662 13739
1016955/1	Airwave Solutions Limited	SX 49620 51726	SX 53133 55545
1017304/2	Airwave Solutions Limited	NS 60941 67775	NS 58333 63607
1017306/2	Airwave Solutions Limited	NS 60942 67776	NS 56957 69456
1017313/1	Airwave Solutions Limited	NS 49712 70645	NS 52837 68377
1017603/2	Airwave Solutions Limited	NS 59979 59049	NS 56551 61511
1020795/1	Airwave Solutions Limited	SP 33109 78359	SP 30034 78137
1021072/2	Airwave Solutions Limited	SK 36478 82867	SK 34200 87445
1021087/1	Airwave Solutions Limited	SK 47400 83087	SK 47261 86417
1021095/2	Airwave Solutions Limited	SU 39944 14963	SU 42398 11606
1021114/2	Airwave Solutions Limited	NS 59979 59049	NS 65200 60870
1021119/1	Airwave Solutions Limited	NO 47799 33369	NO 42859 33078
1022664/2	Airwave Solutions Limited	SU 45219 12314	SU 42382 11581
1022752/1	Airwave Solutions Limited	NS 61323 64038	NS 62585 58251
1022756/2	Airwave Solutions Limited	NS 64583 63111	NS 62586 58252
1022782/3	Airwave Solutions Limited	NS 70553 60058	NS 68862 65248
1022800/2	Airwave Solutions Limited	SK 53590 45022	SK 57274 47271
1022814/2	Airwave Solutions Limited	NT 22230 76705	NT 24866 73941
1026227/1	Airwave Solutions Limited	NS 72933 64194	NS 77656 66964
1030037/2	Airwave Solutions Limited	TQ 29136 83254	TQ 27264 85458
1030088/2	Airwave Solutions Limited	TL 19911 94660	TL 19047 98454
1030110/1	Airwave Solutions Limited	SE 26508 33290	SE 27990 36122
1030114/1	Airwave Solutions Limited	SK 53099 99858	SE 57052 03466
1030342/4	Airwave Solutions Limited	NS 75150 56790	NS 71858 53700
1030346/2	Airwave Solutions Limited	NS 77414 49717	NS 78696 54164
1030372/2	Airwave Solutions Limited	SJ 68733 86636	SJ 63682 90009
1032245/2	Airwave Solutions Limited	TG 12660 02400	TG 17315 06537
1032270/2	Airwave Solutions Limited	SJ 84503 41867	SJ 90300 45100
1032291/1	Airwave Solutions Limited	ST 15789 73563	ST 11060 74110
1032295/1	Airwave Solutions Limited	ST 15789 73563	ST 19989 73573
1032871/2	Airwave Solutions Limited	SU 72647 77324	SU 68506 73068
1033489/3	Airwave Solutions Limited	SE 17475 20729	SE 14361 16387
1033850/4	Airwave Solutions Limited	SE 18590 16106	SE 14361 16387
1033852/1	Airwave Solutions Limited	SE 17579 17943	SE 11971 17418
1035780/2	Airwave Solutions Limited	NS 54997 64570	NS 52631 68169
1036272/1	Airwave Solutions Limited	NZ 45632 16134	NZ 42397 21045
1036655/2	Airwave Solutions Limited	SK 58108 35070	SK 56481 38821
1036671/2	Airwave Solutions Limited	SJ 91234 16209	SJ 95501 20106
1038118/2	Airwave Solutions Limited	NS 61934 52870	NS 63099 56852
1038129/1	Airwave Solutions Limited	TQ 35048 73475	TQ 31157 71823
1038168/3	Airwave Solutions Limited	TQ 49404 75313	TQ 47192 70552
1038177/1	Airwave Solutions Limited	NO 43000 28400	NO 46110 31030
1038271/3	Airwave Solutions Limited	NZ 27157 59373	NZ 20744 62579
1038286/3	Airwave Solutions Limited	TL 75147 12180	TL 73059 07767

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
1038621/3	Airwave Solutions Limited	NS 75150 56790	NS 69234 56088
1038630/2	Airwave Solutions Limited	NZ 45684 31627	NZ 50710 32640
1038632/2	Airwave Solutions Limited	NZ 45684 31627	NZ 50837 30093
1039891/2	Airwave Solutions Limited	NT 25499 70570	NT 27405 74865
1044003/2	Airwave Solutions Limited	TQ 58140 94810	TQ 59123 91479
1044034/2	Airwave Solutions Limited	SJ 94192 47457	SJ 90287 45095
1044036/2	Airwave Solutions Limited	SJ 94192 47503	SJ 95654 42050
1044050/5	Airwave Solutions Limited	SD 72520 03430	SD 67520 01080
1044062/2	Airwave Solutions Limited	TQ 63844 76107	TQ 68328 77635
1044072/1	Airwave Solutions Limited	SE 28044 20616	SE 27921 26675
1044296/3	Airwave Solutions Limited	SE 60619 51779	SE 60865 56205
1046436/2	Airwave Solutions Limited	NZ 27561 62012	NZ 25046 64592
1048924/2	Airwave Solutions Limited	SK 42567 92723	SK 38891 91183
1049419/2	Airwave Solutions Limited	SK 51853 95943	SK 47128 92436
1051682/2	Airwave Solutions Limited	SK 58246 38280	SK 57801 40191
1051697/3	Airwave Solutions Limited	SK 62677 43246	SK 58582 42140
1058622/1	Airwave Solutions Limited	TQ 76711 67509	TQ 70415 66285
1061648/3	Airwave Solutions Limited	SP 05518 80115	SP 04030 83910
1073842/1	Airwave Solutions Limited	NZ 34793 73684	NZ 33698 69062
1076792/1	Airwave Solutions Limited	TQ 40151 92284	TQ 32090 96689
1076818/1	Airwave Solutions Limited	SP 01063 85330	SO 98959 81443
1078805/1	Airwave Solutions Limited	SU 56520 03622	SU 60730 00230
1078989/1	Airwave Solutions Limited	NT 18749 71267	NT 25055 69440
1081344/1	Airwave Solutions Limited	SP 88076 34175	SP 85107 38627
1081346/1	Airwave Solutions Limited	NS 61932 52865	NS 56011 53124
1081555/1	Airwave Solutions Limited	SK 61411 01075	SK 59300 04750
1082973/1	Airwave Solutions Limited	TQ 43160 72110	TQ 48303 75382
1084630/1	Airwave Solutions Limited	ST 76957 65491	ST 72880 65920
1089635/2	Airwave Solutions Limited	SU 67227 73942	SU 71148 73387
1092127/1	Airwave Solutions Limited	ST 57391 66513	ST 50671 66487
1092154/1	Airwave Solutions Limited	SP 34227 83832	SP 36930 82380
1092158/1	Airwave Solutions Limited	TQ 75739 61352	TQ 75956 56170
1092160/1	Airwave Solutions Limited	TQ 75739 61352	TQ 81399 58666
1093578/1	Airwave Solutions Limited	SK 34850 83160	SK 32380 87189
1095072/2	Airwave Solutions Limited	SP 54460 04067	SP 48343 02928
1095076/1	Airwave Solutions Limited	TL 52429 57754	TL 48271 55499
1105112/1	Airwave Solutions Limited	ST 57391 66513	ST 58795 72818
1110374/2	Airwave Solutions Limited	TG 22549 05665	TG 25730 02780
1110540/1	Airwave Solutions Limited	SP 32002 86850	SP 33575 80940
1112282/1	Airwave Solutions Limited	ST 12359 83593	ST 11568 88061
1112507/1	Airwave Solutions Limited	SU 47300 66990	SU 52865 66117
1113178/1	Airwave Solutions Limited	SJ 58764 83740	SJ 53570 82947
1113182/1	Airwave Solutions Limited	SJ 41227 86637	SJ 38050 89122
1113200/2	Airwave Solutions Limited	TQ 32863 79942	TQ 29220 81925
1115064/1	Airwave Solutions Limited	SJ 41226 86637	SJ 43410 82593
1115260/1	Airwave Solutions Limited	SU 47300 66990	SU 46980 72626
1117285/1	Airwave Solutions Limited	SJ 31015 94219	SJ 34599 95879
1118116/1	Airwave Solutions Limited	TQ 02020 78200	SU 98205 79803

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
1129633/1	Airwave Solutions Limited	SP 56629 10513	SP 50580 09010
1129635/1	Airwave Solutions Limited	SP 51328 05770	SP 48348 02927
1130174/1	Airwave Solutions Limited	SU 76770 73180	SU 71152 73411
1130687/1	Airwave Solutions Limited	SK 53958 19888	SK 54149 24818
1136696/1	Airwave Solutions Limited	SK 50363 43533	SK 45591 46480
1137072/1	Airwave Solutions Limited	TQ 38393 57220	TQ 33578 53353
1138900/2	Airwave Solutions Limited	NS 82900 64820	NS 77664 66950
1139774/2	Airwave Solutions Limited	TQ 24431 81181	TQ 27286 85386
1145330/1	Airwave Solutions Limited	SP 05419 75570	SP 10655 79580
1145333/1	Airwave Solutions Limited	SP 05419 75570	SP 00680 73700
1145340/2	Airwave Solutions Limited	SE 29966 29919	SE 30515 34380
1148893/1	Airwave Solutions Limited	TR 26577 46633	TR 30499 44481
1148895/1	Airwave Solutions Limited	TR 31890 40338	TR 27405 39738
1149208/1	Airwave Solutions Limited	SO 94800 22000	SO 99364 24808
1150467/1	Airwave Solutions Limited	SJ 80750 48428	SJ 74490 47661
1152251/1	Airwave Solutions Limited	SU 65439 75927	SU 64720 81306
1154227/1	Airwave Solutions Limited	SE 36214 34490	SE 29986 34096
1155811/1	Airwave Solutions Limited	SP 04694 93068	SP 00799 90880
1158721/1	Airwave Solutions Limited	SU 93640 75310	SU 95104 80944
1169526/1	Airwave Solutions Limited	NZ 26617 66906	NZ 25653 62754
1173685/1	Airwave Solutions Limited	SK 35226 86131	SK 32380 87189
1179561/2	Airwave Solutions Limited	TQ 49772 85444	TQ 44320 86664
1179791/1	Airwave Solutions Limited	NZ 26822 60274	NZ 25653 62754
1220021/1	Airwave Solutions Limited	TQ 67635 69840	TQ 63682 74131
1245526/1	Airwave Solutions Limited	TQ 39560 91650	TQ 32070 96672
1245841/1	Airwave Solutions Limited	TQ 38540 57308	TQ 33578 53353
1262996/1	Airwave Solutions Limited	TQ 32100 62350	TQ 28980 58499
0480790/1	Arqiva Limited	TL 48100 63000	TL 39200 59400
0489682/1	Arqiva Limited	TL 12800 91500	TL 17800 96900
1217812/1	Arqiva Limited	SS 67180 94020	SS 65800 93080
1217813/1	Arqiva Limited	SS 67180 94020	SS 65800 93080
1094644/2	Associated British Ports	SU 41883 10755	SU 43203 07886
1098138/1	Associated British Ports	SU 41911 10507	SU 39353 12213
1098142/1	Associated British Ports	SU 41906 10503	SU 37796 11584
0958905/1	British Telecommunications Public Limited Company	SK 93950 68160	SK 97988 65205
1001761/3	British Telecommunications Public Limited Company	TA 11825 30289	TA 09410 28650
1001778/3	British Telecommunications Public Limited Company	TA 07815 31745	TA 09410 28650
1002254/2	British Telecommunications Public Limited Company	TA 10344 32330	TA 09410 28650
1002278/2	British Telecommunications Public Limited Company	TA 10520 30978	TA 09410 28650
1045099/1	British Telecommunications Public Limited Company	TA 07297 28731	TA 09410 28650
1061680/2	British Telecommunications Public Limited Company	SK 43520 81310	SK 46940 76987
1064991/1	British Telecommunications Public Limited Company	TQ 53220 96360	TQ 59730 94000
1066983/1	British Telecommunications Public Limited Company	TQ 93550 86600	TQ 87429 85848
1069985/1	British Telecommunications Public Limited Company	SJ 47124 08041	SJ 49350 12250
1101004/1	British Telecommunications Public Limited Company	SK 35051 36161	SK 39545 36877
1101995/1	British Telecommunications Public Limited Company	TQ 03036 60280	TQ 00651 58595
1104584/1	British Telecommunications Public Limited Company	TL 66750 05500	TL 70820 07070
1104606/1	British Telecommunications Public Limited Company	TL 71190 09560	TL 70820 07070

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
1104614/1	British Telecommunications Public Limited Company	TL 34300 04400	TL 36155 00604
1134556/1	British Telecommunications Public Limited Company	SE 60620 51780	SE 66520 47670
1165122/1	British Telecommunications Public Limited Company	TQ 07900 78750	TQ 09880 79960
1180045/2	British Telecommunications Public Limited Company	SE 30000 30870	SE 31161 28207
1196621/1	British Telecommunications Public Limited Company	TA 08247 29972	TA 09410 28650
1199982/1	British Telecommunications Public Limited Company	TA 07815 31745	TA 09410 28650
1200003/1	British Telecommunications Public Limited Company	TA 03565 28961	TA 09410 28650
1200718/1	British Telecommunications Public Limited Company	TA 10773 34382	TA 09410 28650
1132154/1	C.E.M. Day Limited	SS 67180 94020	SS 66866 96594
1106162/1	DRW NX UK LTD	TQ 32941 81954	TQ 29222 81925
1126267/2	DRW NX UK LTD	SU 94828 81384	TQ 01405 81010
1152400/2	DRW NX UK LTD	SU 94823 81381	TQ 01405 81010
1152417/2	DRW NX UK LTD	SU 94823 81381	TQ 01405 81010
1225453/2	DRW NX UK LTD	SU 94823 81381	TQ 01405 81010
1267960/1	DRW NX UK LTD	SU 94828 81384	TQ 01405 81010
1267970/2	DRW NX UK LTD	SU 94828 81384	TQ 01405 81010
1272820/1	DRW NX UK LTD	TQ 33740 82307	TQ 29223 81925
0502723/1	EE Limited	SO 96820 88710	SO 91900 86750
0513451/1	EE Limited	SD 35780 39060	SD 32750 33850
0822745/1	Ingenitech Ltd	SJ 73802 96948	SJ 77552 98319
0921179/1	Ingenitech Ltd	SD 77537 01668	SJ 81772 97093
0966774/1	Ingenitech Ltd	SD 77562 01643	SJ 78832 92084
1013011/3	Ingenitech Ltd	SD 77562 01643	SJ 75147 96933
1030677/1	Ingenitech Ltd	SD 77562 01643	SJ 81621 98778
1044701/1	Joint Radio Company Limited	SK 49667 89717	SK 50176 92287
1045019/2	Joint Radio Company Limited	SE 60370 06140	SE 56668 03580
1045418/2	Joint Radio Company Limited	SE 11920 22010	SE 12500 19700
1049732/1	Joint Radio Company Limited	SK 31132 96884	SK 26433 99072
1199266/1	KBR (Keeping Business Running) Limited	NZ 56759 24163	NZ 54189 16131
1206900/1	KBR (Keeping Business Running) Limited	NZ 45874 15999	NZ 54189 16131
1265905/1	KBS Maritime Limited	SZ 62687 99273	SU 61970 01251
0735087/3	London Borough of Hounslow	TQ 18339 78035	TQ 13438 76316
0735099/3	London Borough of Hounslow	TQ 13365 77829	TQ 13438 76316
0753708/1	London Borough of Hounslow	TQ 10295 73496	TQ 13438 76316
0809500/1	London Borough of Hounslow	TQ 10295 73496	TQ 11534 75100
0818794/1	London Borough of Hounslow	TQ 18339 78035	TQ 15715 74637
0823745/2	London Borough of Hounslow	TQ 18339 78035	TQ 15715 74637
0814194/2	M247 UK Limited	SD 88416 02108	SJ 84075 97678
0850480/4	M247 UK Limited	SP 13279 87203	SP 06415 86827
0868351/1	M247 UK Limited	SJ 85759 99733	SJ 89035 93398
0870169/3	M247 UK Limited	SJ 85759 99733	SJ 85404 95024
0870173/1	M247 UK Limited	SD 88373 02180	SJ 89044 96631
0873386/2	M247 UK Limited	SJ 34044 90811	SJ 34380 95020
0903655/1	M247 UK Limited	SJ 79319 94150	SJ 77818 97419
0923600/1	M247 UK Limited	SE 30260 34242	SE 30250 36724
0936047/1	M247 UK Limited	SJ 91336 93140	SJ 87525 95373
0967603/2	M247 UK Limited	SD 88373 02180	SD 91052 05917
0971324/1	M247 UK Limited	SE 41580 33996	SE 36103 36759

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
0972729/1	M247 UK Limited	SP 07362 87239	SP 07701 84159
0976739/1	M247 UK Limited	SJ 85783 97385	SJ 87525 95373
0983353/1	M247 UK Limited	SJ 85043 90584	SJ 87525 95373
0997412/1	M247 UK Limited	SE 40959 33752	SE 36104 36777
1011277/2	M247 UK Limited	SJ 78076 97222	SJ 84082 98431
1025496/3	M247 UK Limited	SJ 79319 94150	SJ 71708 93175
1031769/3	M247 UK Limited	SJ 77636 95689	SJ 76386 92588
1073709/3	M247 UK Limited	SD 88373 02180	SD 91478 04597
1074414/1	M247 UK Limited	SJ 89754 89437	SJ 98338 82313
1074453/2	M247 UK Limited	SE 29699 34637	SE 36104 36777
1078669/1	M247 UK Limited	SJ 43390 99264	SJ 34246 95623
1084691/1	M247 UK Limited	NZ 32067 68668	NZ 24990 64664
1090181/1	M247 UK Limited	SE 25960 38940	SE 24419 28571
1097251/2	M247 UK Limited	NZ 23268 63573	NZ 28060 67763
1098681/1	M247 UK Limited	SP 13279 87203	SP 20283 91780
1102801/2	M247 UK Limited	SJ 59526 88044	SJ 50871 92591
1107862/2	M247 UK Limited	SJ 43187 82722	SJ 51738 76932
1108766/2	M247 UK Limited	SJ 42652 96225	SJ 34265 95569
1113289/1	M247 UK Limited	SJ 80935 98938	SD 69937 05232
1115935/1	M247 UK Limited	SP 11793 89694	SP 06463 86735
1117555/1	M247 UK Limited	SJ 80801 89421	SJ 89261 90120
1117906/1	M247 UK Limited	SE 29374 33492	SE 20863 29222
1121471/1	M247 UK Limited	SJ 88043 99710	SD 84165 08401
1124519/2	M247 UK Limited	SP 15567 91888	SP 06463 86735
1124549/1	M247 UK Limited	SJ 43186 82720	SJ 42002 74993
1141951/1	M247 UK Limited	SJ 89803 89342	SJ 95864 88517
1148284/1	M247 UK Limited	SE 17011 33480	SE 07888 31698
1151566/1	M247 UK Limited	SJ 35815 94045	SJ 34285 95543
1152961/2	M247 UK Limited	SD 70783 07554	SD 74621 17637
1153120/2	M247 UK Limited	SD 88419 02100	SJ 93713 96854
0998384/1	Mckay Brothers Communications Ltd	TR 07793 59033	TR 30486 44440
0998385/1	Mckay Brothers Communications Ltd	TR 07793 59033	TR 30486 44440
1002605/1	Mckay Brothers International SA	TQ 72238 90336	TQ 80365 87712
1002606/1	Mckay Brothers International SA	TQ 72238 90336	TQ 80365 87712
1002620/1	Mckay Brothers International SA	TQ 72238 90336	TQ 80365 87712
1002623/1	Mckay Brothers International SA	TQ 72238 90336	TQ 80365 87712
1118054/1	Mckay Brothers International SA	SU 94826 81383	SU 97924 80194
1118067/1	Mckay Brothers International SA	SU 94826 81383	SU 97924 80194
1122129/1	Mckay Brothers International SA	SU 94826 81383	SU 97965 80235
1122418/1	Mckay Brothers International SA	SU 94826 81383	SU 97965 80235
1131954/2	Mckay Brothers International SA	SU 94822 81383	SU 97963 80195
0881141/1	Mobile Broadband Network Limited	SD 87215 00814	SJ 93107 98422
0881886/1	Mobile Broadband Network Limited	TQ 23259 75309	TQ 28517 80103
1056121/1	Mobile Broadband Network Limited	NO 39996 24300	NO 36297 29711
1066266/1	Mobile Broadband Network Limited	SK 33797 91653	SK 32444 87070
1088601/4	Mobile Broadband Network Limited	SS 56678 95080	SS 61156 99197
1197700/1	National Grid Telecoms Limited	ST 26156 84881	ST 32517 83805
1197766/1	National Grid Telecoms Limited	SS 61387 94072	SS 52661 99548

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
1197772/1	National Grid Telecoms Limited	ST 17218 81337	ST 15571 74826
1197775/1	National Grid Telecoms Limited	ST 14722 68874	ST 15571 74826
1197852/1	National Grid Telecoms Limited	ST 16911 79333	ST 15571 74826
1197884/1	National Grid Telecoms Limited	SX 49739 51801	SX 49469 54221
1197896/1	National Grid Telecoms Limited	ST 18370 84147	ST 15571 74826
1197899/1	National Grid Telecoms Limited	SP 01900 77605	SO 96000 78500
1198050/2	National Grid Telecoms Limited	SO 99000 81200	SO 96000 78500
1198051/1	National Grid Telecoms Limited	SO 83900 54800	SO 86000 52100
1198060/1	National Grid Telecoms Limited	SJ 94100 47500	SJ 94400 48800
1198085/1	National Grid Telecoms Limited	SP 79400 61100	SP 77000 56900
1198100/1	National Grid Telecoms Limited	SJ 92400 04000	SO 91400 99100
1198101/1	National Grid Telecoms Limited	SJ 95300 00100	SO 91000 96700
1198127/1	National Grid Telecoms Limited	SK 95488 69056	SK 98110 65152
1198130/1	National Grid Telecoms Limited	SO 97497 93263	SO 96684 89308
1198131/1	National Grid Telecoms Limited	SO 92232 87923	SO 96684 89308
1198184/1	National Grid Telecoms Limited	SS 67195 94023	SS 73946 93357
1030429/1	New Line Networks LLC	TQ 36460 78481	TQ 30206 78692
1030430/1	New Line Networks LLC	TQ 36460 78481	TQ 30206 78692
1030432/1	New Line Networks LLC	TQ 36460 78481	TQ 37650 79150
1030444/1	New Line Networks LLC	TQ 36460 78481	TQ 37650 79150
1126159/1	New Line Networks LLC	TQ 72248 90425	TQ 80390 87730
1126163/1	New Line Networks LLC	TQ 72248 90425	TQ 80390 87730
1126354/1	New Line Networks LLC	TQ 32941 81954	TQ 29223 81928
1126355/1	New Line Networks LLC	TQ 32941 81954	TQ 29223 81928
1132459/1	New Line Networks LLC	SU 94827 81387	TQ 07289 78404
1132464/1	New Line Networks LLC	SU 94827 81387	TQ 07289 78404
1153197/1	New Line Networks LLC	TQ 71571 90360	TQ 65006 89488
1153204/1	New Line Networks LLC	TQ 71571 90360	TQ 65006 89488
0959444/2	PD Teesport Limited	NZ 51196 20820	NZ 54326 23391
0959461/2	PD Teesport Limited	NZ 51959 34214	NZ 54326 23391
0959466/3	PD Teesport Limited	NZ 51959 34214	NZ 55720 28261
0959470/2	PD Teesport Limited	NZ 51959 34214	NZ 52648 33449
0959477/3	PD Teesport Limited	NZ 54903 24696	NZ 54362 23391
0879678/1	Port Of London Authority Limited	TQ 50741 79328	TQ 43574 76565
1046650/3	Port Of London Authority Limited	TQ 44465 80843	TQ 41714 79293
0940683/1	Qinetiq Group Plc	TR 03535 93283	TQ 95984 87619
0805855/1	Sandwell Homes Limited	SP 00851 91965	SP 02319 95642
0987029/3	Scot-Tel-Gould Limited	NJ 96642 03811	NJ 91100 06897
1180446/2	Trellisworks Limited	SU 40053 13950	SU 37418 13822
1181180/1	Trellisworks Limited	SU 41663 11964	SU 37418 13822
1181940/1	Trellisworks Limited	SU 40053 13950	SU 43182 12565
1189221/1	Trellisworks Limited	TQ 43548 88577	TQ 45071 88823
1217456/1	Trellisworks Limited	TQ 30910 95696	TQ 35355 93998
1245492/1	Trellisworks Limited	SU 40053 13950	SU 38212 13000
0495407/1	Vodafone Limited	TQ 21007 81541	TQ 24409 82119
0503062/1	Vodafone Limited	SE 32950 21110	SE 33100 20640
0796028/2	Vodafone Limited	SP 40200 77600	SP 37206 79380
0867517/3	Vodafone Limited	TQ 07004 91591	TQ 11111 89928

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
0869020/4	Vodafone Limited	TL 14885 00036	TL 10716 03372
0872146/4	Vodafone Limited	TQ 56000 71830	TQ 56576 69010
0949738/1	Vodafone Limited	SJ 93650 00400	SO 91430 99080
0949783/1	Vodafone Limited	SE 57700 02800	SE 57060 03480
0949805/1	Vodafone Limited	SD 65820 14930	SD 66440 09160
0949993/1	Vodafone Limited	TQ 13320 75530	TQ 09850 70050
0949997/1	Vodafone Limited	ST 29450 95300	ST 31100 88060
0950020/1	Vodafone Limited	NZ 24430 64430	NZ 25050 64580
0950022/1	Vodafone Limited	NZ 27300 70700	NZ 25050 64580
0950030/1	Vodafone Limited	NZ 51550 26050	NZ 57040 18290
0950036/1	Vodafone Limited	SK 55700 38000	SK 56490 38810
0950047/1	Vodafone Limited	SJ 87600 46030	SJ 87600 45690
0950055/1	Vodafone Limited	SK 55700 38000	SK 56490 38810
0950057/1	Vodafone Limited	SK 56920 39780	SK 57470 38990
0950058/1	Vodafone Limited	SK 56920 39780	SK 57390 40220
0950073/1	Vodafone Limited	NS 51630 67130	NS 46020 59310
0950077/1	Vodafone Limited	SS 67200 94000	SS 75550 97560
0950089/1	Vodafone Limited	TF 18150 00400	TL 18200 96450
0950090/1	Vodafone Limited	TF 18150 00400	TL 15250 95350
0950132/1	Vodafone Limited	TL 46600 55200	TL 44750 57900
0950368/1	Vodafone Limited	SO 97800 96000	SO 91430 99080
0950370/1	Vodafone Limited	SP 91450 34230	SP 89712 35276
0950392/1	Vodafone Limited	SP 84500 40220	SP 90120 38379
0950439/1	Vodafone Limited	TQ 31380 79630	TQ 30200 78750
0950447/1	Vodafone Limited	NW 46187 29308	NW 47900 32900
0950477/3	Vodafone Limited	SJ 26050 90760	SJ 35900 90730
0950492/1	Vodafone Limited	TQ 66346 88151	TQ 68110 86610
0950515/1	Vodafone Limited	SJ 39400 96400	SJ 38000 96800
0950785/1	Vodafone Limited	SD 66300 14700	SD 67200 03400
0951150/1	Vodafone Limited	SD 53850 29550	SD 54450 33600
1038986/1	Vodafone Limited	TQ 16183 73575	TQ 16801 71370
1038990/1	Vodafone Limited	TQ 16183 73575	TQ 16801 71370
1040730/1	Vodafone Limited	TQ 19360 85605	TQ 21820 82680
1048465/1	Vodafone Limited	TQ 54702 94560	TQ 59140 91560
1048697/1	Vodafone Limited	TQ 54702 94560	TQ 59140 91560
1048766/3	Vodafone Limited	TL 14885 00036	TL 10716 03372
1053162/1	Vodafone Limited	TQ 40813 91728	TQ 41582 88544
1085193/1	Vodafone Limited	TQ 06866 81845	TQ 04227 77616
1089272/1	Vodafone Limited	NZ 51170 26317	NZ 57038 18264
1097444/1	Vodafone Limited	SU 65569 04199	SU 66558 06451
1116256/2	Vodafone Limited	ST 23185 78860	ST 18337 76671
1171022/1	Vodafone Limited	TQ 40472 85289	TQ 39371 86877
1225417/1	Vodafone Limited	NW 46190 29225	NW 43825 29762
1281669/1	Voneus Limited	SS 61397 94069	SN 62787 04183
1281674/1	Voneus Limited	SN 63494 04012	SS 67629 94058
1281675/1	Voneus Limited	SS 61397 94069	SS 53509 88604
0916544/5	WATMOS Community Homes	SP 01987 98486	SJ 99516 02379
0993901/2	Zycomm Electronics Limited	SK 35206 36495	SK 37552 42137

Table A2.2: 26 GHz links operating around high density areas, which coexistence analysis shows are likely to receive interference from new mobile services in high density areas

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
0497862/2	Airwave Solutions Limited	SU 71560 20240	SU 69300 25050
0502848/3	Airwave Solutions Limited	NZ 15445 73835	NZ 08700 70400
0509836/3	Airwave Solutions Limited	SK 47750 71950	SK 51617 75861
0509837/3	Airwave Solutions Limited	SK 51800 95900	SK 51473 90072
0510682/3	Airwave Solutions Limited	SJ 52628 45064	SJ 54751 44699
0511180/3	Airwave Solutions Limited	SK 29500 55320	SK 30494 51623
0511198/3	Airwave Solutions Limited	SK 26799 94025	SK 27500 99100
0511199/3	Airwave Solutions Limited	SE 25792 04548	SK 27500 99100
0511881/2	Airwave Solutions Limited	TR 20860 43923	TR 22320 43020
0526463/4	Airwave Solutions Limited	SE 43479 39311	SE 44079 40204
0567043/2	Airwave Solutions Limited	SE 04815 11125	SE 05880 13860
0587159/2	Airwave Solutions Limited	SH 83682 76671	SH 86206 78487
0820758/1	Airwave Solutions Limited	SY 59459 90077	SY 63817 90465
0987924/1	Airwave Solutions Limited	SJ 95217 58716	SJ 99976 56162
0987957/3	Airwave Solutions Limited	SD 63271 10522	SD 61791 13461
0987998/2	Airwave Solutions Limited	SD 56458 25786	SD 59205 23408
0990368/2	Airwave Solutions Limited	SJ 72604 83104	SJ 77938 83073
0990403/1	Airwave Solutions Limited	TQ 36250 06997	TQ 41764 11226
0995266/3	Airwave Solutions Limited	SE 40647 47392	SE 38049 44239
0995268/2	Airwave Solutions Limited	SE 41877 43660	SE 44679 45667
0995272/1	Airwave Solutions Limited	SE 32865 45220	SE 38049 44239
0997751/3	Airwave Solutions Limited	SJ 67475 61178	SJ 67129 66977
0997787/4	Airwave Solutions Limited	SP 24513 89805	SP 22326 96909
1003733/2	Airwave Solutions Limited	SU 47115 08917	SU 50837 08869
1003789/1	Airwave Solutions Limited	SU 85841 35393	SU 83399 36286
1003799/1	Airwave Solutions Limited	SU 44910 29518	SU 41796 27039
1007060/2	Airwave Solutions Limited	SU 44932 29518	SU 48284 33432
1007178/2	Airwave Solutions Limited	TM 25916 49588	TM 24981 44864
1009780/1	Airwave Solutions Limited	TL 17031 13607	TL 18600 19618
1009785/1	Airwave Solutions Limited	TL 22362 16138	TL 18600 19618
1010543/1	Airwave Solutions Limited	SJ 91799 82499	SJ 97361 81479
1010547/1	Airwave Solutions Limited	SJ 94049 84733	SJ 97361 81479
1016839/1	Airwave Solutions Limited	SU 87913 95550	SU 86212 92549
1017296/2	Airwave Solutions Limited	SU 42626 05078	SU 45345 02662
1017299/1	Airwave Solutions Limited	SU 19746 05041	SU 19329 00229
1020798/1	Airwave Solutions Limited	SP 32930 66383	SP 32439 71768
1020811/2	Airwave Solutions Limited	NS 27758 74943	NS 31825 73883
1022670/1	Airwave Solutions Limited	TQ 12480 43980	TQ 06110 47160
1028624/3	Airwave Solutions Limited	TQ 87260 60629	TQ 89030 62765
1029054/2	Airwave Solutions Limited	SE 69739 13774	SE 68250 07329
1029958/1	Airwave Solutions Limited	SE 47970 13002	SE 51945 07968
1030052/2	Airwave Solutions Limited	SJ 53768 81527	SJ 51959 76661
1030354/4	Airwave Solutions Limited	SK 57229 94805	SK 60435 88353
1030368/2	Airwave Solutions Limited	SJ 56891 97738	SJ 51147 95739
1033904/4	Airwave Solutions Limited	SE 44205 22149	SE 48892 19609

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
1037986/1	Airwave Solutions Limited	SK 54081 85717	SK 51473 90072
1038016/1	Airwave Solutions Limited	TQ 76264 87623	TQ 79180 83255
1038106/1	Airwave Solutions Limited	SK 74717 81813	SK 70825 80410
1040857/3	Airwave Solutions Limited	TQ 02002 91469	TQ 05662 94545
1041589/1	Airwave Solutions Limited	TQ 82641 59875	TQ 89030 62765
1046442/2	Airwave Solutions Limited	SU 81702 91785	SU 84798 92257
1049421/3	Airwave Solutions Limited	SK 51852 95943	SK 48215 98770
1051717/3	Airwave Solutions Limited	SK 06982 43069	SK 03042 43518
1058610/1	Airwave Solutions Limited	SE 43063 15479	SE 39479 13851
1059917/1	Airwave Solutions Limited	NZ 45188 36888	NZ 43259 41508
1059924/1	Airwave Solutions Limited	TQ 96511 50472	TR 01670 50485
1064571/1	Airwave Solutions Limited	SP 90180 89760	SP 96210 93042
1074755/1	Airwave Solutions Limited	SU 87930 95567	SU 95797 95512
1088409/1	Airwave Solutions Limited	SO 93248 83820	SO 96050 78565
1103383/1	Airwave Solutions Limited	TQ 33903 30678	TQ 28375 30990
1115069/1	Airwave Solutions Limited	ST 51664 98077	ST 55076 94554
1116893/1	Airwave Solutions Limited	SO 94765 73005	SO 96050 78565
1117279/1	Airwave Solutions Limited	SJ 52720 74960	SJ 58640 71440
1120024/1	Airwave Solutions Limited	TM 25894 75823	TM 24701 82554
1148056/2	Airwave Solutions Limited	TR 22913 38206	TR 27405 39738
1150465/1	Airwave Solutions Limited	SU 50380 79008	SU 52116 74131
1150544/1	Airwave Solutions Limited	SU 85655 94255	SU 86899 92938
1152254/1	Airwave Solutions Limited	SU 65846 86265	SU 64720 81306
1159603/1	Airwave Solutions Limited	NY 94485 89586	NY 99387 85511
1236345/1	Airwave Solutions Limited	SE 16807 46634	SE 21021 44585
1065333/2	Aquila Air Traffic Management Services Limited	SE 39216 79065	SE 37730 72407
1082461/2	Aquila Air Traffic Management Services Limited	SJ 47791 22930	SJ 54389 22431
1092601/2	Aquila Air Traffic Management Services Limited	SK 91806 16207	SK 99444 07221
1109513/3	Aquila Air Traffic Management Services Limited	SU 25076 35040	SU 29591 37985
0464291/1	Arqiva Limited	ST 78800 96500	ST 66600 90100
1079203/1	Arqiva Limited	SU 85650 94240	SU 87700 91090
1268543/1	Arqiva Limited	SE 26830 55600	SE 21150 51440
1094648/1	Associated British Ports	SU 48800 02500	SU 43200 07800
1098140/1	Associated British Ports	SU 48840 02526	SU 49223 05285
0800457/1	British Telecommunications Public Limited Company	TG 38520 03370	TG 25850 02660
1041509/2	British Telecommunications Public Limited Company	SU 71570 20210	SU 74450 23400
1057739/1	British Telecommunications Public Limited Company	NZ 60770 22201	NZ 60450 25100
1057745/1	British Telecommunications Public Limited Company	NZ 28606 14649	NZ 31880 17700
1060758/1	British Telecommunications Public Limited Company	ST 16505 89610	ST 15290 86730
0839858/1	EE Limited	SK 51950 95950	SE 51800 07950
1158959/1	Joint Radio Company Limited	NS 64382 74410	NS 74855 81164
1131949/1	Mckay Brothers International SA	TQ 82877 83781	TQ 79838 82436
0456115/1	MLL Telecom Ltd	NZ 18400 47400	NZ 21000 45000
0881296/1	Mobile Broadband Network Limited	TL 12700 91300	TF 07249 00706
0902317/2	Mobile Broadband Network Limited	NW 23620 47251	NW 27709 44846
1004125/1	Mobile Broadband Network Limited	SD 52215 75470	SD 49627 69552
1011743/1	Mobile Broadband Network Limited	SP 62372 50638	SP 68918 46742

Licence number	Licence holder name	Station 1 NGR	Station 2 NGR
1019390/1	Mobile Broadband Network Limited	TM 09758 52750	TM 04374 58420
1046066/1	Mobile Broadband Network Limited	SK 60326 82154	SK 59279 87809
1098622/1	Mobile Broadband Network Limited	SP 82441 03544	SP 82855 09328
1113603/1	Mobile Broadband Network Limited	SD 52217 75466	SD 48584 69202
1129932/1	Mobile Broadband Network Limited	SE 09493 04075	SE 14714 08384
1188791/1	Mobile Broadband Network Limited	SK 41558 53417	SK 38911 59538
1197873/1	National Grid Telecoms Limited	ST 51663 98075	ST 50752 87639
1197883/1	National Grid Telecoms Limited	SS 97955 67590	ST 02633 74094
1197936/1	National Grid Telecoms Limited	SP 77700 36200	SP 76900 31800
1197967/1	National Grid Telecoms Limited	SK 30665 51514	SK 28262 45380
1197994/1	National Grid Telecoms Limited	SO 96900 83900	SO 96000 78500
1198002/1	National Grid Telecoms Limited	SK 46200 39100	SK 49509 35744
1198009/1	National Grid Telecoms Limited	SJ 98600 14500	SJ 98800 09300
1198190/1	National Grid Telecoms Limited	SS 84752 82801	SS 78354 86832
1154983/2	New Line Networks LLC	TR 30711 50424	TR 20929 53431
1154991/3	New Line Networks LLC	TR 30711 50424	TR 20929 53431
0959474/3	PD Teesport Limited	NZ 54903 24696	NZ 55720 28261
0505493/1	Vodafone Limited	SK 53440 28780	SK 50845 25472
0505495/1	Vodafone Limited	SK 48775 32200	SK 49510 35740
0903548/1	Vodafone Limited	SU 92619 69341	SU 94090 67580
0950091/1	Vodafone Limited	TL 24400 13400	TL 29170 06700
0953872/1	Vodafone Limited	SD 37405 07414	SD 39061 11140
1016515/1	Vodafone Limited	SO 93857 02345	ST 97856 97828
1042776/1	Vodafone Limited	NS 70307 70069	NS 66465 68770
1059637/1	Zycomm Electronics Limited	SK 21954 48722	SK 24878 39515